

16. GIS MAPPING TOOLS FOR WETLAND PROJECTS

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Te Aroha

Te Hoe

Lake Ohinewai



Ohinewai Wetland



Whatungarongaro te tāngata toitū te whenua

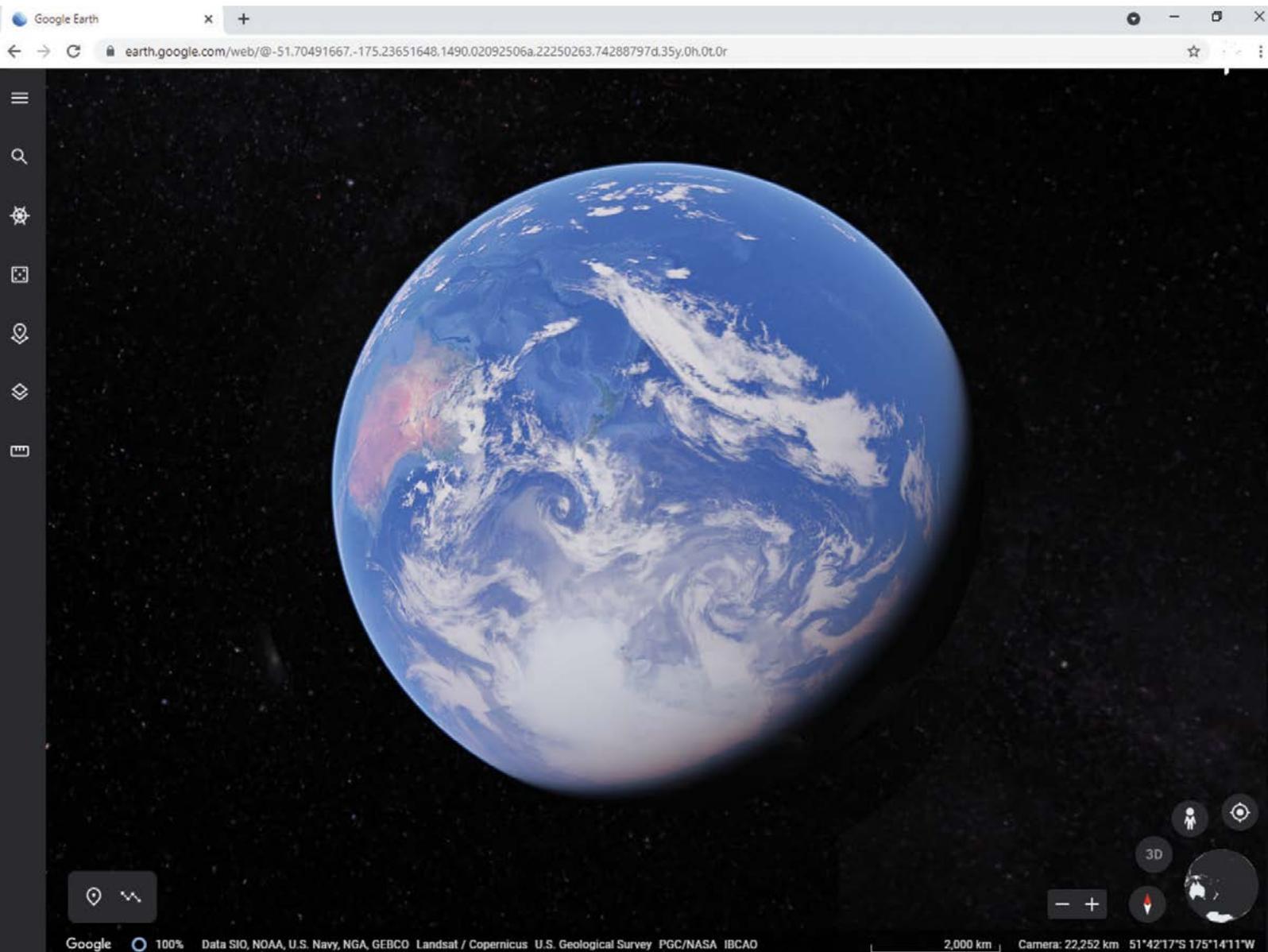
As people disappear from sight, the land remains

When we think about maps, we might remember several years ago frustratingly unfolding, folding, and refolding large maps of towns or cities on the bonnet of the car. Huge advances in mobile technologies and access to datasets to the wider public now mean those large, multi-creased paper maps have been replaced by smartphone-based maps that even talk to you as you navigate through unfamiliar roads and streets.

