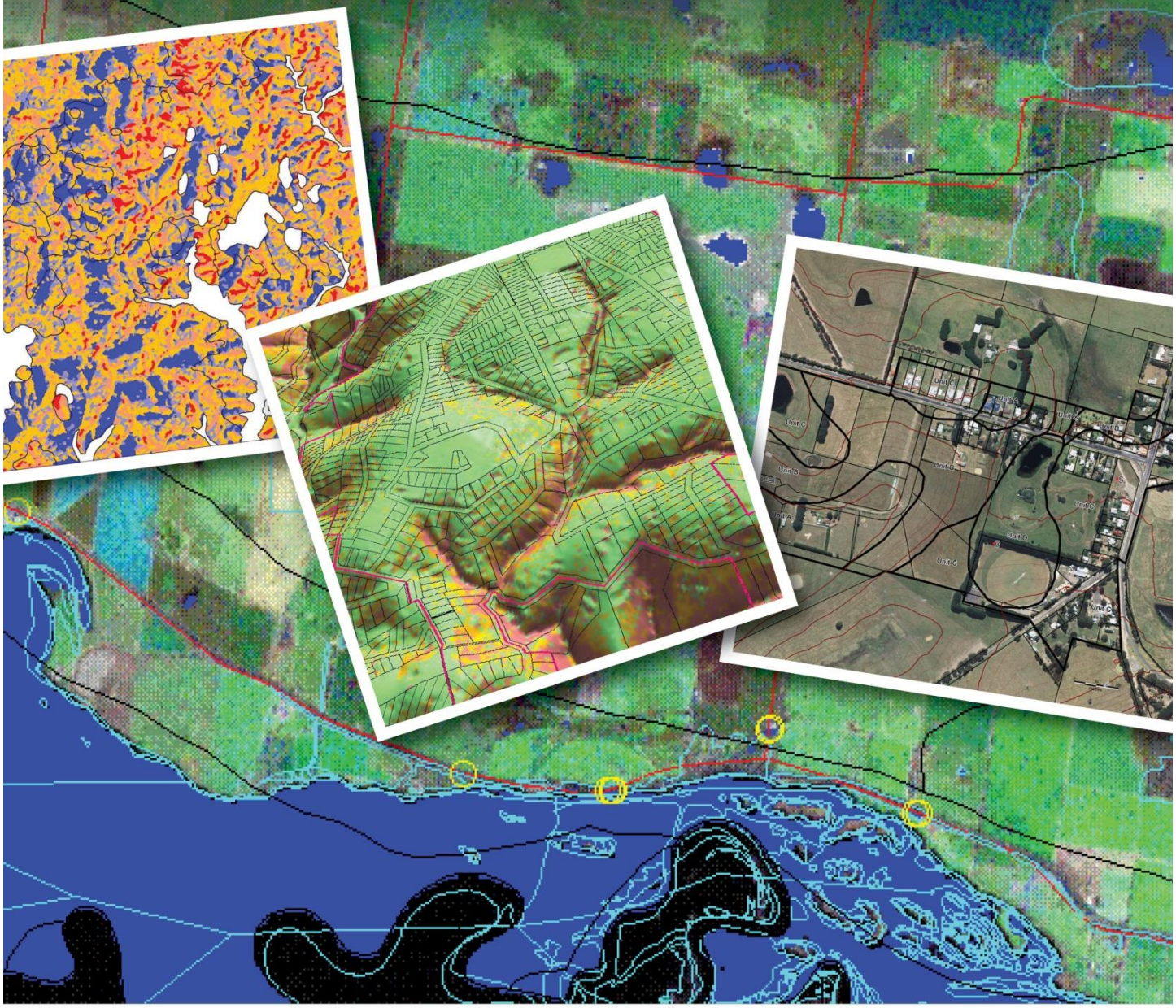
GIS UNIVERSITY

Environmental Mapping with GIS

ISSUES AND EXAMPLES



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Introduction

In many organizations GIS is polarized so strategic environmental mapping projects often miss out. The polarization happens on two fronts …

1. On the one hand GIS professionals:

    a. **Too busy:** Technically competent GIS professionals are too busy with day-to-day problems to take the time to understand the environmental problems in their organization that need to be mapped.

    b. **Problems get technologized:** Environmental problems get defined in GIS terms so GIS departments provide environmental professionals maps that may not be useful to them.

2. On the other hand environmental professionals:

    a. **Intimidated by GIS:** Often environmental professionals are intimidated by GIS. Perhaps they tried to use it years ago and remember how difficult it used to be. Whatever the reason, they prefer business-as-usual – hand drawing onto maps they probably bought from their local map shop, reducing / enlarging maps on photocopiers to make them scale-compatible, etc.

    b. **Avoid strategic mapping projects:** Or, they avoid strategic mapping altogether and focus on site level assessments where there are no GIS mapping requirements.

In such an environment everybody who might benefit from a good quality GIS mapping project loses. Hand drawn maps that sit in the back of project reports rarely make their way into the corporate GIS for future use by other projects. One thing is for certain, in the absence of GIS, environmental mapping projects rarely reach their full potential.

I want to make the case for the GIS-Analyst – someone who understands both the problem that needs to be mapped and the GIS technology that can be used to express that problem to both decision makers and stakeholders. Such as person only needs a basic understanding of a topic, and then be interested enough to ask intelligent questions of the environmental scientists. Rarely are the mapping requirements complex, and rarely are such projects beyond the reach of small teams containing both GIS and environmental professionals. The skill that GIS professionals need to learn is how to create useful field-maps for environmental scientists that will then be easy for the GIS department to incorporate into the corporate GIS.

In the text that follows I begin by defining what GIS is, and in doing so I suggest why some environmentalists have been so reluctant to use GIS for strategic mapping. I then delve deeper into why GIS analysts are so important in the environmental sector, what a good GIS base map looks like, and then how to work with an environmental professional in a way that allows them to be comfortable with GIS. You'll get to see GIS analyst techniques gleaned from my two decades of working with engineers, archaeologists, demographers, soil scientists, economists, ecologists, and epidemiologists.

Finally I show, with the aid of examples, what can be achieved when you get it right…simple GIS projects that become powerful decision making tools.

What is a Geographical Information System (GIS)

The definitions of Geographical Information Systems (GIS) that you find in text books and around the web are often too technical or too obscure for beginners to easily understand. Definitions such as…

A Geographical Information System (GIS), is a computer application that allows you to capture, store, search, manipulate, relate and manage maps and information about them.

…although true, are formal, lack meaning to the GIS newcomer, and so can be a barrier to environmental professionals getting involved. Often such definitions are from a time when there were many technical obstacles for GIS to overcome. GIS has since been tamed. These days GISs are so reliable, relatively user friendly, and compatible with each other such that the brand of GIS you're using rarely matters. The era of difficult-to-use GIS is over and now its time to focus on solving geographical problems!

Why Now is the Perfect Storm for GIS

It's a perfect storm for GIS - GIS maps, GIS software and computer hardware have all matured, and many of the GIS tasks that were once near-impossible are now routine. Society's social and environmental problems are better understood, and more often than before governments, corporates, and the press are communicating these problems with maps. Google and others have put mapping into the hands of the masses and social media is giving the masses a greater say. A flow-on from this is that the expectations of map consumers have been raised. More sophisticated skills are required to analyse and present maps in ways that allow them to be easily understood. The opportunities for newcomers are exciting.

The Case for the GIS Analyst

Sadly, and understandably, the great advances that have occurred for GIS technology have not always been matched with advances in environmental GIS applications. Mostly this is due to lack-of-interest by both GIS Professionals and

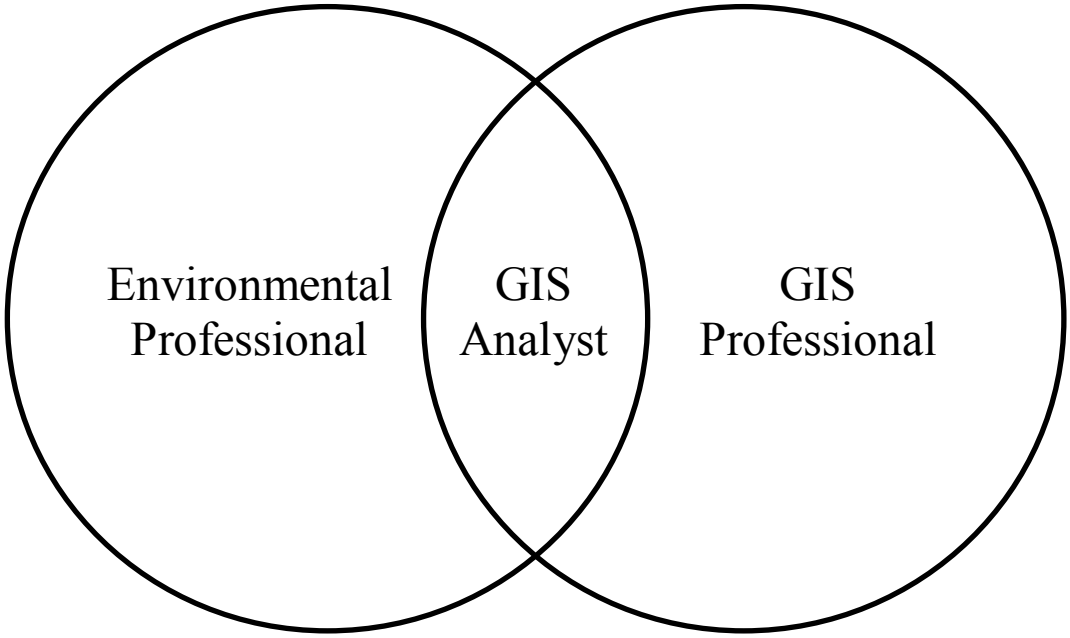


Figure 1: GIS Analysts sit somewhere between Environmental Professionals and GIS Professionals. They need to know enough about the problem being mapped to ask intelligent questions of the field scientists, and enough about GIS to bring useful information to the field scientists, and to bring a field map into a corporate GIS.

Environmental Professionals …

1. **GIS Professionals:** Those with GIS know-how tend to be technology-focussed and not interested in learning about the geographical problems they could be helping with.

2. **Environmental Professionals:** Most Environmental Professionals would prefer to be in the field rather than being behind a desk, and so they tend not to be interested in learning GIS.

Herein lays the opportunity for GIS newcomers. There is a great need for environmental professionals to take an interest in the basic use of GIS, and a great need for GIS professionals to take an interest in the basics of the geographical problems that they should be involved in mapping. Maps are so much more useful when the people creating them understand all the facets of the GIS project - the data inputs, the GIS processes used to create them, the nature of the problem being mapped, and what the resulting maps mean!

For the past two decades my work has involved a wide variety of geographical problems. For the environmental sector in particular, there are two major GIS issues that have not changed in this time…

1. **GIS environmental maps are often poor quality:** Because the cartographic clues to map quality that exist in the paper version of the GIS map (scale bars, thick lines, etc) get lost when the map is converted to GIS, maps are often poor without the users realizing it.

2. **Incorrect use of maps:** In a GIS, maps become scaleless, and while scalelessness is not a big issue for surveyed maps, it is a very big issue for environmental maps. The understanding of the data that lies behind GIS maps is often lacking by those who are using the maps and so the maps get used incorrectly. This is understandable because end users are used to using accurate GIS maps created by licensed surveyors – cadastre, engineering assets such as water pipes and electricity, etc, overlaid onto GIS corrected (ortho-rectified) air photos. In contrast, environmental maps are “interpreted” and their scale relates closely to the amount of fieldwork that went into creating them.

Why Simplicity Makes GIS Maps More Useful

Most of the GIS maps I create just demonstrate a thoughtful understanding of a geographical problem. I make a real effort to understand the problem I’m mapping so that I am able to ask intelligent questions of environmental professionals. I’ve often found that the key researchers in projects are amazed

at how far some simple GIS mapping can take them well beyond their initial expectations.

