Land Type Resource Digitisation

GEOG309 - Assignment 4

Research Project Final Report

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Executive Summary

- **Context:**

  To update current land type resources to a digital platform in order to improve the efficiency and effectiveness of decision making regarding land use in New Zealand. Significant land use change will have to be carried out for New Zealand's economy to adapt to the challenges of the 21st century. This report places emphasis on the proposition that land typing will be integral to this.

- **Research Question:**

  How feasible and beneficial is it to convert current land type resources to a digital platform?

- **Literature Review:**

  Conceptual literature review includes New Zealand Coastal Policy Statement Policy 15C which regards land typing as an important method in protecting the natural features of the coastal landscape. Also, Vivid Economics: Net Zero In New Zealand, which highlights the need for land typing in achieving New Zealand's emissions goals. Technical Literature review discusses details regarding the choice of platform and the technical aspects of the approach to land type digitisation.

- **Methodology:**

  Convert Di Lucas associates land type maps to a digital platform. First an appropriate platform had to be selected, then the maps had to be uploaded, georeferenced and feature enhanced for usability and effectiveness. This was a difficult process but the results show it is possible, and a useful tool in visualising land type information.

  The digital platform chosen was Google Earth. The KML file, which included a variety of image layers was overlaid on Google Earth's topographic base map. This demo was provided to five professionals who worked through a task sheet and questionnaire which gave the group qualitative feedback data.

- **Results:**

  A KML file was displayed using Google Earth which had functions and capabilities to those who have limited GIS knowledge. Key features included in the final product are; pop-ups showing visuals and data extracted from the report, legend, 3D functionality and interchangeable layers.

Responses suggested that there is a need for a land typing program that spans across New Zealand. Benefits would include a better understanding of land-typing, data collated together on one database, and improvement of decision making. The created KML was interactive and user friendly, while also providing a basic overview of the specified area. It was not suitable for professional end users, due to limited data processing and analytical features.

- **Discussion:**

Project limitations included the short time frame of the project, and the format of maps that were digitised which limited their quality and processing capabilities. Future research should be centered around optimising the platform for data processing to make it more functional for industry professionals. Investigation into funding should also be conducted to ensure the research and longevity of an enhanced platform.

- **Conclusion:**

The final platform was limited in its capabilities in a professional context due to its limited GIS processing power. The platform is effective as purely a visualisation tool. A different way to approach this research that would provide more beneficial results would be to digitise raw data instead of PDF files.

Introduction

This report summarises the research carried out by Megan Brown, Cameron Chappell, Fraser Dixon, and Sean Potter between July 29th and October 7th 2017, as part of the University of Canterbury Geography 309 paper: Research Methods in Geography. The research question investigated was, "How feasible and beneficial is it to convert current land type resources to a digital platform?" A land type is a combination of characteristics of land. Such as; geology, lithology, climate, and vegetation. The combination of these characteristics is used to differentiate between areas of land, for example; alluvial flood plain, semi-arid mountain range, inland basin, soft rock hill. This has important implications regarding appropriate land use of an environment.

This report includes the following sections; Introduction, Literature Review, Methodology, Results, Discussion, and Conclusion. The aim of this research was to investigate the feasibility and benefits of updating land type resources by converting existing Lucas Associates land type maps of the Mackenzie District Subzone onto a digital platform. The research objective was to find an effective methodology that could be replicated to convert larger areas of land type information to a digital platform that could be used by professionals to assist in land use decisions. This is important as current land type resources are very limited in that they only exist in the physical form. There is no central database of land type information for any area, region or the whole of New Zealand. This leaves individuals and businesses who need this information, like landscape architects, property developers, and regional councils, limited in their access to the information that could be vital in checking the feasibility of their subdivision development, dairy farm conversion, or planned future land use respectively. If a decentralised open source land type platform was operational in New Zealand, more appropriate decisions could be made around land use change.