If we move that idea to mapping areas such as 'sites of significance', there are huge advances from hand-drawn paths, places, and areas on topographic maps, to the wonder of digital 'real world' images with data layers that can be edited and turned on and off.

Previous page: A snapshot view using Google Earth Web.

The Earth's globe on Google Earth Web.
Source: <https://earth.google.com/web>

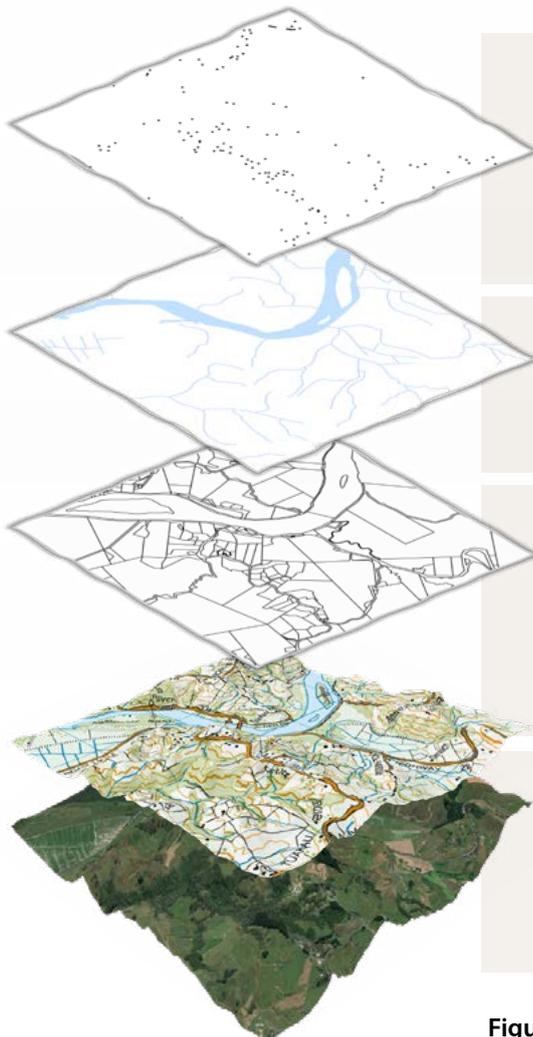


The same single data source can be transformed into 3D (three dimensional) scenes with flythrough capabilities and can be used to tell a story – like a journey with photos, video, and audio using Google Earth and StoryMaps. These tools are related by geography or the term geospatial – data linked to a place or geographical location that includes information on both the surface of the earth and underneath it. These data sets are portrayed visually as a map or 3D globe. Map layers, like layers of a pizza, can be collated and overlaid using coordinate systems – latitude/longitude or northing/easting – that line up using geography. You can have any flavours you want on your pizza map, but only if they all use the same square box (Fig. 1). You'll also want a variety of different pizza toppings for different appetites, as one with everything on is not the easiest to consume.

Geospatial tools can be used to support all types of wetland projects. Mapping applications can be used to:

- monitor and report on ecological restorations over time
- plan riparian planting, to calculate requirements
- monitor water quality, and use real time live streams
- track pest control, and automate trap monitoring
- assess cultural sites using forms to collect and describe values
- communicate a problem or results in an easy-to-understand, map-based, and 3D story format.