Usually the maps I produce are deliberately simple so that both stakeholders and decision makers can understand them readily. I always try to get to the point where few people would argue about a map. When you can get your audience to that point, decisions are the outcome of an informed political process, and a good map is far more likely to influence decision makers than a bad map.

There are two keys to creating useful GIS maps.

1. **Understand the problem:** You need to make the effort to understand the data behind the theme you're mapping, and
2. **Understand the Client:** You need to make the effort to put yourself in the boots of your client – how will they use the information you present to them and how can you make the interpretation easy for them to digest?

I always think of my maps as an executive summary because in a report maps are usually what people look at first. Pay attention to these simple ideas and you'll quickly gain the attention of key people in your workplace as being someone who produces useful information.

What's Environmental GIS?

One of the most useful types of environmental maps are soils maps. This is because soils determine so much of what goes on environmentally. I have used soil maps for projects such as water catchment management, agricultural quality assessments, crop and land use suitability, native vegetation assessments, and even buried water pipe performance in urban areas.

Many environmental maps were created using old field techniques. Often these incredibly inaccurate maps find their way into GIS and day-to-day use. However, with so many high quality complimentary GIS maps such as geology, contours,

waterways, etc, becoming available, many of these old GIS maps are ripe for updating. In the next section I'm going to introduce you to a clever approach for reinterpreting old paper maps in a GIS. This can be done in a fraction of the time and at a fraction of the cost of producing new maps from scratch.

The Secret to Creating Environmental GIS Maps Quickly

Often field scientists are sceptical of or intimidated by GIS, particularly older ones. This is frustrating because many of them have so much knowledge that would be lost if they were to leave the organization – and much of that knowledge is spatial. I'm talking about the sort of field scientist who has forgotten more about their topic than most people will ever know about it. These end-of-career professionals are at the top of their game and mostly have no motivation (or need) to learn GIS.

The trick to working successfully with field scientists is to remove GIS barriers by expressing your maps in their terms. This means that you need to produce paper base-maps for them to draw their interpretation on. You'll need to make your base-maps compatible with other maps they're familiar with in terms of scale and look, and highly focused in terms of the information you put on the map for them to use. Many field scientists find it easier if your basemap is comparable (scale and appearance) to a local road atlas that they're familiar with.

There's a bunch of information that people interpreting environmental themes need...

Air photos

It's best if the bottom layer of your basemap is an air photograph. These are generally taken around midday on the summer solstice. This is when the sun is highest and shadows are least. The colours and shades on the photography provide clues to the vegetation, soils, land cover, land use, etc. Although its counter-intuitive, black and white photography often shows more about a landscape than colour photography.

Stereo photos are raw air photos with a large overlap with adjoining photos. When viewed in a stereoscope you can see the terrain in three dimensions. Do not underestimate the usefulness of old-fashioned stereo photography for some projects. They can be an invaluable aid for pinpointing important areas to visit while in the field.

Rainfall records

For many environmental themes it's a good idea to match air photos with rainfall records from a nearby rain gauge. Rainfall records are available from your national weather bureau. Rainfall can have an enormous influence on the sorts of themes you can easily interpret – photos taken during dry periods can be good for interpreting detailed watercourse maps, and during wet periods, areas that might be susceptible to flooding. Never underestimate the importance of water – depending on how it interacts with the landscape it can influence soil formation and vegetation, and ultimately the level of engineering required to develop an area of land.

Soil and Geology Maps

For many environmental mapping projects, soil and geology maps are important. For example, sandy soils and clayey soils have quite different characteristics for plant growth, interactions with contaminates, building foundations and other engineering applications, etc.

Expect old maps to be spatially inaccurate because most were produced without the aid of modern surveying instruments. Its common for boundaries to be displaced by tens of metres – in one project I worked on they were displaced by two kilometres. However, even though the boundaries are displaced, the shapes and descriptions are likely to be accurate and just in need of updating with reference to more recent (spatially accurate) contours.

Other Maps

Other information that might be useful to environmental mapping projects are roads, fence lines, cadastre, slope maps, contours and water features. If you plan to use non-GIS maps as basemaps then scan and georeference them in your GIS and then print them out at the same scale as other basemaps in your project.

In most cases, if you can produce one single composite base-map with those themes that are most important to the interpretation, then that's sufficient.

Before you go into the field be sure to run your basemaps past your colleagues. Until you get to know how your colleague works, you will need to produce a number of basemap options for them to choose from. If you can, go into the field and try and understand how your maps are being used. Also, look at the maps that they're used to using, and then format your maps along those lines if you can.

What I'm talking about here is reducing barriers to the adoption of your maps. Too often GIS departments produce information that they think will be useful without first having a conversation about it with the people who'll be using the maps. This is not about you, it's about producing information in a way that can be easily consumed by your client!

Scale of Basemaps

Old-timers are used to putting maps on top of each other on light tables so producing your maps at the same scale is very important. For some projects I have even gone so far as producing the maps on transparencies so they can be overlaid onto the other maps I've produced for the project. Be aware that the heat from laser printers can shrink transparencies slightly. This often doesn't matter so much if you are intelligent about how the transparency gets used and how you input it into your GIS.

Once they've drawn their soils map onto the basemap you can input it into your GIS. I use a scan -> georeferenced -> on-screen digitize path for this.

Then use the resulting soils as a new basemap. Overlay important themes to the mapping project – themes such as water bodies and streams, contours and roads come to mind. Print the map out at the same scale as the basemap/s you used earlier. Give this map to your colleague to validate. Repeat this validation step as necessary until everyone satisfied that the map is final.

Example: Deriving a Soil Map from a Digital Elevation Model

Key Points

- **Stereo air photography:** GIS departments are often surprised when they hear that unprocessed air photos and old-fashioned stereoscopes are superior for some uses than are GIS air photos. Both types of photos have their place.

- **Field validation:** We used free iGIS on an iPad to field validate and calibrate our models.

- **Data quality:** Digital Elevation Models (DEM) are fascinating to look at, but unless created from quality height information, may be good for little more than visualization or regional scale GIS modelling. For this project, our soil model was incorrect when created using a contour generated DEM, but correct when run using a LIDAR DEM.

Good GIS modelling rarely happens in the absence of involvement of someone who really understands the problem being mapped. This project required input from a geomorphologist. Geomorphology is the study of landforms and landscapes, and how things such as wind, water, ice and fire mould the landscape. Similar geologies in different climates produce different landforms and different soils. A geomorphologist's understanding of processes allows them to describe models of landscapes and the soils that are associated with those landscapes. GIS is an ideal tool to express these models so when GIS meets geomorphology, magic sometimes happens!

In this example I teamed with a geomorphologist to model the location of…

1. deep soils,
2. soils containing rock floaters, and
3. surface rock

…to provide ease-of-digging mapping for a low pressure sewerage retrofit project in an urban area. The aim was to understand where small in-ground sewerage holding tanks could be easily located for each house. Site level sampling to do this would be prohibitively expensive for a whole-of-suburb project. In contrast, we produced a sufficiently accurate GIS soils model at a fraction of the cost.

Geomorphological background that informed the GIS model

Good GIS modelling rarely happens in the absence of involvement of someone who really understands the problem being mapped. For this project the geomorphologist needed to have an understanding of local soil formation processes to form a working hypothesis that could be then validated in the field. Here's the understanding he started with…

Hill slope erosion is known to be affected by slope gradient as well as by the density of the vegetative cover. The steeper the slope, the greater will be the rate and incidence of erosion, while the greater the density of the vegetative cover, the lesser will be the erosion severity. At the site the aspect of a hill slope has a major effect on vegetation density. South and east facing slopes (in the southern hemisphere) are always cooler and moister than north and west facing slopes, with a consequent difference in vegetation. The hot north and west facing aspects of the hills tend to have suffered more severely from bush fires and have lighter vegetation due to reduced rainfall effectiveness, and therefore have shallower soils from increased natural erosion. Topography also plays a major role. Convex slopes likewise will have shallower soils than concave slopes where erosion products may collect and linger.

The GIS model was informed by a preliminary field study that took into account this general understanding. This preliminary study used stereoscopic interpretation of aerial photography (scale 1:16,000), hand drawn onto GIS base mapping of a GIS corrected aerial photograph overlaid with contours and 56 borehole locations, printed at large scale. Field work added further hypotheses relating to slope breaks, the relationship between longer slopes and deeper soils, the influence of slope shape, and the influence of aspect.

Mapping

The stereoscope based mapping project was essential in order to develop the initial geomorphic hypothesis. Following the preliminary fieldwork, our improved understanding of the local geomorphologic processes allowed us to articulate a model of the local landscape as the three classes shown in Table 1. These numbers have a degree of arbitrariness but in a complex landscape it will never be possible to develop exact class groups. The best result that can be expected is classes that broadly have very different excavation costs associated with them.

Table 1: The three soil characteristic classes that were developed for the ease-of-digging map

Class	Aspect	Slope
Class 1: Soils to depth (2 metres) and hardly any floaters	West and north	0-12%
	South and east	0-20%
Class 2: Rock or floaters likely within 2 metres	West and north	12-30%
	South and east	20-35%
Class 3: Bedrock at surface in many places	West and north	>30%
	South and east	>35%

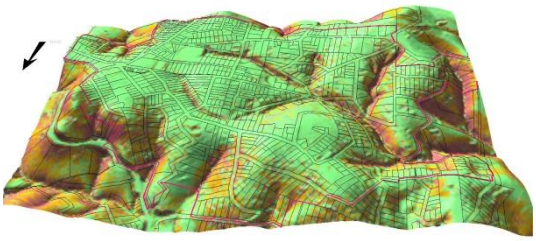
Once the geomorphological model in Table 1 was produced, GIS modelling could begin. That was undertaken using Grid Cell techniques in the Open Source GRASS GIS. Both slope and aspect maps were required so the first step was to create a Digital Elevation Model (DEM) that these could be derived from.

Digital Elevation Model version 1: The first version of the DEM was created using 1m contour data that was digitized off contour maps from the 1970s. Although the resulting soils model showed “promise”, fieldwork revealed that it was not sufficiently accurate to be used as a result for this project. The data path for a contour-derived DEM is convoluted and less accurate than other sources of DEMs such as LIDAR. Contours are good for creating “indicative”

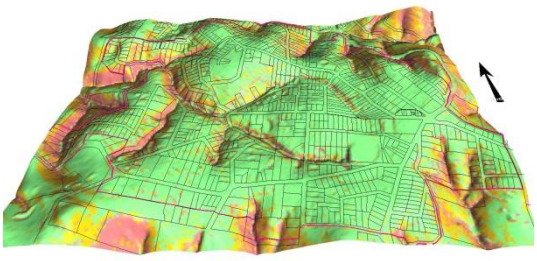
DEMs that while suitable for small scale applications, are unsuitable for a large scale application such as this one.

Digital Elevation Model version 2: A 1 metre grid cell resolution DEM produced from LIDAR became available part way through the project. LIDAR is an airborne technique for the direct acquisition of terrain height information. When the same geomorphological model was applied to the LIDAR DEM, the resulting maps accurately represented the three soil characteristic classes shown in Table 1. This model is shown as Map 1 and draped over the DEM in Figure 2.

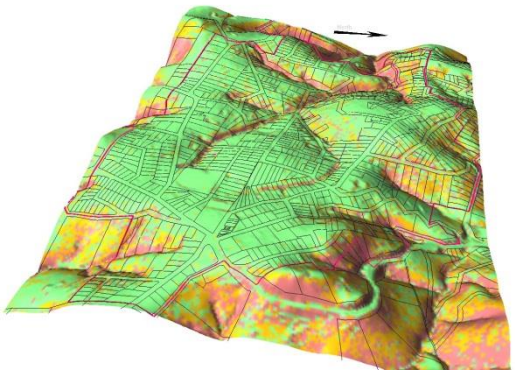
Map 1: The soil characteristics map overlaid with boreholes (see appendix 2 for descriptions) and cadastre.



