Implications of Land*online* for GIS users

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ABSTRACT

The aim of this paper is to explore the effect of Land*online* on the GIS user community in New Zealand. It describes the major changes that will occur and what these will mean to the user. Strategies that the user may adopt to cope with the changes are outlined, the means of accessing the data are described, and finally some thoughts on opportunities are presented.

Keywords and phrases**:** Land*online*, LINZ, DCDB, GIS, cadastral automation.

1. Land*online*: A UNIQUE AUTOMATION PROJECT

By any standards, Land*online* is an ambitious project. Not only ambitious, but unique – its comprehensive management of land-related records will be at the leading edge of cadastral automation. The key development that enabled even the conception of such a project was the establishment of LINZ (Land Information New Zealand) in 1996. The new Department incorporated, for the first time, the previously separate organisations responsible for the various core land records and focussed its role on providing essential functions for government rather than being required to generate revenue (Bevin, 1998). The management of land title records, survey data, geodetic information, Crown lands, the topographic and hydrographic databases, and the oversight of land valuation processes, could now proceed in an integrated manner.

As part of the government restructuring that produced LINZ, it was acknowledged that not only was spatial data of strategic importance to New Zealand, but that the government should continue to be responsible for the provision of its infrastructure. In addition, the objectives of LINZ included references to secure land property rights and the certainty of title, the efficient management of Crown land assets, and the ongoing maintenance of publicly available core geographic information (Bevin, 1998). The Survey and Title Automation Programme was consequently developed as the most effective means of providing these services and meeting the outcomes required by central government; the public face of this project is Land*online*.

The aims of Land*online* were to integrate all survey and title processes, to provide them in digital form, to reduce the costs of both provision and compliance, to utilise technological development, and to meet the growing community demand for improved quality and delivery (Bevin, 1999). The outcome was the Core Record System (CRS), the database at the heart of Land*online*. Although the design of CRS was sharply focussed on the cadastral (both survey and title) and geodetic functions of LINZ, it includes not only the actual data, but also all the associated processes such as work-flow and quality control. The entity-relationship diagrams of CRS are indeed impressive! The inclusion of the other land related functions referred to above (topographic mapping, hydrographic charting, Crown Land) has not been specifically allowed for in CRS, but their possible later incorporation has not been precluded in its development.

2. WHAT DOES Land*online* MEAN FOR GIS USERS

Land*online* was not in fact designed to meet the needs of the GIS community, but was restricted to the core requirements of the survey and title systems; ie, it was built to support the cadastral system and its users, those involved in the ownership, transfer, and subdivision of land. The fact that most of the spatial definition and data needs of GIS users will be met by Land*online* is really a fortuitous break. Nevertheless, with the rigour that has been used in its design, this outcome is not perhaps surprising.

The concept of Land*online* for GIS users is similar to that of the current DCDB where the government supplies a cadastral base map that can then be overlaid by other users with different datasets. However, there are three significant changes in Land*online*: there will be more spatial objects to link to; they will be more accurately positioned; but they will be on a different coordinate system. These three points are described in more depth in the sections below.

The last of these is due to the recent adoption of a new datum in New Zealand, NZGD2000, and is likely to cause some initial consternation. We have generally been isolated from datum changes in New Zealand, unlike many overseas countries, and despite the short-term pain this change will inflict on some users, there is little doubt that it will have definite long-term benefits. When combined with the improvements to the data itself, in positional accuracy and types of data available, the developments in Land*online* will provide opportunities for data integration and other applications not currently feasible.

Although designed to meet the government's core cadastral requirements, Land*online* will be of considerable benefit to a wide range of users in the GIS, utility, and land administration fields (Bevin, 1999). This power and flexibility for further connections from a core government cadastral database sounds remarkably like the aim of the first instantiation of LINZ in the 1980s!

3. THE CHANGE TO NZGD2000

Most GIS users have never heard of geodesy or datums, and probably also projections; continued ignorance will be brief or costly, or both. Geodesy is the science of measuring the Earth, and a geodetic datum is a mathematical surface (normally an ellipsoid) chosen to represent the Earth. We can use geographical coordinates (latitude and longitude) on a curved ellipsoid but it is usually more convenient to project these positions onto a flat surface and use a more familiar north and east rectangular coordinate system.

