

Web Mapping and Scientific Data: The Experiences of Landcare Research

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Introduction

In 1996, Landcare Research launched one of the first interactive mapping sites to appear on the internet and the first to provide access to environmental data (Gibb and Medyckyj-Scott 1996). In this presentation we describe more recent developments at Landcare Research in web mapping of scientific data and some of the cartographic and technical challenges. We will begin by outlining our mapping platform and how it's being used and then consider four facets: the data, the cartography, the UX and the technology all of which are interlinked. We end by describing some new directions: data visualisation and new technologies.

Companies such as Google and Apple have made the earlier novelty of interactive mapping applications seem ordinary, and internet use as a cost-effective mechanism to publish maps continues to grow. Maps displayed in web mapping sites need to be based on solid cartographic design, even though aspects such as interactivity, device type and size, and mass usage by unknown users create additional challenges for the map designer. These can lead to significant technical consequences as Landcare Research has discovered.

In 2010, Landcare Research decided to develop a new platform for presenting its land resources data online. For many years Landcare had been supplying data to end users; most recently through its 'clip and ship service' the LRIS Portal (<http://iris.scinfo.org.nz/>). However, users of these data have to do the 'heavy lifting' – importing downloaded data into software packages e.g. ArcGIS, then creating their own maps. It was felt presenting data using interactive mapping applications would lower barriers for users wanting access to this scientific data. The first application was S-map Online (<http://smap.landcareresearch.co.nz>), launched in 2011. It provides maps and supporting information that describes soils in New Zealand at a nominal scale of 1:50,000. It is now used by 2,500 users a month. Next came OurEnvironment (<http://ourenvironment.scinfo.org.nz/>), a land atlas of New Zealand providing maps based on a wide range of land resource data. Key features of these applications included the ability for users to create custom maps and generate map layer statistics and graphs based on user-defined areas.

Other applications have followed including: interactive mapping in the Antarctic Environments Portal (<https://environments.aq/map/>) and a soils mapping viewer (<https://soils-maps.landcareresearch.co.nz/>). Interactive mapping capabilities are being

added to other Landcare web sites as data owners realise the power of displaying their data spatially.

The Data

Landcare collects and manages large amounts of environmental data, so access to data for inclusion in our mapping applications was not a problem. However, various issues did need addressing.

National coverage

- Spatial completeness ensures users across NZ discover interesting maps and data.
- Sparse data leads to cartographic presentation complications.

Scale

- Data captured at one scale are not necessarily suitable for viewing at larger scales.
- Complex, large-scale data rendered at smaller scales can lead to performance and cartographic problems.

Reclassification

- Required when raw data are either too complex for the target audience or not suitable for mapping applications, e.g. data with very high number of classes.

Understanding

- Our science data historically targeted user groups with expert knowledge. Therefore for our mapping applications, metadata, informative legends, glossaries, and explanatory information were included to inform users about the provenance and meaning of the data.

The Cartography

A set of high quality base maps was required for use as backdrop maps for the scientific data. Use of third party web map services were investigated but dismissed due to issues such as map projection support (not NZTM).

Landcare therefore created its own set of base maps.¹ A first priority was a topographic map of New Zealand that could be re-used across the mapping applications. A custom set of scales/resolutions was required akin to paper map scales with which users would be familiar and which corresponded with the mapped scales of our environmental data. Some 30 separate datasets were used to produce the topographic map layer,² which had to be visually merged into a single entity but rendered differently at each of the nine set mapping scales. Custom plot order priorities were given to different features to create an appropriate visual hierarchy. Styling and opacity of each map layer was carefully tuned to blend the datasets into a cohesive cartographic product.

¹ This base map and some science layers are available as web map services (WMS) and web tile services for public use at <http://maps.scinfo.org.nz>.

² LINZ was the source for the majority of the data but Landcare and NIWA data was also used.

A big challenge was the lack of a cartographically positioned text layer, and the priorities of how those textual elements were rendered, both within a map scale, and across scales. The text data LINZ made available publically was a point dataset; using only such data made it difficult to label linear features accurately. Fortunately, for internal use LINZ were working on a richer dataset, which used polylines on which to render text, which they provided to us.

The resulting topographic map layer was subsequently followed by the creation of a shaded relief map and a landcover terrain map (Fig. 1). Monochrome versions of some of these layers were created using a colour to greyscale formula, as experimentation showed a monochrome background map was more suitable for some science layers.



Figure 1. Base maps - colour topographic, colour hybrid terrain/topographic, landcover terrain map (DEM + ECOSAT landcover).

Application purpose and the nature of the data drove cartographic decision making. In OurEnvironment, choropleth mapping was used for both quantitative and qualitative data. For some data sets, alternative cartographic representations were used, e.g. “Direction of slope” layer uses “Aspect-slope” mapping. Where possible, familiar, historic Landcare cartographic styling conventions were preferred, but adjusted for web delivery.