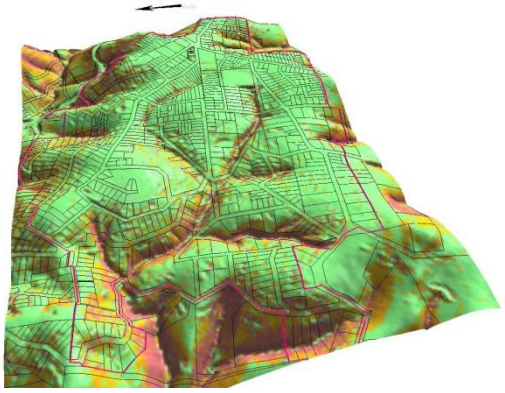
Viewing from north



Viewing from south



Viewing from east



Viewing from west

Figure 2: The soil characteristic model draped over the Digital Elevation Model (viewing height=1000m, vertical exaggeration=2). Looking at the models in this way, the relationship between slope, aspect and soil characteristics becomes obvious.

Conclusion

The soils in the area were mapped into three classes of predicted soil depth and prevalence of floaters and bedrock. These three classes are derived from the three slope classes and two aspect classes shown in Table 1.

The mapping was based on a few simple hypotheses of soil formation by weathering and soil loss by erosion or slumping which are well supported by

geomorphological knowledge of landscape development. These hypotheses were validated against more than 50 bore holes where the depth of soil and the presence of floaters or bedrock outcrop was known, and by further field observations (including deep road cuttings) in the field area.

The initial grid cell GIS modelling that made use of the contour derived DEM produced a map model that, while promising, was not sufficiently accurate to be included as a project result. At this point we almost abandoned the GIS modelling approach in favour of GIS-mapping a stereo photo interpretation. It was a big (and pleasant) surprise that the same geomorphological model (Table 1) applied to the better quality LIDAR DEM produced a GIS map model that accurately represented our three soil characteristic classes. This is confirmed by the following feedback from our client…

All the feedback we got from the auditor / designers and drillers is that the model you made is 'correct' (for the purpose). My understanding is all of the safe (deep enough) tank sites have proved correct and the cover for the line even where it's been tight has been good, they found a couple of place where it was out but not by much, 300mm or so. Nothing really given the trouble they would have expected without the model.

Example: Water Pipes and Very Detailed GIS Soil Environments

Key Point

- **Results are often Scale Dependent:** The more detailed the maps, the more granular the results.

In almost every city in every country, water pipes are buried in the ground. These fail at different rates for reasons that include asset material, age, technique of manufacture and the soil environment they are buried in. Very detailed system wide soil environment information has long been the missing component of water pipe failure models. In this project I related twenty unique soil environments to 7 ½ years of water pipe failure data recorded for ~2000 km of buried water pipes. Contrary to contemporary research directions, I found that to understand which aging assets will perform badly, it is not necessary to understand either the corrosive or mechanical soil characteristics that might lead to variations in water pipe failure rates. When correctly formatted, Very Detailed Soil Environment (VDSE) maps and sufficient historical failure records coupled with custom GIS software can be used to report quantitatively on both the spatial (where) and temporal (when) aspects of asset performance regardless of asset material.

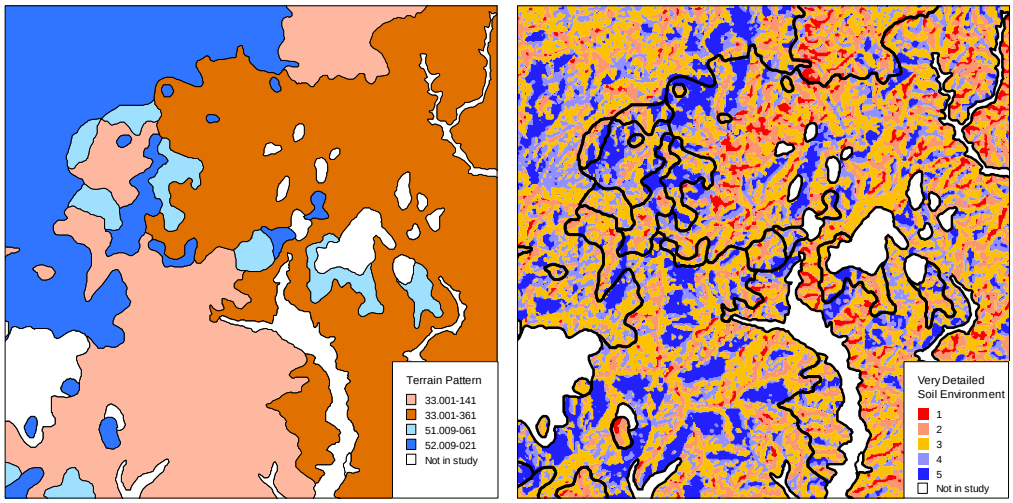
Introduction

In many places around the world, water security has become a very important issue. Water planners are faced with the prospect of having to do more with less. Often the drivers are some combination of drought conditions and an absence of opportunities for new dams, and increasing failure rates for older water pipes. Commonly water leakage accounts for around 10% of water losses, but it can be up to 50% in some places. So, for the water industry, fixing leaking water pipes is an obvious problem to address. Historically, targeting pipes for proactive maintenance has focused on mapping soils that are aggressive to water pipes. I have discovered that if system-wide soil

environment mapping is to be used successfully operationally, then very detailed fit-for-task soil environment mapping is required.

The idea of searching for a recipe to describe aggressive soils dominates the literature. In contrast, I discovered that a uniform group of assets will respond uniformly to a uniform soil environment. The GIS Very Detailed Soil Environment map I used in this study delimits areas likely to be uniform in terms of both soil chemistry and soil reactivity (shrink-swell) combinations. The technique I discovered required only a sufficient number of geo-referenced failure records and assets to train the GIS map of Very Detailed Soil Environments.

Soil Environment Mapping



Map 2: Terrain patterns on the left compared to Very Detailed Soil Environment (VDSE) mapping for four of the five terrain patterns in this study. Overall, the generation of the VDSE map led to an increase in detail of around 250 fold.

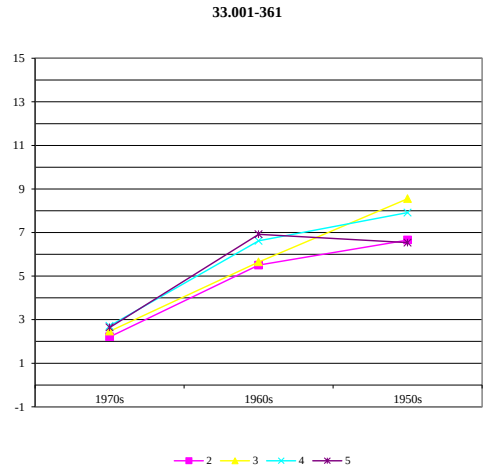
I started my Very Detailed Soil Environment mapping with an accurate 1:25,000 scale GIS terrain pattern map covering 3000 km^2. A Terrain Pattern map is a form of generalized soil map – basically, it's a geology map (often small scale) attributed with very detailed soil descriptions. The Terrain Pattern map in this study was value-added to produce a VDSE map (Map 2). My Very Detailed Soil Environments map made use of historical water pipe bursts, slope and aspect

information (derived from a digital elevation model), and was customized for each terrain pattern. The improvement in map detail for each Terrain Pattern brought about by the creation of the VDSEs was variable, but on average was in the order of around 250 fold (ie. on average, each terrain pattern polygon became 250 Very Detailed Soil Environment polygons).

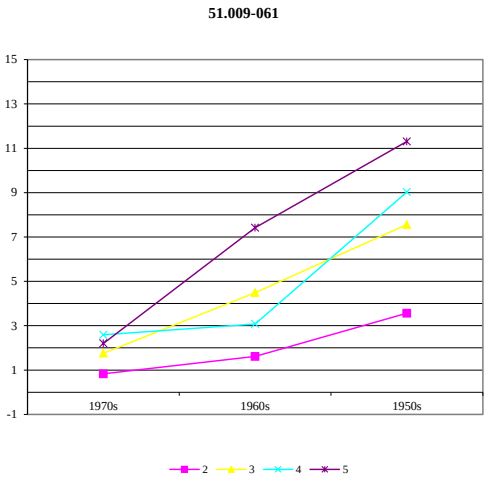
GIS Very Detailed Soil Environment Map and Water Pipe Bursts

Chart Series 1 and Map Series 1 demonstrate that water pipes fail variably not only between Terrain Patterns, but also between the VDSEs within the terrain patterns. Age is a very important factor, and while younger assets almost always perform better than older assets in the same VDSE, there are many cases where younger assets in one VDSE / terrain pattern combination perform worse than older assets in a different VDSE / terrain pattern combination. For example, looking at terrain pattern 51.009-061 in Graph 2, 1960s cast iron water pipes in VDSE 5 of one terrain pattern perform at 7.5 failures / 10 km / yr compared to 1950s cast iron water pipes in VDSE 2 that perform at 3.5 failures / 10 km / yr.

Chart series 1: Cast iron reticulation water pipe performance in groups representing decade of installation (x axis), and expressed in terms of failures per 10 kilometres per year (y axis). The legend values of 2 thru 5 represent the VDSEs within each terrain pattern. In graph 1, although the failure rates increase in older assets, the failure rate remains within ~2 failures/10km/yr. However, in graph 2 although the failure rate increases in older assets too, the variation between in the failure rates of assets in each VDSE is much greater ~8 failures/10km/yr for assets installed in the 1950s.



Graph 1: 279 kilometres of assets



Graph 2: 146 kilometres of assets

Discussion

I found that when asset performance data are aggregated, much of the variation that occurs between asset groups is masked. However, when the data are disaggregated both spatial (where the burst occurred) and temporal (when the burst occurred) variability in water pipe failures is revealed. When VDSEs are incorporated, the range of asset performance is as low as 0.83 failures / 10 km / yr for a group of 1970s cast iron assets, and as high as 17.43 failures / 10 km / yr for a group of 1950s cast iron assets.

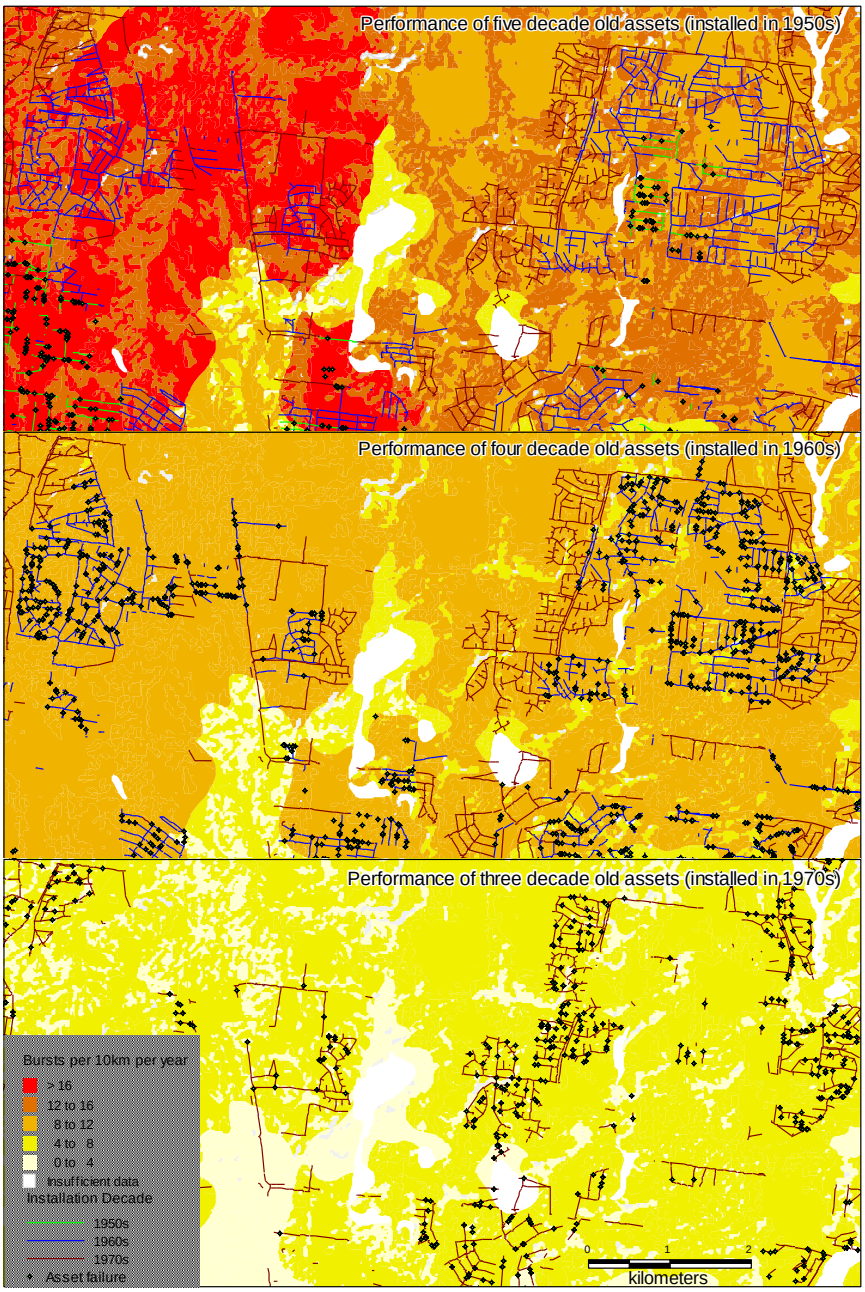
Also, the near doubling of water pipe renewal activity in 1940s water pipes compared to 1950s water pipes would suggest in a decade's time from this 2003 dataset, there might also be a doubling of failing 1950s installed water pipes also. This is also shown in Map Series 1.