With the roll-out of Land*online* in March 2000, we will begin using a new datum, NZGD2000 (New Zealand Geodetic Datum 2000). The GIS and mapping communities have generally been using NZGD49 (usually in the form of NZMG) which, until the last decade or so, has been quite adequate for the needs of most of its users. However, it has become increasingly evident that NZGD49 was no longer sufficient for many applications, particularly in the surveying and scientific communities.

NZGD49 was established to meet the needs of New Zealand in the mid-1900s, well before the advent of satellite surveying techniques such as GPS. Fifty years later, it has become clear that tectonic movement together with systematic errors in the original triangulation have caused significant, and continuing, degradation of the positional accuracy of NZGD49. While coordinates may be consistent locally, they are no longer coherent nationally, with distortions of up to 5m now detected. Of more importance to GIS users, NZGD49 is based on a local Earth model and is not compatible with the direct use of GPS.

In contrast, NZGD2000 is both geocentric and dynamic: a geocentric datum is one based on a global model of the Earth, while the dynamic component will utilise a detailed crustal velocity model of New Zealand. Significant advantages will accrue from these changes. Most importantly, NZGD2000 will be directly compatible with global techniques such as GPS, and will ensure consistently high positional accuracy throughout New Zealand. The dynamic datum will account for tectonic crustal movement, but coordinates will not be constantly changing as the Earth deforms. They will generally be reduced through the velocity model to one epoch, 2000.0, although coordinates at any other epoch can be readily generated if required for a particular application.

The primary effect of the change in datums will be a change in coordinate values of about 200m (mostly north), certainly significant for most users. Although the new datum will be introduced (to GIS users) progressively through New Zealand beginning in the Otago and Southland region in April 2000, users will not be forced to change immediately. Nevertheless, decisions will have to be made on whether to change, when to change, and how to change.

With only the one datum (generally) in New Zealand, we have been largely protected from having to deal with datums; all that has been required for GIS data has been to specify NZMG. Compare this to most other countries where there are several datums, not to mention the many projections, from which to choose from or distinguish between. There are frequent postings on the internet newsgroup GIS-L requesting advice on coordinates and their conversion from one system to another. It is undoubtedly an area of widespread poor understanding.

All Land*online* positional data will be supplied to the data providers by LINZ on NZGD2000 in the form of latitude and longitude. It will then be the role of the data providers (for example, Terralink) to insulate the user from the datum changes. There are two choices: convert all new data from Land*online* back to NZMG on NZGD49, or convert all existing data to NZGD2000. LINZ will provide the necessary software, formulas and transformation parameters to carry out these conversions. The solutions range from a simple national transformation (accurate to ±10m) to a grid of differences to account for the localised effect of distortions that will give an accuracy of ±0.2m (Pearse, 1999). The "how" is relatively straightforward, the issue for most GIS users will be when.

The most uncertain question is what projection to use. Although the new surveying projections have been finalised (eg, North Taieri 2000 here in Dunedin), most GIS data is represented on a mapping projection, almost exclusively NZMG in New Zealand. However, NZMG is based on NZGD49 and a new projection will have to be decided upon. A new version of NZMG in terms of NZGD2000 is one option, but would suffer the same disadvantage as before – it was designed for mainland New Zealand and does not suit offshore applications, or our outlying islands. The leading alternative is probably UTM which is already used for hydrographic charting and is widely accepted and understood globally. LINZ expects to decide on a projection for their topographic data by July 2000.

It may not be necessary to use a projection at all. A simple solution is to actually store the original geographical coordinates and project them as required. GIS software packages are extremely good at handling projections – they often contain definitions for dozens, even hundreds, of them and have the ability to define even more. The data is simply projected if required. Having original coordinates would of course make updates and exchanges of data very simple.

It is understandable that the GIS community is nervous (for example, Critchlow 1997) since any change introduces uncertainty. There will also be costs associated with the change which may not improve small local applications at all, but overall the new datum will allow cheaper and more accurate positioning. GPS will be able to be used directly and with confidence that it is accurate. The global-based system will mean the end of problems dealing with uncertain local coordinate systems, and will permit easy integration with the increasing volume of data that is related to a global model or gathered by global techniques such as GPS and remote sensing. These global space-based techniques continue to increase in accuracy and the reference system must be able to cope.