More complex techniques (from a technical viewpoint) were used in some of the mapping sites. Spatially sparse data layers within the Soils Map Viewer utilised extent polygons and simple zoom animations, allowing identification of areas of science data at larger scales when viewing maps at small scale.

The requirements and processes by which the base maps for the Antarctic Environments portal were created were similar to those of the New Zealand topographic maps (Fig. 2). However, the portal displays information on facilities and important bird sites for which point mapping is used. To manage the presentation of large numbers of point features at different scales, point cluster mapping was used.

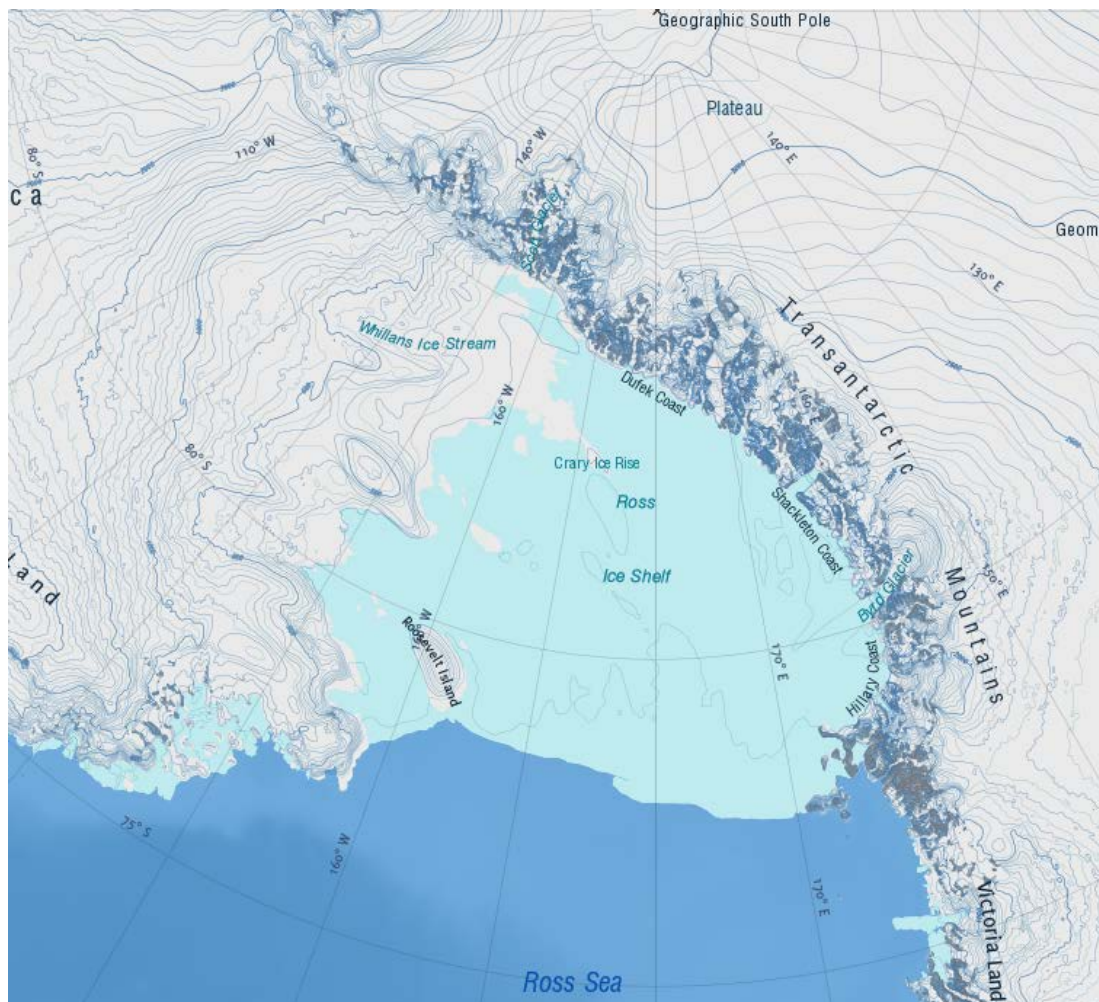


Figure 2. Antarctic base map.

User Interaction and UX Design

All applications make use of common interactive map control features: zoom, pan, zoom to scale, etc. Transparency of the science layers is adjustable, allowing users to relate the science layer to the underlying terrain. Various context layers are available as overlays, including text, transport features, and administrative boundaries.

Some of the applications have unique features:

- The ability to toggle the visibility of individual classes, rather than the map layer as a whole (Fig. 3) enables greater control of the maps that can be created by the user, allowing data to be explored more easily.
- Cartographic quality, hardcopy versions of the maps are available through a simple print tool. Map extent, paper size and orientation, and map title are all configurable.