Conclusion

I created a Very Detailed Soil Environment map using historical water pipe bursts, slope and aspect information (derived from a digital elevation model), and I customized my model for each Terrain Pattern. The improvement in map detail brought about by the creation of the VDSEs was variable, but on average each Terrain Pattern became around 250 fold more detailed. Contrary to established techniques in the literature that focus on creating maps of soils that are aggressive to water pipes, my approach allowed me to match historical water pipe bursts to the VDSE polygons, attach this information to individual sections of water pipe, and then report on historical water pipe performance, as well as modelling future water pipe performance.

I found that Very Detailed Soil Environment (VDSE) Maps and historical failure records can be used to a gain system wide understanding of asset performance variability. Assets that are aging faster than others can be identified and quantified so that organizations can respond in ways that give them the best chance of maintaining the performance of their aging assets within existing budgets. Such responses may involve new strategies such as renewing sections of assets rather than whole assets.

Full citation*: Allan, Ian. "The Role of Very Detailed Soil Environment (VDSE) Maps in Assessing the Performance of Buried Water Pipes." Engineering Asset Management and Infrastructure Sustainability. Springer London, 2012. 39-53.*



Map series 1: Asset performance zones for cast iron assets installed in the 1950s, 1960s and 1970s. This is a small subset of the study area. The relevant failure data are overlayed for each decade, as are subsequent decades of cast iron assets. The VDSE map not only delineates areas in terms of asset performance for the decade being analysed, but also illustrates how younger assets can be expected to perform in the future. For example, the

1950s map also shows how 1960s assets are likely to perform in ten years time and how 1970s assets are likely to perform in twenty years time.

Example: GIS and Environmental Conflict Minimization

Key Points

- In planning conflicts, maps can act to re-focus participant's attention and diffuse entrenched interpersonal conflict.
- It is important to make the effort to bring together fit-for-purpose maps that are relevant to the planning problem. To promote stakeholder confidence in the planning process, if important maps are absent then they should be created.

In the early 1990s I observed a rural planning workshop that was, well, there's no other way to describe it, "constipated" by an entrenched conflict between elderly landowners that obviously dated back to the school yard. If the landowners couldn't agree with each other, how could they possibly reach agreement with planners? Fortunately, the tone of the workshop changed after a landscape architect took a wad of butcher's paper, hand-drew maps of the town on it, and then sticky-taped the maps around the walls of the venue. Almost immediately the interpersonal bickering ceased and *all* the workshop participants started to talk about what was right and what was wrong with the maps. This little episode captured my imagination and I wondered what difference it would make if accurate interactive GIS maps were used in the planning process. That story is the backdrop for both my personal career in GIS and the text that follows.

It is common for rural towns to have many vacant residential blocks. Increasingly there are pressures to build on these by people seeking tree change, sea change, or just affordable housing. Such pressures can trigger planning reviews that must refer to more rigorous environmental standards than were in place when the land was first subdivided. Often these blocks are not connected to town sewerage, so central to the planning conflict that follows these reviews is a block's ability to treat and contain wastewater within its

bounds. If a block is very small, has steep slopes, has inappropriate soils, or some combination of these, then planning regulations might prevent a landowner from building there. But it is not a planner's job to maintain property values. It is their responsibility to ensure both public health and environmental health. Simply put, planners need to be sure that when someone flushes their toilet that the waste doesn't end up in their neighbour's yard, or in the local water supply.

Understandably, when a block of land cannot meet contemporary onsite wastewater performance standards and planners revoke ratepayer's rights to develop their land, it tends to make the ratepayer angry because it can make their land worthless overnight and so impact important life-planning issues such as financial planning and retirement planning.

In the text that follows I'll use two examples to show you how GIS can be used to minimize small town planning conflict. The first uses GIS for conflict resolution and the second uses GIS for conflict avoidance

.

Example: Resolving Planning Conflict in a Waterfront Development

Key Point

- Strategic land use planning can have greater transparency when GIS is involved because it makes the process all-at-once scientific, repeatable, and defensible

These days people's "BS" meters are fully operational. If someone's neighbor can develop their land but they can't, then they want to know why. The Lakefront project demonstrates that GIS has an important role to play here.

Some time ago I worked on a lakefront planning project. At a meeting before my group became involved tempers flared so much that security had to be called. In contrast, following the community meetings my group ran, residents shared tea and biscuits with Council staff. Why the difference? I think it's simple. The GIS approach promoted transparency in the planning process. These days, especially since social media has allowed community voice to be heard, people's "BS" meters are fully operational. If one resident gets an entitlement that another doesn't get, then the reason for the difference needs to be demonstrated. GIS can play a very important role here.

Map 3: When I related all the physical constraints (steep slopes and watercourse buffers) to the blocks, and then superimposed the soil's capability to dispose of domestic wastewater safely, the landowners could see which blocks could be developed, which could not, and why.

In the community meeting we began by talking about the environmental and planning constraints imposed by more senior levels of government and their link to water quality and community health. Then we overlaid the government

regulated GIS constraint maps (steep slopes and watercourse buffers) on top of each other. After that we overlaid a soil map that we created, and finally a property map. Because, the community was able to see how the constraint maps built up and how each of the maps interacted, they could see that this planning process was scientific, repeatable and defensible. We demonstrated and explained to all stakeholders why their town could not sustain development at the density shown in the current plan. We also showed individual lots that could sustainably dispose of wastewater onsite, and which ones couldn't.

Example: Avoiding Planning Conflict in an Estuary Town

Key point

- Many environmental Codes Of Practice incorporate spatial criteria such as size of block, distance from water feature, presence of steep slopes, and soil type. GIS maps of these themes can be combined to produce a map model showing which areas in the map comply with the relevant Code.

When wastewater flows into estuaries it can cause algal blooms and subsequent fish kills, wildlife kills, amenity loss and tourism loss. Estuaries are environmentally and economically important areas that must be protected. The following project is an example of a planning authority trying to understand if a small town on the banks of an estuary has the potential to cause environmental harm.

In this project there was no community conflict but real concern by a Planning Authority that an unsewered small town was polluting a local estuary. Our role was to assess whether the low-tech domestic wastewater systems throughout the town were polluting the estuary. If they were, then a multimillion dollar wastewater system may be required.

Normally we would look for evidence of wastewater problems in a town, but from the outset we knew we would be unlikely to find evidence such as street-side sewerage overflows that are common in so many small unsewered towns because the soils in this town were sandy and porous. Such soils tend to "dispose" of wastewater rather than "treat" it. Compounding this problem was our belief that there were likely to be very old, very basic (and highly polluting) domestic wastewater systems scattered throughout this town. Such systems would not be allowable under the State's new Domestic Wastewater Code of Practice. Often when GIS modelling, some assumptions need to be made, and in this case I had to assume that all the systems in the town complied with the present Code.

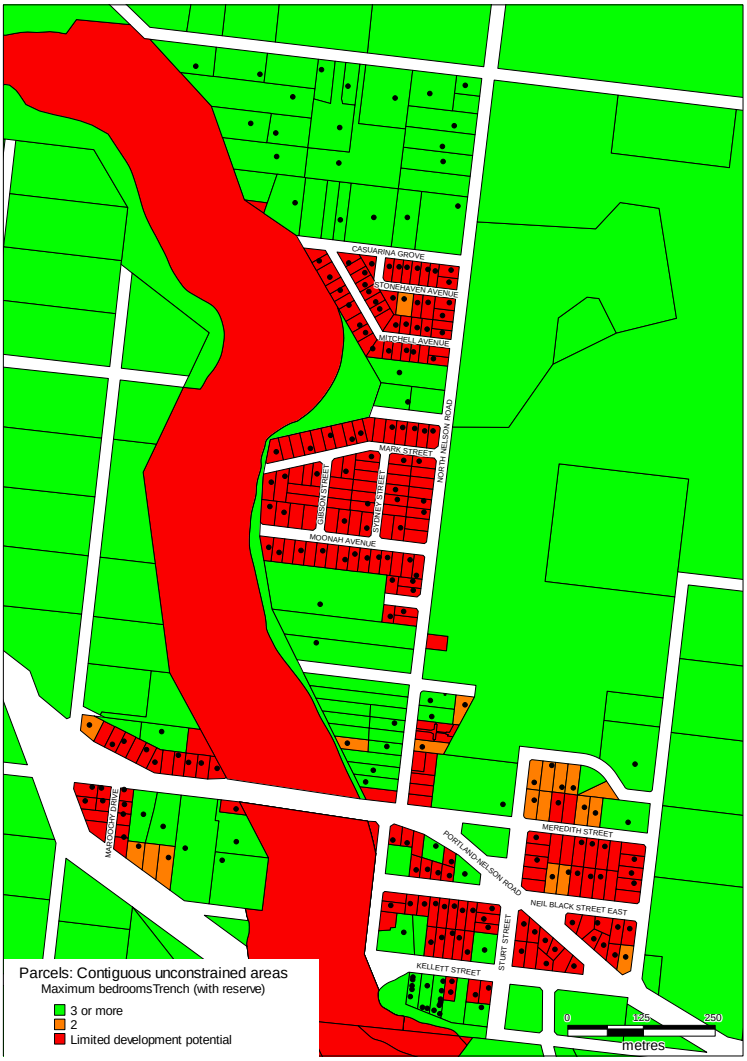
I used GIS to model whether or not each block in the town complied with the wastewater management criteria in the new Code of Practice. I produced map models of two scenarios showing how sustainable the town would be over time, and color coded the resulting maps according to a traffic light principle. What if every block in the town was to be developed and each used...