4. Land*online* DATA

Although Land*online* will appear to many users to be a GIS-type application, it is not GIS oriented at heart, but more a typical IT application that happens to have spatial views. It is fully relational, using ESRI's SDE on an Informix database. Initially, Land*online* will be populated by converting the entities in the DCDB to the new structure. Compatibility will be achieved by retaining the DCDB entity identifiers (the SUFIs) although they will not actually be used by Land*online*. Many more tables will then be populated as Land*online* grows to become one of the largest databases in New Zealand. The DCDB is an index of surveyed subdivision whereas Land*online* will also contain links (although not a spatial depiction) to parcels created by other means, producing a complete record of the cadastral pattern. There will eventually be some 250 entities in Land*online*, about ten of which will have a spatial representation, eg street address, road centreline, parcel, node.

Although designed using relational principles, some object-oriented concepts have been used to ensure that the spatial data is easy to use and that access is as fast. For example, there are separate spatial "layers" for parcels, boundaries, and observations, all will be stored in separate tables in the database, but all of which could refer to the same lines. The spatial coordinates of a node will be stored in the node table, in the lines table for every line to that node, and in the parcel table for every parcel that uses that node, and so on. This concept of spatial objects will result in considerable redundancy and a high maintenance overhead within the database but will allow a GIS user to extract, for example, the parcels of interest in just one table. The traditional approach would be to extract several tables containing all the nodes and lines that make up the parcels and then construct the parcels in the user application.

The DCDB is widely used as a basemap, allowing users to link diverse datasets to parcels, addresses, meshblocks, and so on. Land*online* will extend this usefulness both by providing further entities (such as title reference) and by using accurate coordinates to allow data integration based purely on position..

5. THE SDC – ACCURATE POSITIONS

An essential element of Land*online* is its spatial component, the SDC (Survey accurate Digital Cadastre). To be able to support an automated cadastral system, an accurate positional record of the cadastre is imperative. The existing DCDB was certainly not designed for this purpose. Coordinates in the DCDB were obtained by digitising the cadastral record maps and contain varying and unpredictable errors from two sources: the record maps are of varying scales, and they contained plotting errors, some due to the incremental nature of the plot, some just pure errors. It must be stressed (yet again) that the DCDB was never intended to be more than a graphical index and just could not support some of the many positioning uses for it that were soon discovered. Uncertainties of 1-2m are standard, but it must also be accepted that errors of 20m are common in rural areas.

The SDC is two orders of magnitude better – coordinates will be accurate to a few centimetres by using actual survey data. However, the SDC will only cover the urban and intensive rural areas of New Zealand. Initial population of the nodes in the SDC will be straight from the DCDB, after conversion to NZGD2000. The accurate coordinates will then be generated by entering the dimensions of each parcel, block by block, followed by the mathematical adjustment of each block using a dense network of especially established geodetic control points. The result will be parcel boundary coordinates that represent the best survey data in that area. Where that data is good enough, which will generally be the case, nodes will be accurate to about 3-5cm.

However, this is only in the SDC areas. Outside these areas, the DCDB coordinates with all their existing uncertainties and (unknown) errors will remain. The restriction of the SDC to the urban and intensive rural areas was necessary for both economic and mathematical reasons. In many of the remaining areas, the large rural tracts of New Zealand, the surveys tend to be mathematically inconsistent and to put them through the SDC data capture process would not result in precisions compatible with SDC standards. Nevertheless, about 75% of the total of 2 million parcels in New Zealand will be included in the SDC areas. Figure 1 shows the location of the SDC areas in the eastern part of Otago.