GIS or Geographic Information Systems is a collection of tools that allow you to overlay and integrate data from a variety of different sources to understand relationships and derive new understandings. The most recognisable feature of GIS are different map layers from many different sources being placed on top of each other to tell a story about a particular site or local species. This can be accessed by a smartphone, desktop, and internet mapping tools working together to overlay, map, and manage data from a variety of sources.



Points, Places

Used for: Sites of significance – urupā (burial site), pā (fortified village), puna (springs), pou (poles), mahinga kai (cultivated foods), mara kai, traditional harvest sites, middens; place names, and any pin or latitude longitude type location.

Lines, Paths

Used for: Paths, roads, tracks, ridges, tree lines, boundaries, and awa (rivers).

Polygons, Areas

Used for: Areas of interest (e.g. Post Settlement Government Entity (PSGE)), area of association, takiwā (core area of focus), rohe (tribal area), blocks, boundaries, rahuī (temporary prohibition), buikdings, urupā, and cultivations.

Raster, Imagery

Used to represent: Topographical maps, satellite images, aerial photography, historical scanned survey plans, 3D elevation surfaces, processed LiDAR elevation, depth, and bathymetry.

Figure 1. Overlaying different types of data to create a map.

We can use GIS to help collect data, understand relationships between different physical features, discover and analyse new interactions, or share information based on its shared geography. You could, for example, use historical imagery from the 1950s to the 1990s to identify change, and then use satellite imagery to illustrate change over the past decade (i.e. 2010–2020). You can use this imagery to help

understand patterns, and the impacts of local policy, and land use change.

We can also use GIS to help others understand our findings by using stories, maps, and 3D flythroughs (Fig. 2). In this chapter, we'll take you through some of these tools and how they can be applied to your own wetland mapping projects.



Figure 2. An example wetland near Kimihia, Waikato region, in 3D using Google MyMaps. Source: <https://www.google.com/maps/about/mymaps>

WHERE TO START MAPPING TOOLS FOR WETLAND PROJECTS

Before starting a mapping project, it is important to consider as a whānau (family), what it is you are trying to achieve, and work from there. Start with trying to identify the problem you want to solve:

- For some, it is a case of forming a clearer idea where wetlands used to be, and whether they are still there.
- For others, it might be about understanding changes to either the wetland or valued wetland species over time by using historical aerial photographs.
- Or there might be an interest in better understanding the impacts on wetlands, e.g. loss of vegetation, surrounding land use management, and increases in vertebrate (such as possums, stoats, and rats) pests and predators, to help better plan for restoration.