- **Scenario 1:** Low-tech wastewater technology that would be ineffective if blocks were not large enough (Map 4)
- **Scenario 2:** Advanced wastewater technology that would be effective, even on small blocks (Map 5)

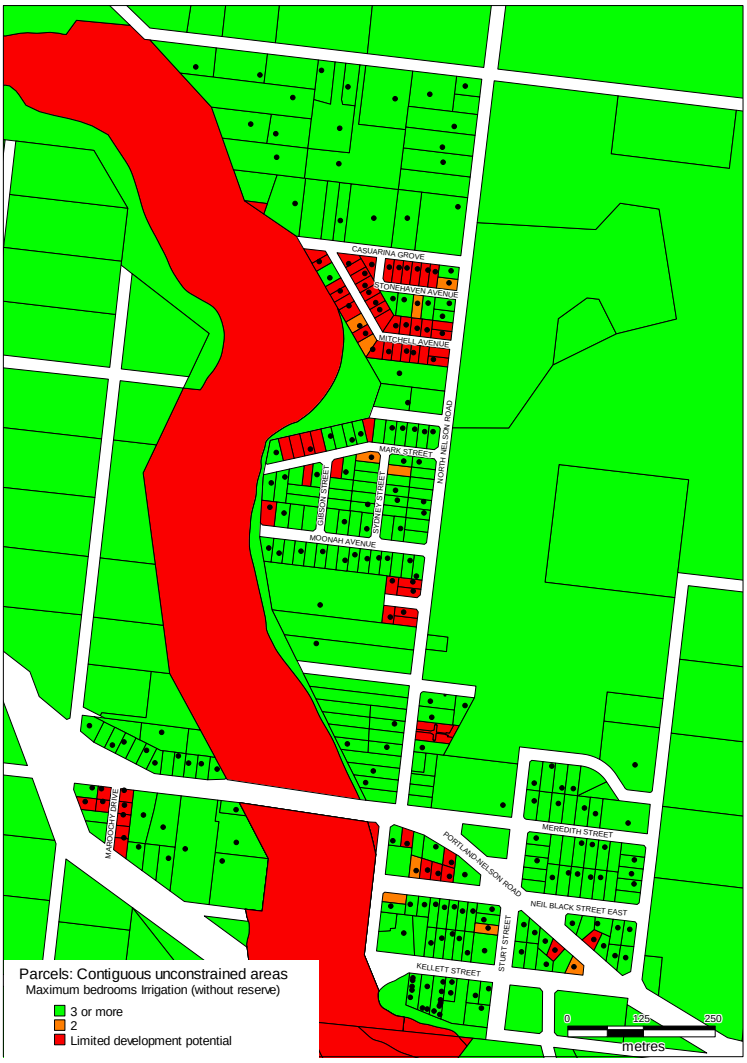
The GIS maps I used were all important to the new Code of Practice - constraints such as steep slopes, proximity to water, and soil suitability. Then I applied a formula that calculated the largest development that would be sustainable on each block, and expressed that in terms of the maximum number of bedrooms that would be allowable according to the Environment Protection Authority Code of Wastewater Practice.

It's clear that the business-as-usual approach (Map 4) would not be sustainable in the long term. In this map the majority of the blocks in the town are shaded red indicating that their wastewater treatment systems do not comply with the present Code of Practice. It seems that the local government's concern for the estuary was justified.

In contrast, Map 5 shows that if the technology in all household wastewater systems were to be upgraded to advanced wastewater technology over time then only a section in the town's north would remain a concern. Although this area may need to be sewered, the project, and therefore cost, would be substantially less than sewering the entire town.

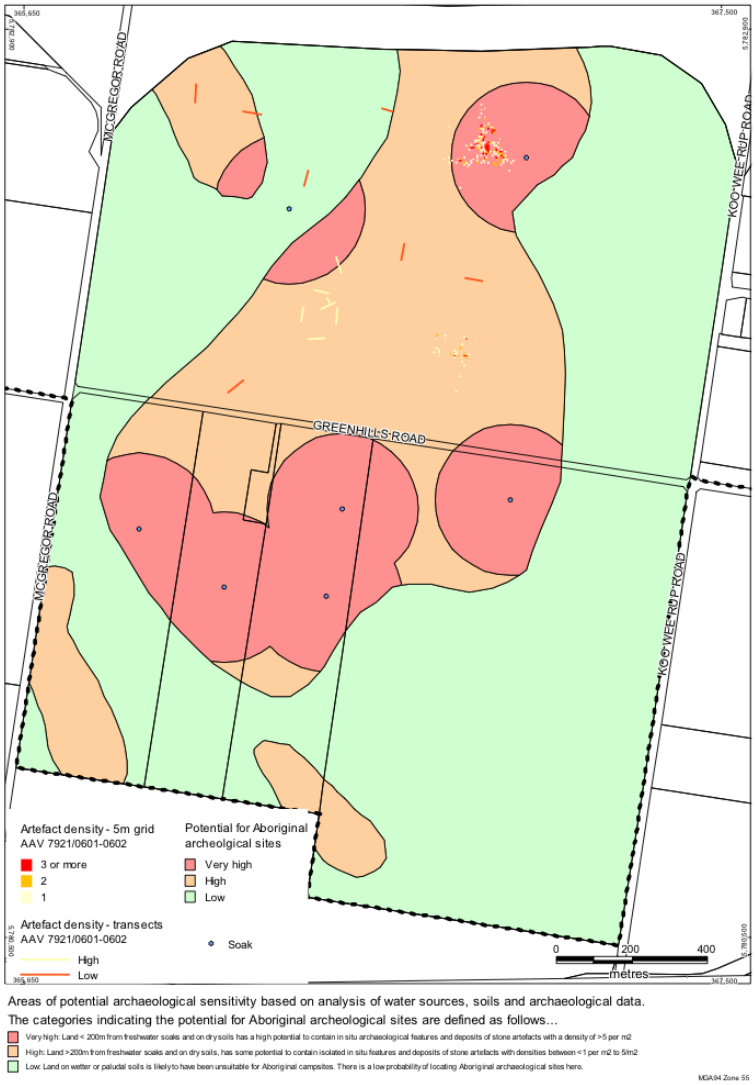


Map 4: This is a GIS map of the sustainability of the town if council continued to approve current wastewater technologies. This GIS map illustrates that the continued use of these systems is not a sustainable option for town growth. There are a significant number of properties with limited development potential. Many of these are already developed (dots), and many are clustered suggesting that there are probably already wastewater problems in the area. Such clusters represent areas where point sources are most concentrated, and by inference are the areas of most pressing concern. Severe problems could emerge if all parcels were to be developed under this scenario.



Map 5: This is a GIS map of the sustainability of domestic wastewater systems if all the existing systems were to be upgraded to a more sophisticated technology. The dots are houses. Blocks that were unsustainable with their existing systems become sustainable when the technology is upgraded. Slope and stream buffer constraints have less impact on developability due to smaller disposal area requirements. There is only one section of the town that seems to be a problem. When we last dealt with Council they were unsure whether a small localized sewerage plant would be installed there or whether residents would be forced to treat their wastewater to a higher standard by upgrading their systems to a better technology.

Example: GIS and Aboriginal Heritage



Map 6: This map was accepted as a starting point for survey and site preservation by traditional owners, regulators and developers.

Key Point

- Many of the reasons why Aboriginals would choose campsite locations are spatial. For example, proximity to drinking water, food and dry locations. Maps of these criteria when combined in a GIS, can act to give focus to archaeological investigations.

Government often frustrates developers by forcing them to undertake expensive and time consuming archaeological investigations on proposed development sites. GIS can speed things up by helping archaeologists focus on areas where they're most likely to find artefacts. Read on for an account of one such project.

These days when someone is developing a large tract of land, all sorts of government bodies have a say. In Australia, as in many parts of the world, the documentation of traditional ownership and sometimes the recovery of significant items is important. Developers dread the government prescribed archaeological surveys because they can be time consuming, expensive and often lack focus. Commonly the prescribed survey methodology involves site sampling on the basis of grid squares. For developers, mostly it's the delay-to-market that concerns them because nowadays their contracts tend to adjust the final purchase price to account for land lost to heritage issues.

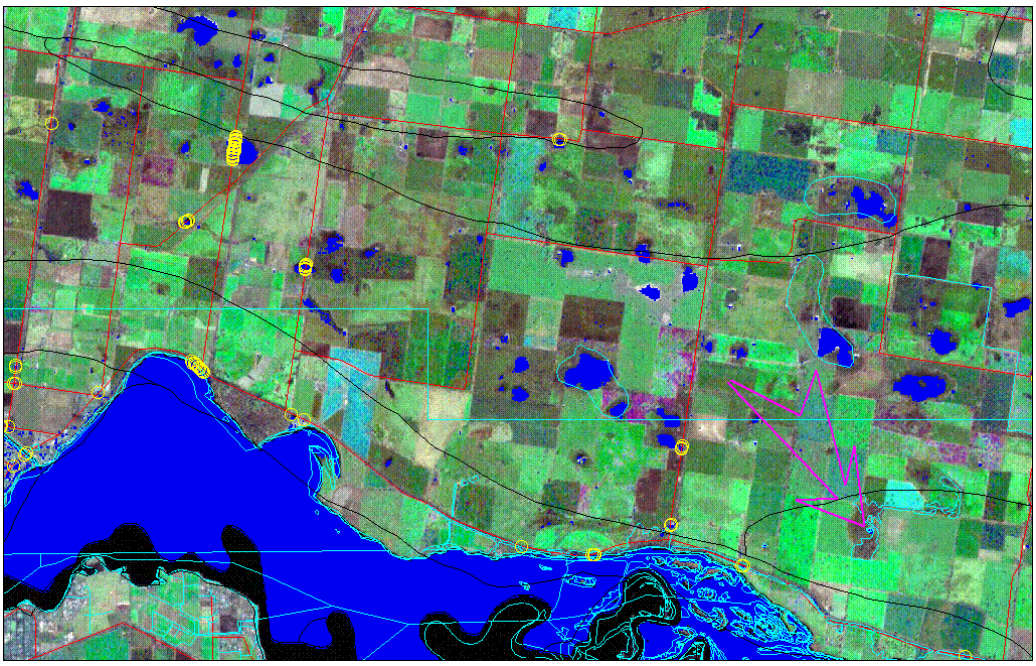
Over the years I have participated in numerous Aboriginal heritage projects. My team's job is to give the archaeological investigation focus. The team includes an archaeologist who understands the cultural behaviours that might lead Aboriginals to favour some places in the landscape over others, a geomorphologist to interpret how the landscape would have looked at the time of occupation, and myself - I have a general understanding of landscape and archaeology, and tend to ask searching questions that usually result in better project outcomes.

In contrast to the grid square approach often prescribed by government, we begin each project with a hypothesis to test. For this study the hypothesis was that Aboriginal camp sites and workshop sites would be selected on the basis of physical advantages, such as dry sheltered sites, and proximity to food and drinking water. The key to these sorts of studies is to match the likely site characteristics to an understanding of how the landscape would have looked at the time of likely occupation (ie. an ideal campsite at one point in geological time might be under water at a different point in geological time).

In this study, the archaeologist told us that Aboriginals preferred to get their drinking water from springs rather than streams, and chose to camp on cooler south and east facing slopes in summer, and the warmer north and west facing slopes in winter. Our report contained much science about why the local landscape was stable during the period of archaeological enquiry and then used this understanding to extrapolate some likely sites.

Map 6 shows water springs that we identified in the field and from air photos, and areas where the probability of finding aboriginal artifacts in certain areas was greater than in others. Often overlooked, another important facet of this map is that it also shows areas where the probability of finding artifacts is low. The map allowed archaeologists to focus their labor intensive efforts and gave planners and developers early warning about the likely pattern of estate development. Our methodology was acceptable to traditional owners, regulators and developers.

Example: Mapping Soil Drainage with Satellite Imagery



Map 7: This is a mixture of multiple GIS maps - roads, irrigation channels, and satellite derived "themes". A LandSat satellite image was "classified" to show ponded water as dark blue. Ponded water indicates that the soil has very poor drainage, and consequently low agricultural productivity. The pink arrow points to an area known to be poorly drained on one side of a fence and well drained on the other side of the fence. This suggests that some of the area's poor drainage problems could be overcome by different land management. The yellow circles were derived from a satellite image collected during drought. These are channel sides with vigorous plant growth and so possibly indicate channel leaks.

Key Point

- Satellite imagery can be a good alternative both logistically (fewer photos) and economically (some satellite imagery is free) to air photography when studies are over large areas. Satellite imagery can be analysed by remote sensing software to detect spectral features, in this case, ponded water. This study highlights the need to carefully select satellite imagery so that the map themes you're interested in are present.