Literature Review

Conceptual

A conceptual overview of the purpose of research begins with a review of the Department of Conservation Coastal Policy Statement (2010). In Policy 15C, land typing is regarded as an important method in protecting the natural features and natural landscapes of the coastal environment from inappropriate subdivision, use, and development. Land typing does this by "identifying and assessing the natural features and natural landscapes of the coastal environment of the region or district." The fact that land typing can play a part in New Zealand policy development gives further purpose to the proposed research and shows that success of the project could have real world implications.

To further give contextual purpose to research project, Vivid Economics: Net Zero in New Zealand (2017) is a report commissioned by 35 members of parliament that details different avenues to domestic emissions neutrality in New Zealand by 2050. The report recommends increased afforestation of New Zealand land by 1.6 million hectares. It states that land typing would be integral to the success of this goal by providing information on the best areas of land for the planting of both exotic and native forests. Without detailed land information, this goal is unlikely to be achieved as areas of land will not be as readily designated to this purpose. The most suitable land plots for forest growth are less likely to be selected for afforestation as their attributes will either be unknown, difficult to access or a combination of the two.

Technical

Selecting the best platform for the project was of absolute importance. Usability, functionality and accessibility were the key criteria considered while reviewing available programs. A reasonable amount of time was attributed to this task where opinions of associates and evidence from literature were both reviewed. GeoPlanner for ArcGIS (an ESRI product) was first examined. It's a browser based geodesign application, with visualisation and analytical tools, created with novice GIS users in mind (Mayfield, 2015). GeoPlanner is not free and costs around 500 USD for one user per year (GeoPlanner for ArcGIS, n.d.). It can also be very limiting to the process of adding data (Mayfield, 2015) unless you publish it via ArcGIS which, again, costs to use. Open source options, QGIS and gvSIG, were also considered.

Free and Open Source Software (FOSS) options are easily accessible and have a wide range

of functions. The term FOSS can be misleading as some interpret free to mean 'freeware' whereas it is intended to mean 'liberty to use, modify and redistribute software' (Bibby & Ducke, 2017). The software still retains its copyrights although very liberally, compared to other options. For example, FOSS can usually be used freely by academics but not by businesses or for commercial use (Bibby & Ducke, 2017). Quantum GIS (QGIS), created in 2002 for Linux, is the most well-known FOSS GIS (Bibby & Ducke, 2017). It now works with a wide range of operating systems including Microsoft Windows and Mac OSX (Steiniger & Bocher, 2009). It relies on volunteers for coding and contributions and claims to have a user-friendly interface providing many functions and features (QGIS, n.d.). Generalitat Valencia Sistema de Información Geográfica (gvSIG) was created by the Spanish government in 2003, contracting Iver, a Spanish software developer (Steiniger & Bocher, 2009). It is not unlike QGIS in regard to functionality and accessibility as it is also FOSS. The issue with using these programs would be that they are primarily for editing datasets and maps rather than for visualising and interacting with them. As there was no raw data to work with, a different approach was needed. This prompted the group to turn to GIS platforms that focused on visualisation and interactivity.

Using a virtual globe platform was suggested by an associate and was investigated for potential use. Yu and Gong (2011) suggest that these platforms enable scientists to communicate data and research on a global scale. As previously mentioned, traditional GIS can be expensive and difficult to use. Virtual globes, such as Google Earth, can address these problems as they are low cost and easy to use in data collection, exploration and visualisation (Yu & Gong, 2011).

Virtual globes gained popularity in 2001 with many startup projects being launched (Bailey & Chen, 2011). EarthViewer, created by Keyhole Inc., was bought by Google in 2004 to be relaunched as Google Earth (Bailey & Chen, 2011). Google Earth is currently the most popular virtual globe platform, particularly in the science community (Bailey & Chen, 2011; Yu & Gong, 2011). For these reasons, a virtual globe approach was decided upon using Google Earth.

A reason for Google Earth's popularity, is that it provides more than just a three-dimensional model of Earth. Using Keyhole Markup Language (KML/ KMZ) it offers the ability to visualise, locate and navigate through personalised geospatial data (Yu & Gong, 2011). KML, while not being the only markup language, became an Open Geospatial Consortium standard in 2008 and is the most widely used by the science community (Yu & Gong, 2011). The methodology began to take shape as a platform and format had both been decided upon.