The rapid rise in mobiles and tablets has required a greater focus on responsive design – making sure the sites are usable and intelligible on small, touch devices. This leads to UX design challenges such as alterations to the functionality available on small devices through a process of graceful degradation.

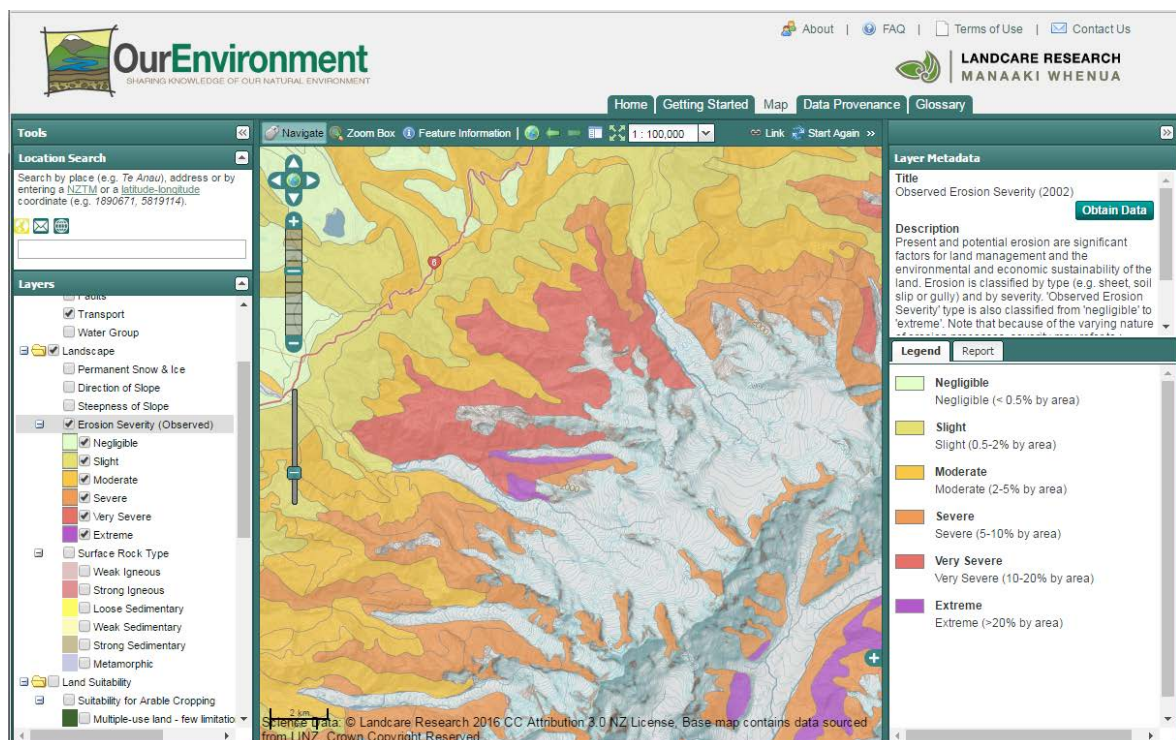


Figure 3. Screenshot of the OurEnvironment interactive mapping application showing layer and class toggling and metadata.

User testing was carried out with 'non-technical' users, who were asked to execute a series of simple tasks using the applications: zoom to a particular place, change the base map to black and white version, find out what erosion level (class) is at a given location. The resulting interactions, which typically involved quite small groups, were either filmed

or recorded on paper (expert observation) and the results reviewed with the development team, allowing insight into which aspects of the UX needed changing.

The Technology

Server side the applications use PostgreSQL/PostGIS, Mapserver, Mapserver's Mapcache, and Mapfish Print (to produce hardcopy PDF versions of the screen maps). Mapserver was chosen over Geoserver because of the higher degree of configuration, stability, and the capability for better/more flexible cartography.

Google Maps has raised user expectations of map rendering speed. We utilise map tile caching software that involves splitting pre-built maps into small tiles stored as images. This avoids rendering images for every map request, which can be compute intensive and results in a much slower presentation of the map to the user; instead the pre-generated images are returned. Landcare paid for Mapcache to be modified to use a Berkley Database backend, giving us extremely fast read times, and improved cache management.

The clients are built using an extensive set of libraries (e.g. Openlayers, JQuery, GeoEXT, PHP, D3). As newer clients are created libraries are updated or replaced, e.g. Bootstrap, a popular HTML, CSS, and JS framework, is used for developing responsive, mobile applications.

The Future

New needs arise constantly and we have been researching ways to visualise data uncertainty, spatio-temporal data (e.g. animated web maps (Heuer et al. 2013), and bivariate web mapping. We are evaluating new technologies for use in our future applications, e.g. vector tile caches and semantic technologies. Looking ahead we see the need for easy and quick ways for scientists to become web map publishers, and tools such as Mapview, an R package (<http://www.r-bloggers.com/mapview-basic-interactive-viewing-of-spatial-data-in-r/>), appear to offer great potential.

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