In low rainfall New South Wales, farms can be enormous - square kilometres in size and their driveways are kilometres long. Often these large farms are a mix

of irrigated and dryland farming. Both water management and land management are important if soil salinity (the area was once an inland sea), a major factor affecting agricultural productivity in the area, is to be managed. In this study I combined satellite imagery analysis with GIS maps to highlight areas where land management could be improved.

I have been involved in numerous regional agricultural studies over the years and this study is one that stands out in my mind. The farms here are large and annual rainfall is low (around 450mm or 17 3/4 inches), and so the area is very dry. The area was so large that we used satellite imagery because it was impractical to use conventional air photography.

Satellite images are not just large photos. Using remote sensing software they can be "trained" to detect features such as ponded water sitting on the ground, a very important theme for this study. I recall writing the following paragraph in the project proposal…

"ideally we would use one satellite image from drought times and then a second image following a large rain event. That way we could detect ponded water sitting on the ground."

In a once-in-a-lifetime coincidence, the week we signed the project contract, the skies opened up to the largest rain event in more than a decade. Immediately following that the skies cleared in time for the Landsat satellite to collect a cloudless image on its one-in-every-16-days pass-over. The way these events unfolded was pure luck!

Map 7 is one of many maps I produced for the final report. It shows irrigation channels with potential leaks, and areas with surface water ponding where altered management practices would improve soils and return retired land to high productivity.

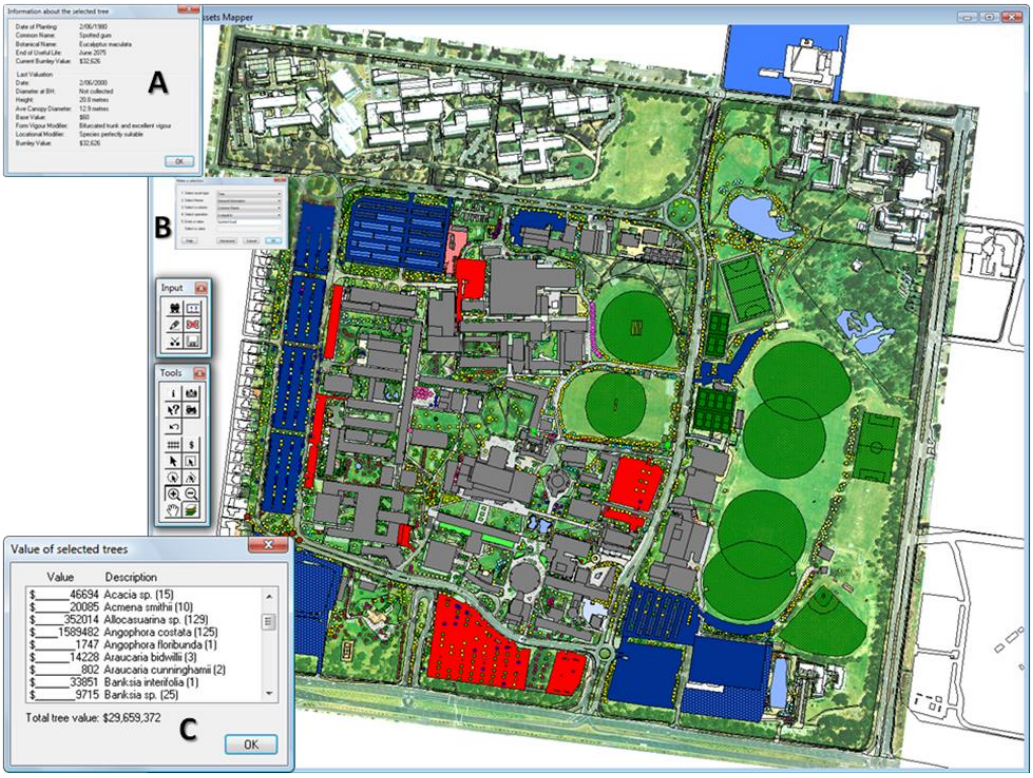
Example: Mapping Natural Assets

These days it is common accounting practice to include plants and gardens on government and corporate asset registers. GIS is an ideal stocktake tool for this. For some parks it is important to document assets such as garden seats and picnic tables. In other parks natural assets such as trees and habitat are important. Once documented, assets can be valued and management regimes determined. The flow on from this is that park managers have a better ability to report on the condition of their assets, and a much sounder basis for funding applications to support works. Park managers also tend to gain an improved status in the decision making loop. Following are two examples of vegetation surveys of quite different types. In the first we place a dollar value on park trees and in the second we document roadside vegetation for its habitat potential.

Key Point

- GIS has made it feasible to map and report on park features as diverse as rubbish bins and trees. When organizations realize that Park Managers control valuable portfolios, this allows them to express them in terms that are acceptable to financial controllers, and so can give Park Managers improved status around the decision making table.

Example: Living Assets Inventory



Map 10: Grounds staff could… A: click on an individual tree and find out information about it, B: look for a particular species of tree on campus (near box B all Spotted Gums are circled), or C: query the value of trees in a selection.

By the end of this project a humble grounds curator was the custodian of a $30 million living asset inventory. Suddenly, decisions concerning his portfolio took on greater importance for his organization.

One of my first projects was to create a Living Assets Inventory for a university. The project involved surveying all the University's trees and writing GIS software to allow the grounds staff to query information about them.

Typically in an organization's circle of decision makers, the grounds curator does not wield the level of influence that other players do. It must be frustrating

to nurture trees till maturity only to see them die because a different department has cut their roots while laying computer cables between buildings.

Using surveying quality GPS we surveyed around 3500 trees and then used a valuation formula developed by a local horticultural college to place a dollar value on each tree. The formula used attributes such as tree age, height and general health. When finished, the trees, now redefined to be “living assets”, were valued at almost $30 million. Although trees would be unlikely to compete with new building plans, on many occasions the grounds department had power around the decision making table that it had not previously had.

Example: Vegetation Condition Assessment

Map 8: This is one map of around 30 that were produced for our client. This map deals with vegetation quality at the mouth of the estuary. We used the grid system from a local street atlas so that casual users could relate the vegetation quality to the street map

Environmental departments are notoriously low priority at funding time. When nature parks are surveyed into areas representing vegetation types, habitat areas and quality, they can be managed in ways that make it more likely they will meet financial controller's funding criteria.

In this project I worked with an ecologist to map native vegetation conditions in public land surrounding an estuary. We used air photos, GPS coordinates, and street map coordinates to visually orient the interpretation. The resulting maps gave the environmental department a clear overview of the vegetation conditions and allowed them to target areas for better protection and improved maintenance, as well as helping budget for new works.

Can you teach yourself GIS?

It is often said that GIS is a highly technical and cutting edge technology. Although this is undoubtedly true for people writing GIS software, it is no longer true for the GIS user community. For the User Community, GIS continues to get easier to use.

The GIS landscape has changed in recent times. In many organizations GIS has become as routine as word processing. And in recent years Google and others have played an important role in making mapping accessible. As a consequence many organizations now expect projects to include maps and spatial analyses.

Although mapping using canned data (a small number of standard GIS maps such as roads, public transport, air photos, etc.) on web applications such as Google Maps has been a boom for many industries, the absence of custom GIS maps and analytical techniques on Google and others has frustrated those people who would love some way to create and analyse their own GIS maps. Custom GIS mapping and analysis requires specialist GIS software and also the knowledge of how to go about bringing GIS to your project. The good news is that no matter what level you want to be involved at, **these days there are NO OBSTACLES to learning GIS…**

- Computers are fast, reliable and affordable,
- GIS Software has become simpler and more logical to use, more functional and Open Source GIS such as Quantum GIS is free.
- GIS Maps are more readily available than ever before. Many can be downloaded for free from websites over an internet that just gets faster and faster
- Training options range from forums for trouble-shooting, ad-hoc tutorials on the web, university degrees, commercial training and web based training.

This can absolutely work for you!

New comers are often intimidated by the breadth of things that some web sites imply that you need to know. However, the gem that rarely emerges is that **once you have core training, you only need to know those bits of GIS that are required to solve the problems that you're working on**. Very few GIS professionals ever use the full range of GIS functionality – they just get very good with the bits that they use frequently.

You don't need to be some "techo" to become proficient at GIS. In fact, it can be just the opposite. Some of the most interesting uses of GIS come from people who delegate it to the role of "tool" in their job. People who are primarily foresters, demographers, marketers, planners, academics, engineers and even just people who are passionate about solving a problem that has come into their life. No one is born a GIS guru.

Your Personal Characteristics

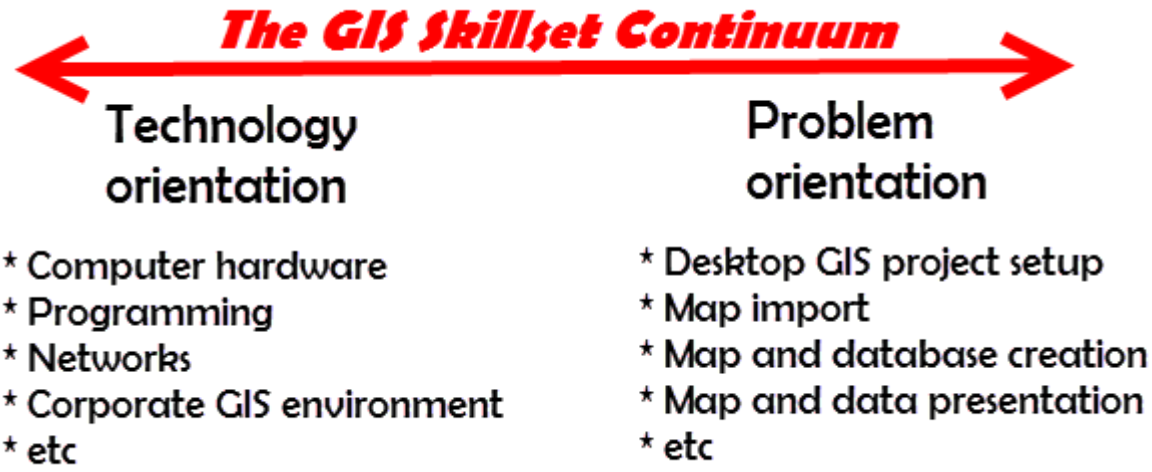


Figure 3: The GIS Skillset Continuum. At one end there are jobs that are very Technically Oriented, and at the other end there are jobs that are Problem Oriented.

GIS jobs lie on a continuum with very Technically Oriented jobs at one end and Problem Oriented at the other end that no more technical than that of competent

word processing. Of course, there are any number of GIS jobs that lie somewhere in the middle of the continuum.

Are You Technically Inclined?

These are the people who can always get obscure file types to open, who can work through coordinate system issues and overcome network and plotter errors. These people do well in corporate situations where technical trouble-shooting skills are really valued. They thrive on the scripting and programming challenges that GIS has to offer. To be really good at their job, they should also have a basic understanding of cartographic theory.

Are You Application Inclined?

These are usually professional people who have a need to add a GIS to their toolkit. They might be an engineer, an environmental scientist, or a social scientist. They know what mapping they want to create or analyse, but just need to be shown the GIS functionality that's relevant to their project and how to link the functionality together to get the results that they're after. As successful professionals already, GIS tends to make them more successful in their career because GIS becomes a tool to explore the problems that they're working on in a new way. And as young professionals, GIS makes them invaluable team member earlier in the careers than otherwise would have been the case

The Thirteen Basic Skills You'll Need to be Good at GIS

Whether you have a technical bias or an application bias, there are some fundamental GIS skills that you will need to do your job. However the level of technical proficiency you'll need at each skill will depend very much on the type of GIS work that you're doing. In short, ask yourself "what do I want to do with GIS". Then you'll be well placed to find out what you need to know about GIS. The only area of knowledge I feel should be compulsory for all, is a good understanding of the traditions of geography and cartography. That's because many GIS maps started out as paper maps, but the cartographers tools such as scale, line weight, fill patterns, etc tend not to find their way into GIS.

Below are thirteen types of GIS skills that, depending on how you use GIS, may or may not be useful to you.