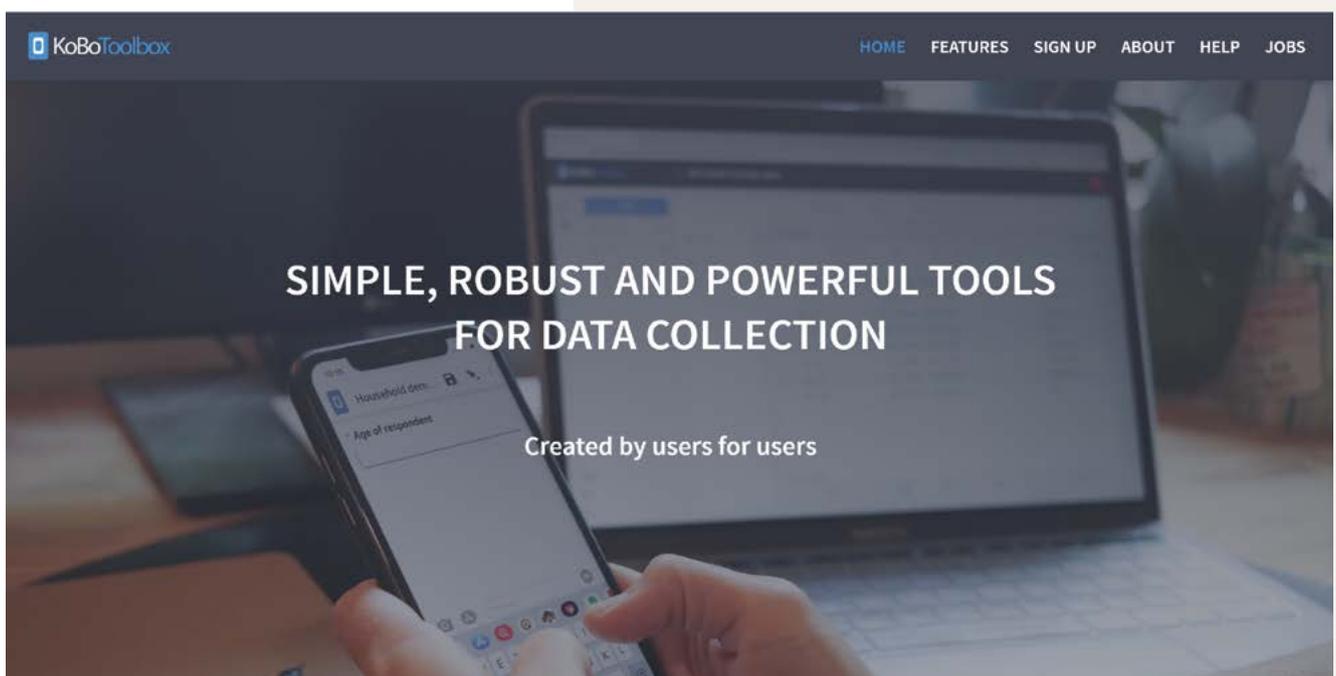
Using data from other organisations to overlay with your own information is a key foundation of GIS. Here are a few examples of how mapping can be used in your project.

Monitoring changes over time

Map-based forms can be developed to collect water quality and observations of current vegetation for use on smartphones, including a GPS location, a photograph, recent weather trends, and location name or placename. The information collected can help describe a trend over time, for example, the relationship between seasons, weather events, physical change or other variables.

In the case of vegetation, any changes to the types of plants on the site can indicate changes to water levels, nutrient levels, and water quality (Retrolens.nz). The presence of mānuka (NZ tea tree; *Leptospermum scoparium*), for example, is a good indicator of normally wetter lands becoming drier (i.e. the water table dropping). In this case, aerial photography and satellite images can be used to show broader landscape and vegetative change over time.

If you were monitoring species caught in a trap overnight – such as tuna (freshwater eels; *Anguilla* spp.) across a range of hinaki (eel baskets) locations – you can visualise these data to understand species diversity within a wetland, by creating a graph with a map showing monitoring sites. Low abundance of species can be indicators of a wetland in poor condition. Mapping the abundance of valued species like tuna, and where low relative abundance is found, can help to look further at underlying causes such as lowered habitat diversity or nutrient pollution, which can then be overlaid with your own water quality observations using forms developed in tools like ArcGIS Survey123 or KoBoToolbox. Check: <https://survey123.arcgis.com> or <https://www.kobotoolbox.org>





Retrolens.nz home page. Source: <https://retrolens.co.nz>



Riparian Planner (DairyNZ and Manaaki Whenua) home page. Source: <https://riparian-planner.dairynz.co.nz>

What was there before?

Retrolens NZ is a treasure trove of scanned aerial photographs that have been taken between 1936 and 2005 and contains more than 500,000 free downloadable images. This historic image resource came about as the result of a scanning project started in 2015 by partnerships between the Local Government Geospatial Alliance and Toitū Te Whenua (Land Information of New Zealand). You can filter by year or decade to gather a series of images that demonstrate change over time. The easiest way to use this imagery is as standalone photographs of the same location, one for each decade, animated within a presentation using slideshow. The advantage is that you can show the impact of local environmental change over time, such as habitat loss or deforestation. Check the Retrolens NZ website: <https://retrolens.co.nz>