There are large amounts of geographical data in formats that cannot be immediately used with other GIS data (Manjula, Jyothi & Varma, 2010). This was the case with the land type maps provided. The solution to georeference this data was made by an associate and then further investigated. A study by Manjula et al. (2010) also used this method with the scope to digitise forest resource maps. The process of georeferencing relies on the synchronisation of points on the image (needing georeferenced) with points on geographically referenced data (Manjula et al., 2010). Google Earth uses the World Geodetic System of 1984 (WGS1984) datum (Yu & Gong, 2011). So, it was essential to georeference using this coordinate system on ArcMap. The land type maps were successfully georeferenced using this method and could easily be converted to KML format (using ArcMap) ready to be used with Google Earth. This will be detailed next in methodology.

Methodology

Methodological Development

The methodological framework developed alongside the changing nature of the project research question:

1. How much can we convert the land typing method be to using available digital resources?
2. To what extent can the land typing method by digitised?
3. What are the limitations of a land characterisation digital platform?
4. How feasible and beneficial is it to convert current land type resources to a digital platform?

The first and second research questions prompted an attempt to create a digital land types program. This program would ideally fulfil the desires proposed by Di Lucas in the initial group meeting. These desires included multiple layers of maps, a nested hierarchy, data pop-ups, a search function and the ability to be 'timeless'. 'Timeless' was intended to mean easily updatable and multiple sources of data being able to be utilised for the dynamic landscape of New Zealand.

It was realised that creating a program would be an immense challenge for the groups' limited experience, expertise, and time frame. A decision was made to change the research question to a focus on utilising an existing program. The new proposed method was to test a variety of GIS

software to find the best digitisation platform. Each member of the group experimented with a different GIS program, these included ArcGIS, QGIS, gvSIG and ArcGIS' GeoPlanner.

At this stage of the project the group was attempting to answer the third research question which was concerned with the limitations of digital land characterisation platform. A wide range of limitations were found by all members, but this did not provide any useful qualitative data.

Following a meeting with the group tutor (Matt Wilson) and community partner (Di Lucas), a decision was reached to digitise an existing Lucas Associates document. The fourth and final research question was formulated – "How feasible and beneficial is it to convert current land type resources to a digital platform?" As a result of discussions with Matt Wilson, it was decided that the document would be digitised using ArcGIS and Google Earth. Matt's experience with GIS was of substantial benefit to the results the group achieved. If questions arose with the process of digitisation, the group would seek advice from Matt to make progress in an unfamiliar discipline.

Digitisation of a Land Type Resource

The document to be digitised was the attachments evidence from a case Di Lucas was involved in, concerning a Mackenzie District Plan Change in 2016. Di had given evidence as a representative for the Mackenzie Guardians; a group who advocate for the environmental protection of the Mackenzie Country. The attachments document included a variety of land type maps and diagrams. The method the group employed was to transfer these maps and associated diagrams onto a digital platform using ArcGIS as an image manipulator and Google Earth as display software.

A digital PDF version of the full document was provided, from which high resolution cut outs of a selection of maps were taken. The group then proceeded to georeference the map images. The maps were loaded onto ArcGIS and placed over a base map of New Zealand with the WGS1984 coordinate system. Georeference points were placed on the document images and corresponded to points placed in the same location on the base map. This process resulted in a collection of georeferenced map images which could be converted to KML files, compatible with Google Earth.

The KML map files were loaded onto Google Earth and appeared as overlaid images over the Mackenzie Country. Diagrams and pictures from the PDF document were loaded onto the digital platform through placement of pins on the map layers. Maps could be viewed in context to

related diagrams, pictures and tables of land type information. By clicking on pins around the map overlay, the user can view pictures and diagrams which have been linked to image files on the computer drive or the internet.

Collection of Qualitative Data - Demo and Questionnaire

With a final platform produced, the group turned to the collection of qualitative data. Professional individuals who have experience with the manual process of the land typing method were sought. Di Lucas was helpful with this process and managed to facilitate meetings with 5 people, including herself.