Basic Cartographic Traditions

You should take the time to understand the geographical and cartographical traditions behind GIS. That way you'll soon learn that the real power of GIS is in combining disparate datasets to analyse things, and then make decisions from the analysis. Pattern recognition is also an important skill to learn here.

Basic GIS Theory

Many of the sophisticated algorithms being used for GIS analysis (such as pattern recognition, classification algorithms, and spatial auto correlation) are best applied by GIS professionals who know the underlying theory. The need for in-depth knowledge of these topics will depend on the nature of GIS tasks you undertake.

How to Produce Cartographically Pleasing Maps

The ability to make a good map that communicates to its audience is important. This does not mean that you need to be able to produce a map that National Geographic would publish though - that's a Graphic Artist's job. It is however, important that any map you create is done so on the basis of cartographic principles.

How to Create and Edit GIS Maps

Often the full range of GIS maps required for a project will not be available. This means that you need to know how to turn a paper map into a GIS map (digitizing). Because high quality environmental GIS maps are often missing in corporate GIS systems, this is an important skill for you to learn.

How to Create, Edit and Query Tables

Tables (think spreadsheets) hold information about geographical objects. For example, a point on a map could be a rubbish bin or a tree or a power pole. The

ability to create and populate tables in a meaningful way is an important GIS skill.

As an example, a municipality might map its rubbish bin assets as points, and then attribute each point as being a rubbish bin, made of other plastic or metal, and installed on a particular date. With a GIS database setup, maintenance-scheduling engineers could ask the GIS to “show me all metal rubbish bins in each suburb that are more than 10 years old”.

How to Clean Tabular Data and Represent it Consistently

GIS can only be used to produce meaningful and reliable maps on the basis of good quality data. Not all data cleaning needs to be done in a GIS. For example, spreadsheets are important data cleaning tools. They can be used to make data changes quickly and easily, especially for simple tasks like changing uppercase letters to lowercase, or finding and replacing text.

How to Use Global Positioning Systems (GPS)

Being able to use GPS is an important skill for those who want to map their fieldwork, as is the ability to move information between a GPS and GIS. These days the GPS in smartphones are sufficiently accurate for many GIS projects.

Basic Air Photo Interpretation

Air photos are not just pretty backdrops to other maps. When carefully selected (ie. accounting for season, matching rainfall records, and for dates that are important to your project) air photos can be used to show areas of vegetation under stress, assist with archaeological investigations, help map land use change, and much more.

Geocoding (Mapping an Address in a Table)

Turning your own spreadsheet data into a GIS map is an important skill. The approach you need to take to do this depends on the GIS maps you’re geocoding to. Many people give up on geocoding because achieving acceptable success rates can be difficult. However, with some training you can improve

your geocoding success rates significantly, particularly if you get good at data cleaning.

Metadata (Describing Datasets)

You need to be able to describe your GIS projects so that other people can understand how the maps in it were created. Metadata requirements can be very formal, but there are also minimal requirements that are not onerous to meet.

Programming and scripting

Scripting and programming are advanced GIS tasks. It is not necessary to know them when you first start using GIS. It is however the key to automating repetitive tasks. For example, a routine editing job such as combining thousands of house numbers and street names into address information could be achieved in seconds using a short script. Python is undoubtedly the scripting language to learn these days.

Data Presentation

A basic knowledge of spreadsheets or database systems will also help. Its not always about the map. Sometimes it also about summarising the data within the map - for example summarizing in tabular form how many hectares of high habitat quality there are, or how many kilometres of water pipe are asbestos cement, how many properties are affected by a new planning proposal, or how many kilometres of roads are poor quality.

You Need to Understand the Problem You're Mapping

Knowing how to apply GIS to an industry is important, and will make GIS easier to learn. That is why, if possible, you should manage your own small hobby-project while you're learning.

The traits of a good GIS course

The most important trait of a good GIS course is that the way its presented suits the way you learn best. And that its content also matches to what you want to gain from the course.

The really big problem for learning GIS is the ubiquity of information on the web. It is frequently incomplete, it is often difficult to tell whether or not what you're learning is current or not, and also ***many tutorials are written by people involved in WRITING the software rather than people who are involved in USING the software.*** This means that lessons on the web often have a technical bent that can be difficult for non-technicians to unravel.

Some courses teach only a basic understanding of GIS such as how to open maps, how to colour maps, and how to present them using canned data (preconfigured maps that may not meet your needs exactly). However, the best courses will teach you how to do your own GIS project from scratch by creating your own GIS maps and databases, doing meaningful spatial analyses, and presenting them in a way that's easily understandable by your audience.

Course style

Some people emphasize the need for a good step-by-step course, but step-by-step means different things for different people. For some people this means a good instructional book, for others a commercial course, and for others a university course.

A lot of GIS classes are click-here and click-there oriented. An element of "click" is required when learning GIS, but GIS is far more than that. Basic introductory classes offered by software providers will not teach you how to use GIS. These tend to be fast paced introduction-to-functionality type courses.

However, if you learn the basics, no matter what GIS you come across, you will be able to adapt to a new environment. Adapting to different GISs is much like the difference between an automatic car and a manual car.

The best courses are those that help you put the way you intend to use GIS into a context of geographical understanding. They should also have lots of notes and be supported by video that you can play over-and-over until you fully understand each lesson. I say this based on my experience teaching GIS in the classroom. When I introduced video captures of GIS exercises into my first GIS curriculum, my workload as a teacher dropped because the students were able to watch the video over and over. And the questions being asked of me were less inclined to be of a technical nature. This style of teaching is available as an adjunct to many university courses and also in some online GIS courses.

	Advantages	**Disadvantages**
Classroom	• Some people need others to motivate them. • Face-to-face contact. • Classroom colleagueship and networking opportunities.	• Expensive. • Timetable may not fit yours. • You need to be on-your-toes. The "moment" can disappear and so you can miss what's being shown.
Online courses	• Affordability • Flexible timetable to suit you. • No such thing as missed-moments because videos can be watched over-and-over.	• Absence of face-to-face. • Absence of classroom colleagueship *(but you can still join online forums and local user groups).* • Requires self-motivation.
Online forums	• Specific problems often addressed well.	• Peacemeal - no thread to the education. • Often links are dated without you realizing.

Course datasets over the same area

Courses that provide coherent datasets relating to the same geographical area are better because…

1. You're not always having to come to terms with new geographies.
2. You can see how one GIS map might add to the value of another GIS map.
3. You can experiment with different types of analysis over the same geographical area.
4. You can deal with a range of problems over the same area, so you can see how the same GIS maps can be used by different professions in different ways.

How to Build on Your GIS Education

It's important that your GIS education extends beyond your GIS course. How you go about this will depend on what you want from GIS. Some students will be interested in developing a GIS career with a technical bent and others in improving techniques that are relevant to their field of enquiry. Some will have their needs met by local user groups, but others will need to cast a wider net – forums, national user groups, etc.

Participate in Networks and User Forums

Network with local GIS user groups and read industry magazines. This will help you fill in knowledge gaps. Technical GISers will be interested in online GIS magazines, while others will be interested in application focussed sites.

Fortunately these days help is far easier to access than what it used to be. Online forums such as GIS Stack Exchange, Quora and LinkedIn are just a few that are good for ad-hoc problems. Google Search, of course, is another.

Gain Experience (consider volunteering)

This means that you should work on projects other than just classroom projects. Real world problem solving will ramp-up your understanding and provide something meaningful for you to show people. Projects might be your own, for a local community group, or even GIS communities such as OpenStreetMap.org. For some of you reading this article, this is your opportunity to build a portfolio to show potential employers.

Read Books

Look for books and articles that show you the logic that people have used for GIS analysis that answers specific research questions in your field. Sometimes you can find topics specific tutorials on the web.

Conclusion

We have had a perfect storm of improved GIS software usability and functionality, desktop computer power, GIS maps and data availability and internet speed. This means that GIS is not nearly as difficult to learn as it once was, it is also more accessible.

GIS jobs fall on a continuum with very technical jobs at one end and minimally technical jobs at the other. It is this fact that means **you should NEVER accept someone else's opinion that GIS is too hard** – you need to find where GIS fits into how you imagine your perfect job to be and then make that decision for yourself.

Learning GIS has never been easier. There are many online forums, online courses and university degrees nowadays. At the user end of the continuum (mostly where my teachings lie), the best courses will emphasise a need for an understanding of cartographic theory as it relates to the problem that you're mapping.

If you feel that an online GIS course would meet your needs then I currently offer two courses.

1. **The 5 Step GIS Challenge (introductory)**
2. **Step-by-step 7 Module eCourse (intermediate)**

Both are entirely online with captioned videos and downloadable course materials

What Does Taking a GIS Course Involve?

Some of the GIS courses out there are strictly for people who are looking for a professional certification for their job or career while others like you are simply wanting to know more about GIS and the technology surrounding it. Two major areas of concern for those wanting to take a GIS class are the time involved to complete the course and how much it will cost them.

The time factor

If you are interested in taking a GIS course, you may be concerned about how much of your time it will take to complete. After all, you may already have a busy schedule and you don't want to take up too much of your time because of something you're simply curious about.

You may have even researched the GIS courses that are available and were probably surprised to find the wide range in times it takes to complete this type of coursework (or been disappointed to find that a course you enrolled in at your local College has been cancelled yet again). Some don't even offer an online option meaning you would have to take more time out of your schedule to physically attend the class.

Of course, if you want a career in GIS, you will probably be interested in a degree course. But if you want to simply add GIS to your skill set, much less dedication is needed.

Look at the screenshot below –

This course is available online but it will take you over a month and a half to complete.

Take a look at this next course –

The USC Advantage in Spatial Thinking

- 16 month online program
- Certificate or Master's program available
- Field excursion to The Wrigley Institute
- Master skills that are in demand across many industries
- Access to an extensive library of open-source and proprietary GIS resources

Would you really take a 16-month course if you're not sure that you want a degree or certificate?

Your best bet is to find a full course that you can complete quickly. That way you can get a whole understanding of the subject matter and whether or not you want to pursue a degree course.

The Cost factor

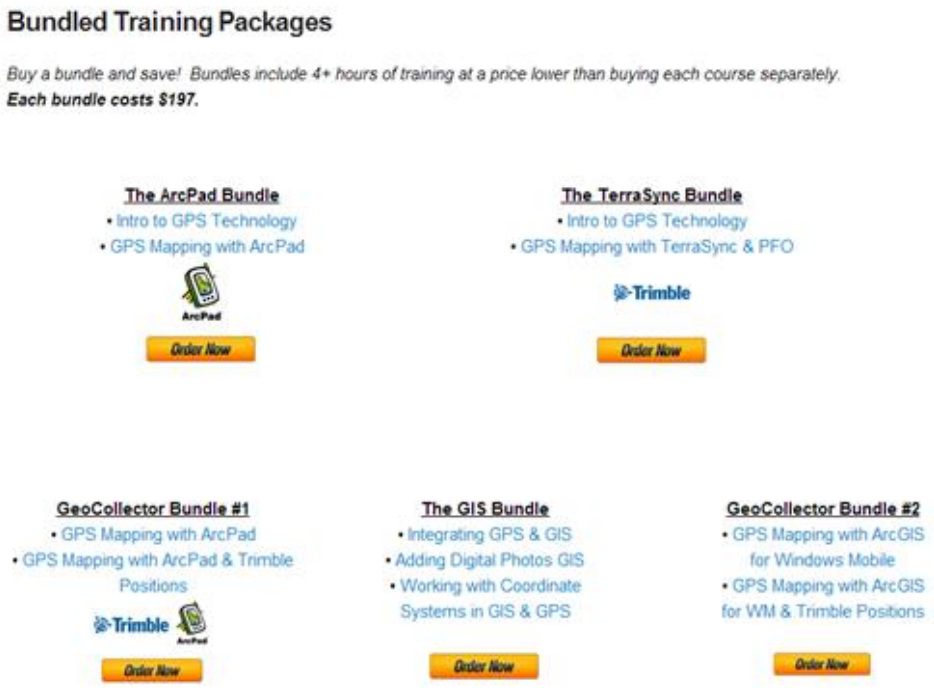
Again, if you're looking for a career in GIS, then the cost to get your certification will be comparable to college courses. If you decide to go that route, you could end up paying for application fees and textbooks in addition to the cost of the course itself.