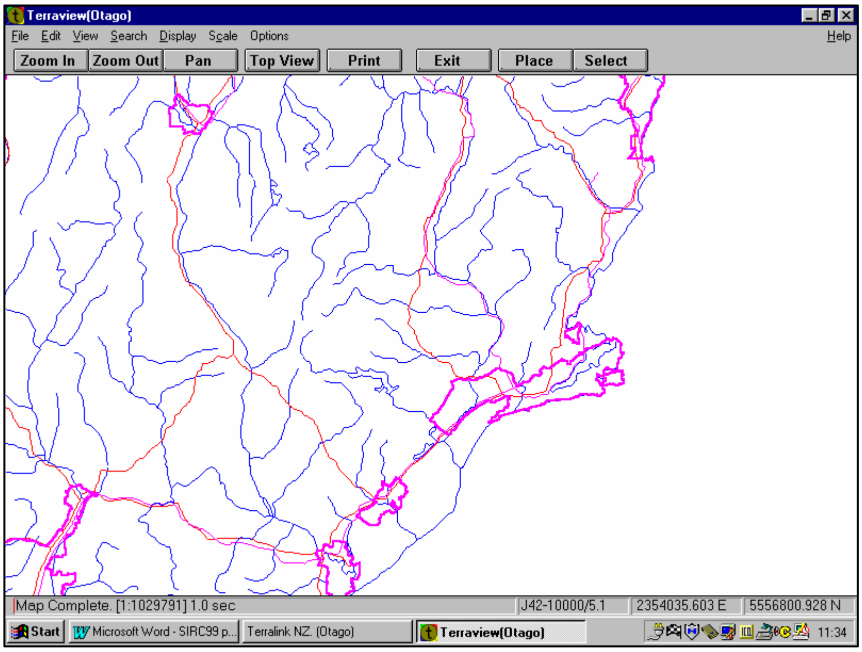

Figure 1. SDC areas near Dunedin.

Throughout the country, new surveys will be used to update positions in Land*online*. There will be minimal movement, if any, in the SDC areas, but there is likely to be significant positional changes elsewhere. This procedure, and the resulting "wobble" in coordinate values, is similar to that used in the past to update the DCDB.

6. ACCESS TO THE DATA

In line with government policy, LINZ will not be in the business of selling Land*online* data but will make it available to a number of data providers who will then supply it to the end users (Haanen and Grant, 1998). The bulk extract of data for GIS users will be by table from Land*online* into delimited ascii files, including the spatial representation in modified WKT format similar to the example in Figure 2.

```
40000|1003|||PRIM||25950.0|||DCDB|CURR||1 POLYGON (( 176.11388340 -
40.19048975, 176.11648968 -40.19099348, 176.11679323 -40.19078668,
176.11641845 -40.18950288, 176.11563897 -40.18958252, 176.11514922
-40.18982337, 176.11448065 -40.18972888, 176.11388340 -
40.19048975))||40000|
```

Figure 2. Example of a parcel in WKT format.

The data will become available as the 12 separate DCDB databases are progressively converted to Land*online* from March 2000. Incremental updates will be supported, probably daily, while complete refreshes will be available monthly.

The costs that will be charged for GIS data are still being determined, but the real question is whether Land*online* data will follow the same path as the topographic data and be made available at the cost of dissemination rather than at the cost of creation. The government's policy on charging for information has been set out by the State Services Commission (1997) and provides for various levels, from free dissemination to full cost recovery of production. However, despite having SSC backing, it still took LINZ some considerable time to convince the Treasury that full cost recovery for the topographic data was not appropriate and that only the cost of dissemination would be charged.

7. OPPORTUNITIES – IS THERE A DOLLAR IN IT?

There will of course be opportunities opened up by Land*online*. There may also be some pitfalls – we have yet to see the system in action or to try out the new processes. To a large extent, the opportunities will depend on the pricing strategy that LINZ adopts. If the initial enthusiasm surrounding the drop in fees for topographic data continues into quantifiable benefits, significant pressure could be exerted on the government by the GIS community for a similar move with Land*online*.

Regardless of the fee structure, Land*online* will still offer benefits as a result of the changes described above. The actual data entities likely to be of interest to GIS users are similar to those in DCDB but the additional spatial entities and the comprehensive data model incorporating both title and survey will allow new applications. Coordinates which are both accurate and aligned with a global model of the Earth will open up new avenues, both in data capture and in dataset integration. LINZ itself is in no doubt and would seem at this stage quite justified in its claim (Bevin 1999) that "The ability for this database to be used to support a wide range of other large scale mapping, GIS or remote sensing applications is considerable, and likely to expand enormously, creating significant opportunities for commercial added value initiatives."

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ACRONYMS USED

CRS	Core Record System
DCDB	Digital Cadastral DataBase
GPS	Global Positioning System
LINZ	Land Information New Zealand
NZGD2000	NZ Geodetic Datum 2000
NZGD49	NZ geodetic Datum 1949
NZMG	New Zealand Map Grid
SDC	Survey-accurate Digital Cadastre
SDE	Spatial Database Engine
SSC	State Services Commission
SUFI	Static unique feature identifier
UTM	Universal Transverse Mercator