A simple demo task sheet was created to accompany the Google Earth digital platform. The method was to give the 5 demo recipients an opportunity to test the platform for usability and potential usefulness to their consultancies. Following the demo, the individuals were provided with a questionnaire to express their views and provide feedback and improvement.

There were two meetings set up. The first meeting was with James Barringer, a professional from Landcare Research, who conducts land type classification and terrain analysis. Landcare Research has had a lot of involvement with Lucas Associates in creating land type documents such as the resource which was digitised. James progressed through the demo task sheet, and took away the questionnaire which was completed and returned to the group at a later stage.

The second meeting was with the final four professionals. This included Di Lucas, her colleague Glenys Drury (who had worked with Di on a variety of projects), along with two landscape planners, James Bentley and Yvonne Pflüger from Boffa Miskell - an environmental planning and design consultancy. Questionnaires were completed at the end of the meeting and given to the group immediately.

Both meetings provided the group with critical feedback on the final digital land type platform. Each professional had an opportunity to see how the platform worked and filled out questionnaires which provided relevant qualitative data. Responses from the questionnaire and remarks during the meetings were compiled and analysed for the results and discussion.

Results

The KML file, displayed on Google Earth, met the requirements of converting current land typing resources to a digital platform. The group achieved a variety of proposed criteria which were desired early on in the project. This included pop-ups, 3-D interactivity, interchangeable layers and incorporated tables with artist interpretations of the environment (see figures 5 and 6).

Capabilities

The end product was an interactive representation of the Mackenzie Basin Subzone with the original maps being represented as interchangeable layers (see figure 1). Key features included: independent legends for each layer, pop-ups containing extracts from the Mackenzie Basin Subzone report (e.g. photos, tables and artist environment interpretations), and the visualisation of map layers draped over a three-dimensional environment (see figure 3). The data pop-ups (see figures 2, 4 and 5) which were represented could be expanded. This was especially useful for reading information from the tables.

Google Earth was used for its visualisation component and for its functionality on other devices such as tablets. The group tested a tablet to ensure it could run Google Earth with the KML file. The result was sufficient as the program could be used without any major constraints other than loading time when changing layers. This was also an issue when used on a computer. One way to temporarily fix the issue was to load in all the individual layers before presentation, allowing them to be switched instantaneously.
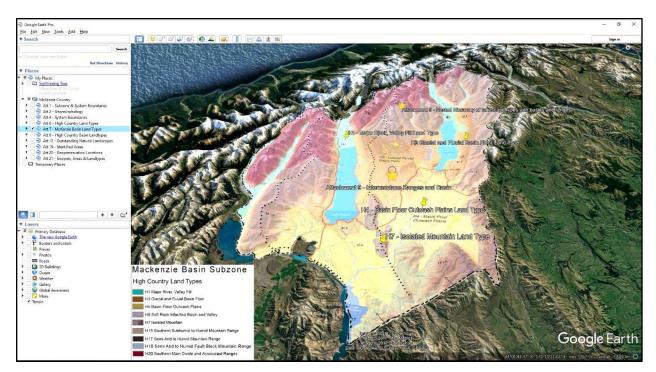
Figure 1: *Google Earth interface with created KML product, showing a Mackenzie Basin Subzone layer representing the High Country land types with a legend and appropriate points. Multiple map layers are listed on the left.*
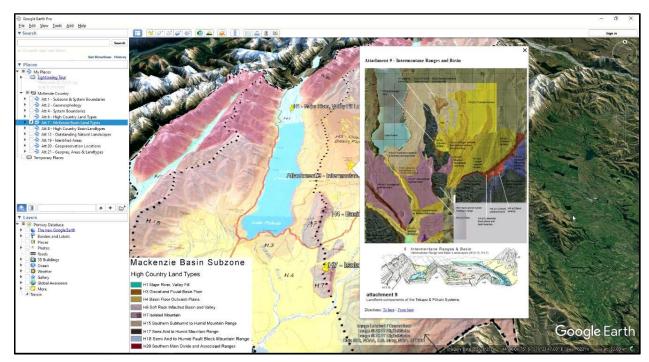

Figure 2: *Representation of the nested hierarchy being incorporated onto a layer using the points pop-up feature. The attachment pop-up can be clicked on creating an enhanced zoom which provides more detail.*