But if you are just looking to learn more, you will want to shop around so that you don't end up spending a ridiculous amount of money just because you're curious.

Some GIS courses may be affordable but they aren't offered online so you have to spend money to travel as well as to attend them. Even then there's no guarantee of what you'll actually learn or if the course is user-friendly.

Remember the 16 month USC course mentioned earlier? There's really not much more information available online unless you download a brochure for a class syllabus. Then an advisor will contact you to answer any questions you have. Don't forget that this is all before you even find out how much the course is. Doesn't leave you with a good feeling on affordability, does it?

Take a look at the course shown below:



The good thing is that you can pick and choose what classes you want, and that the cost could add up quickly depending on which packages you choose. In the small print, it states that you can order the entire bundled package for a discount. But you can only access the videos for 4 months!

If you buy a course, why would you be limited to how long you can access it? What happens if you want to come back to it later for a refresher? What if you decide to pursue more courses somewhere down the road and you need to access some of the fundamentals within those courses? What if you need to access the information for research?

It just doesn't seem like a fair offer.

You will want to find a GIS course that:

- doesn't take an extensive amount of time to complete
- is affordable
- is taught by qualified instructors
- won't cost you the equivalent of a college tuition
- doesn't place excessive limit you on how long you have to access the information it contains
- provides you with a money-back guarantee

Make sure that as you research the variety of GIS courses out there that these elements are a part of the program. Doing this will not only save you time and money but it will give you the assurance that the company offering the course has your best interest in mind.

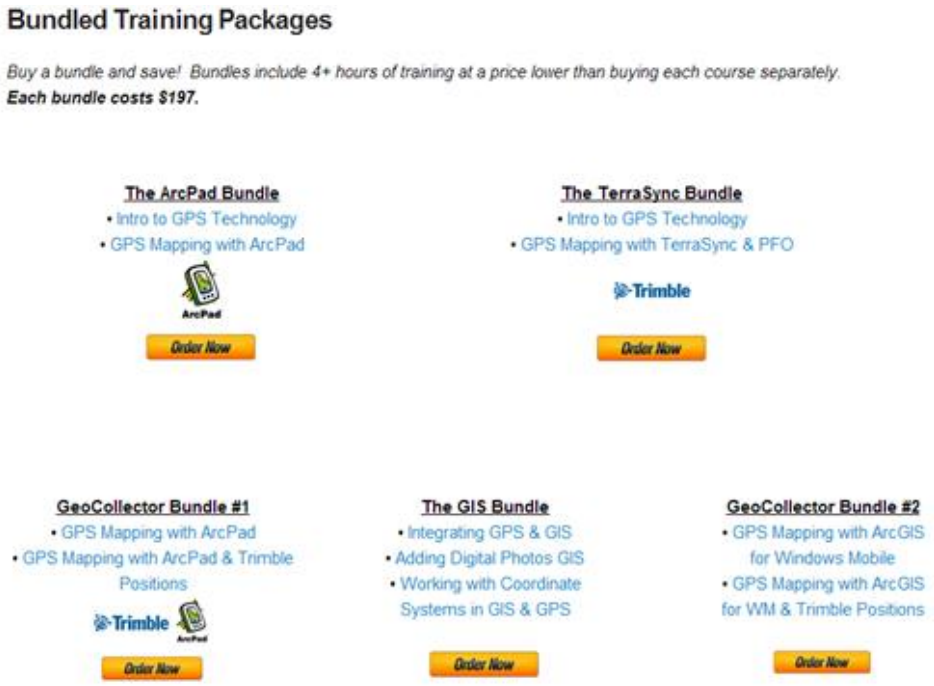
How to Decide on the Right GIS Course

So maybe you've now found a GIS course that is relatively inexpensive and won't take months or years away from your life.

But have you really looked at what the course covers?

Although cost is not always a measure of quality, the unfortunate truth is that you most likely will have to pay thousands of dollars for every class they offer to get a complete GIS course.

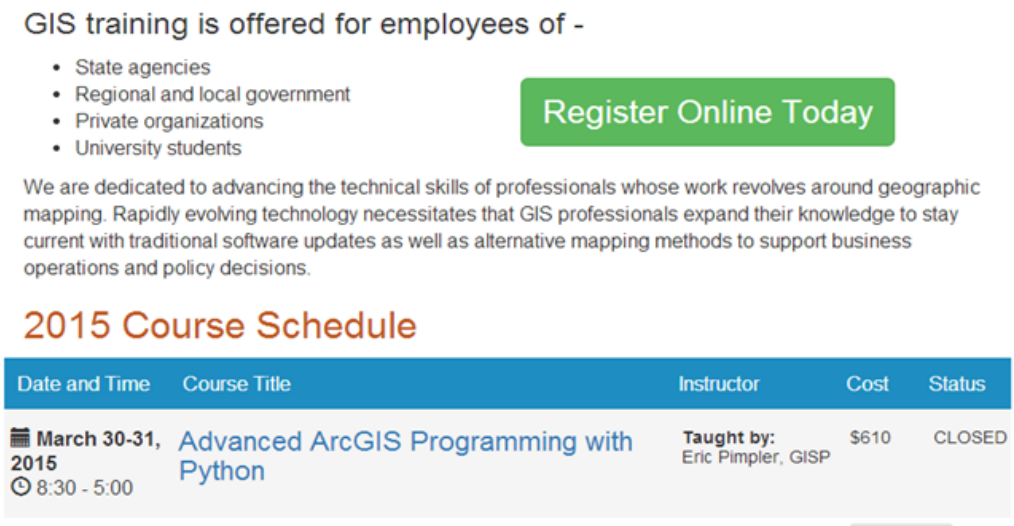
Look again at the classes we mentioned in the last chapter



How would you know what classes you needed or actually wanted to take? Should you purchase the entire bundle of courses? If you can only afford a few of the bundles, which ones should you purchase? Which ones are most important to what you are trying to learn?

The problem is that there's no way for you to know and you could end up spending a lot of money on a group of classes that aren't relevant to what you want to learn.

Another problem you might run into is trainings that are only available for a select group of individuals.



In order for you to take this course, you have to be an employee of a specific set of government or private organizations or you have to be a university student. Even if you do fall into that category, this course is only one small part of what you'd really want to learn.

If you wanted to have a full understanding of GIS, you'd still have to take many more courses to accomplish this. Looking at a small sample of the listings shown on their site, taking more courses would quickly add up to a very expensive way to learn about GIS.

Date and Time	Course Title	Instructor	Cost	Status
March 30-31, 2015 8:30 - 5:00	Advanced ArcGIS Programming with Python	Taught by: Eric Pimpler, GISP	$610	CLOSED
	Take your geoprocessing script development skills to the next level with ArcGIS.	Full Info		
April 14-15, 2015 8:30 - 5:00	ArcGIS Online for the Desktop User	Taught by: TeachMeGIS Instructor	$775	OPEN
	What is ArcGIS Online? Who can use it? How do you get it and where do you start? This course will answer these questions and more. .	Full Info		
April 16-17, 2015 8:30 - 5:00	Fundamentals of ArcGIS	Taught by: TeachMeGIS Instructor	$775	CLOSED
	This course helps you understand the types of data that ArcGIS supports, and how to manipulate the data.	Full Info		

Just these three courses alone would cost you over $2,000 and you still wouldn't have a complete course on GIS.

Here's a look at GIS courses available through a government program:

Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
AM 8:00–noon	Staying Current with GIS: Beyond the Basics	Managing Tabular Data Using SQL and GIS Tools (Part 1)	Topics in Advanced GIS Editing (Part 1)	Efficient Geo-processing Using Modelbuilder (Part 1)	Effective Analysis: A Tour of GIS Tools
noon–1:00pm	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
PM 1:00–5:00	Document Your Data: Mastering Metadata	Managing Tabular Data Using SQL and GIS Tools (Part 2)	Topics in Advanced GIS Editing (Part 2)	Efficient Geo-processing Using Modelbuilder (Part 2)	Putting It All Together: A Project Workshop to Visualize Your Data

Cost

Individual Academy classes cost between $275 and $425. Or sign up for the entire GIS Academy and save more than 20%! — your total will be only $1,595 (King County employees save even more). See King County GIS Training Prices.

As you can see, these classes are all-day and last for a full week and require you to attend. This means you would have to take time off of work and spend all day in a class setting for a full week.

They do offer a discount for taking the entire set of classes but you have to be an employee of the county to receive it. Even if you were eligible for the discount, you still end up spending well over a thousand dollars for this small set of classes. You would have to spend more money to take a complete GIS course.

Overall, you will want to enroll in a program that gives you an entire set of classes instead of a small sampling of ones you may or may not be interested in. Doing this will provide you with a complete understanding of GIS and that will give you a good foundation in case you decide you want to continue your education or obtain a certificate or degree in GIS.

How to Find a Complete GIS Course

By now, you may be wondering if you can truly find a GIS course that doesn't cost you a fortune and won't take months or years of your life to complete.

But that's not all that you have to worry about, is it?

How do you know whose teaching the course? Are they qualified to train you? What is their experience level?

And then you also have to worry about…

What happens if you spend money on a class and realize it isn't for you? What if the class is difficult to navigate or you find out that it's way above your level of comprehension?

Now what do you do?

Even if you take the time to struggle through it, how much are you really learning?

Simply by reading this e-book, you know that you have a lot of choices to make when it comes to taking a GIS course.

You can either attend a class in person, take classes online or pursue a certificate or degree program at a university.

Whatever you decide to do, you shouldn't have to worry about taking a risk and not getting what you pay for. Or worse, you could end up paying hundreds or thousands of dollars only to find out it's not what you wanted and you're stuck without the chance of getting a refund.

But how can you avoid it when there are so many choices to make?

When you take a GIS course that is affordable, is easily finished in a matter of days, and give you a guarantee - you basically take on no risk.

If you want access to a full GIS training course without taking on any risk, you may want to consider a course with GIS University.

My course provides you with a full set of training and it's available online so you won't incur any travel costs or need to take time off of work to attend.

This course is a full GIS education, wrapped into one easy-to-follow video training package:

It consists of 7 in-depth training modules carrying you from beginner, to intermediate to advanced in as little as 7 short days if you're really keen. And remember, the entire training is designed around step-by-step follow-along VIDEO so you will be learning in a fun environment.

Some of the highlights you'll discover include:

- Free, fully functional Quantum GIS software that allows you to build GIS maps right from your computer.
- The 11 step process to creating shaded maps with your census data...
- The secret to combining database query with geographical query, and why it's so important...
- How to geocode a street map, an address point, Google Maps and OpenStreetMaps...
- 3 ways to combine data sets from ANY source into a single map (for example, Census Data from the government could be related to a realtors house sales data etc...)
- How to use project files to recreate screen environments from days, months or even years ago...

- The history of GIS, how it was created, and how it's being used today (for you history buffs out there, you'll find these videos entertaining and fun to watch)...
- How to use GIS software, including button pads, navigation menus, scale bars and much more.(without understanding these vital elements, you'll just be constantly frustrated at how little progress you are making)...

The full course can be completed in as little as 7 days and it costs you much less than $500.

http://gis-university.com/home-study-gis-course-01/

By taking the full course from GIS University, you can:

- Receive a full 30-day money back guarantee (no questions asked) [
- Be taught by real university instructors who know what they're talking about
- Have access to both video trainings and PDF downloads so you can study from anywhere

You may feel more comfortable taking the time to research what other programs out there have to offer. No matter what you decide, make sure you're getting what you're paying for. Not only that but make sure that what you're paying for is 100% guaranteed!

There are a lot of GIS courses online and some are offered for free. But do they really provide any value?

Only you can decide what GIS course will suit your needs.

But in order to get true value and a GIS course that will provide you with full training and qualified instructors, you may want to check out GIS University. To learn more about the course, click the link below.

http://gis-university.com/home-study-gis-course-01/

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