Figure 3: *The Google Earth interface with an image overlaid from the provided Mackenzie Basin Subzone report. This image displays the 3D functionality of the program and the extent of the zoom in resolution.*

Figure 4: *Visual representation of the layer's functionality, showing an image as a pop-up. This provided the observer a sense of being in the environment and displayed what environmental aspects exist in the area.*
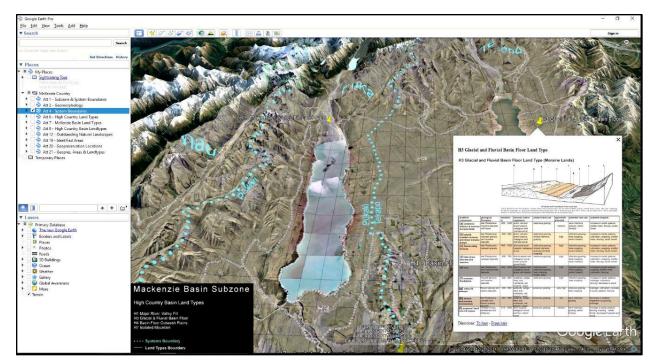
Figure 5: Google Earth interface displaying the use of pop-ups on a layer. A data table and artist interpretation are displayed which reimagines the area enclosed by specific system boundaries.
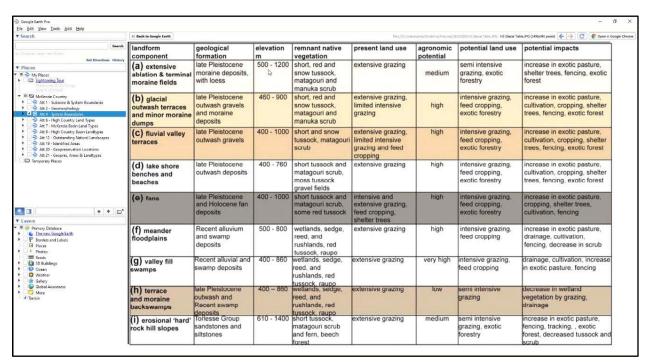

Figure 6: Representation of the table shown in Figure 5, expanded to reveal clear information. Image expansion can be carried out for all pop-up images, including photos and artists interpretations.

Responses

To assess the practicality of the KML file from a professional perspective, it was tested on those who have experience in the industry. Professionals were sought who had encountered land typing in their field of expertise. The group provided questionnaires to the individuals to obtain relevant qualitative data. From what was gathered in the two meetings, the general consensus was that there is a need for a program of a greater caliber. Specifically, a program that covers the whole of New Zealand, including raw data and various spatial scales. The benefits of this would include an increased public awareness of land typing, and the ability of experts being able to make more informed decisions in the field. Experts could be provided with detailed information when creating resource consents and data could be queried and overlaid in one digital resource.

The produced KML file was ideal for people with limited GIS knowledge or understanding. It could be used for educational purposes as it is an interactive and user-friendly tool which provides a basic overview of the specific area. The responses reflected that the platform is a great base for broad research and knowledge when presenting to clients. It is a good starting point for digitising land use data in an open sourced database and is feasible for those who do not have a GIS background. The KML can be easily downloaded and updated, for whomever is seeking basic information on the area. One response mentioned that the method used is effective for digitising old maps and plans. These paper images, created in the past using traditional mapping methods, could be collated onto one digitised database.

The downsides to this project according to the responses is that Google Earth has inadequate GIS processing tools that are used in the industry. It is a powerful visualisation tool but lacks the features needed to process raw data, required to provide sufficient land typing information. Individual layers of information need to be shown at different spatial scales allowing more effective use of the zoom. The KML layers were prone to deteriorating image quality at smaller scales. The use of raw data could have improved the functionality of the KML file. Another suggestion was tracing polygons around the outlines of overlaid layer images to improve pop-up capabilities (e.g. clicking on an area rather than a point).

Suggestions were made for this project to go further, incorporating both the required features for professional users and usability by the public. Features that were recommended were; a topographic map base layer, integration of individual layers, display information at various levels (nested hierarchy), search function and raw data to enable processing. Funding was a potential

option via government organisations such as Land Information New Zealand (LINZ), Ministry for the Environment (MfE), or the New Zealand Institute for Landscape Architects (NZILA).

Discussion

During the research process, it was discovered that the created KML file is adequate for the presentation of land typing data but had an absence of processing functions required for professional use. The product is a visualisation program which could be improved by using raw data rather than using a report provided by the community partner in PDF format.

To include the suggested features, a new platform would need to be created which would incorporate open source development and be available online. Currently, ArcGIS dominates the professional GIS market as it offers a variety of software across various platforms (Bates, 2012). The platform would aim to have similar functionality to ArcGIS' data processing potential and offer the same 3D interactivity and ease of use provided by Google Earth.

Limitations

To be able to create a program that has functionality for professional users, and remains interactive, experience in software development would be required. A program incorporating the previously mentioned features requires a background that none of the members have and extends beyond geographical sciences. If experience was acquired, a new platform could be developed using an online database that is open to the public. This platform could be similar to the digital soil map (S-Map) developed by Landcare Research (2017). However, it would be more specific to land typing rather than soils and would cover the entire country.

Specified limitations of the produced KML and Google Earth are the limited data processing features and functionality which are needed from a professional point of view. Data needs to be processed and manipulated to be able to keep it updated and to provide necessary information for projects and developments, so informed decisions can be made regarding the natural environment. ArcGIS and QGIS (tested in the earlier stages of the project development) outperformed Google Earth in regard to data analysis and the sheer number of tools that can be used to manipulate the data. Therefore, QGIS was originally chosen as it has the benefit of being free and open source, an element which ArcGIS did not offer. ArcGIS online was also investigated, however as with all ESRI products, it was expensive. During the process, a

compromise was made to prioritise interactivity, ease of use, online capabilities and accessibility at the expense of data processing capabilities. This decision was necessary to allow completion of the project in a limited timeframe, but resulted in a digital platform product which was less suitable for professional end users.

Retrieving and analysing adequate literature was a difficult task due to fact that the research project was seemingly unrelated to anything done before. Initially remote sensing was considered, as data analysis and understanding its collection was the initial direction chosen. This changed during the research process when the presentation of data was prioritised. Very limited literature provided insight into the methodology of research, therefore the project was predominantly self-guided.

Future research

Future research should be centered around expanding on the data processing capabilities of the platform to increase functionality for industry professionals. Incorporating the features suggested in the meetings (topographic base layer, integration of individual layers, display information at various levels, search function and raw data to enable processing) will be a challenge for any future research. For this to be successful, Google Earth is unlikely to be suitable, as the increased data size would drastically reduce the speed of interaction with the platform. As mentioned in the results and limitations sections, Google Earth lacks the processing power to successfully run these features.

Future research could also focus on how this platform could reach the necessary level of funding for it to be successful. Whether funding should be sourced from the public or private sector is certainly a topic of debate when one considers the place that land typing has in New Zealand policy (NZCPS, 2010).

Conclusion

The main finding, based on the qualitative data we received, is that Google Earth as a platform is only suitable as a visualisation tool. Google Earth's main benefits for industry professionals are its usefulness in presenting data, to give clients an overview of an area of interest and to share research within the science community itself. This project's achievements provide a solid base for future research. The limitations of this platform, specifically the lack of GIS processing power, are hard to overlook when one reviews the benefits of digitising land type resources. To combat this, the information used to create the platform would have to be in the form of raw data instead of PDF extractions. The platform would ideally be capable of conducting powerful GIS processing. A potential solution to this challenge would be to use an advanced product such as an ESRI platform, although cost is a barrier. The opportunities provided by Free and Open Source Software (FOSS) may be an avenue of investigation for cost-efficiency. The visualisation platform could be interpreted as a foundation to future research towards digitisation of the land typing discipline. This objective was to create a repeatable methodology to digitise land type resources. While this digitisation has been limited to visualisation, what has been achieved has benefits to the industry and the clients it serves.

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