Riparian planting

Planning and managing riparian plantings can use GIS to help calculate an area to be planted, the number of plants, length of fencing, and other resources required to support funding applications. 3D visualisations can show the changes over time and what the vegetation will look like. Considering the length of time it can take for native plants to establish, a 3D visualisation can help predict a restoration project for those generations who may not live long enough to see it reach its full potential. Check the Riparian Planner: <https://riparian-planner.dairynz.co.nz>

Animal pest and predator, and weed control

You can use GIS to help identify and track progress for trapping and pest control, as well as for recording weed control. These are particularly useful in supporting funding applications and reporting on progress made with existing grants. There are many existing trapping applications you can use, such as Trap.nz, and export the visualisation data within your own tools. Check the Track.NZ website: <https://trap.nz>

Trap.NZ home page. Source: <https://www.trap.nz>

trap.nz is a free service used throughout NZ for recording trap, bait, monitoring, and biodiversity outcome data.



Cultural Health Indicators

Geospatial information can support monitoring observations of Cultural Health Index (CHI) assessments. The CHI is a tool Māori can use to assess and manage waterways in their area – measuring factors of cultural importance by incorporating Māori perspectives and values for freshwater health in management decisions. The index allows whānau, hapū (sub-tribes), and iwi (tribes) to assess the cultural and biological health of a stream or catchment, and then communicate this information to water managers in a way that can be understood and integrated into resource management processes. Geospatial information can support restoration projects by quantitatively (numerical data) measuring change over time, or providing a baseline before, during, and after restoration. These can help in understanding qualitative (descriptive and conceptual) values alongside quantitative assessment that can indicate change or trends over time. Check the CHI publication: <https://environment.govt.nz/publications/using-the-cultural-health-index-how-to-assess-the-health-of-streams-and-waterways>

Sharing Narratives using ArcGIS StoryMaps

3D flythroughs are a great way to tell a story, and these can be embedded within an interactive ArcGIS StoryMaps. StoryMaps are free to create using a personal ArcGIS account. The use of historical images and photographs describing the current situation and can help expand your story in ways other tools can't.

You can browse the Esri ArcGIS gallery at <https://tinyurl.com/StoryGallery>, or check some of these StoryMaps examples:

- Great Wetlands of the World: <https://tinyurl.com/WetlandsStory>
- Working Wetlands, removing nutrients: <https://tinyurl.com/workingwetlands>
- <https://tinyurl.com/workingwetlands>
- Te Puni Kōkiri. Te Matapaeroa: Insights – research reveals a clearer view of Māori business <https://tinyurl.com/tpk21>
- First Nations: The Voices of Grand Canyon – read, listen, watch, and learn <https://tinyurl.com/GCVoices>
- Sounds of the Wild West – an audio tour of four major ecosystems <https://tinyurl.com/WWSounds>
- Climate Change – weather, science, impacts, affects, and what we can do <https://tinyurl.com/NZClimate>



Figure 3. StoryMaps used to show the impact of sea level rise. Source: <https://www.learnz.org.nz/climatechange201/readings>

Create 3D views by setting a 'default bookmark' on each view within most 3D mapping tools; Google Earth Pro calls these 'snapshot views'. Data from environmental monitoring, planting, and pest control can be overlaid on maps, and provide a real time map showing all available data. StoryMaps is a relatively quick way to deploy a feature-long, scrolling interactive article (Fig. 3). You may also see these on online news articles (i.e. stuff.co.nz). For more help with setting up a StoryMaps, have a look on the ArcGIS StoryMaps website: <https://storymaps.arcgis.com> or join an online training session with Toitū Te Whenua (LINZ): <https://www.linz.govt.nz/poutama>.

Google Earth now supports creating and sharing map-based, place-to-place tours. These work on smartphones and can be readily viewed in low-cost cardboard '3D Virtual Reality', providing an immersive perspective. Google Earth Web is one of the simplest tools for creating a virtual reality tour as seen in Figure 4.



Figure 4. A snapshot view of a proposed planting area at Lake Ohinewai, Waikato region, using Google Earth Web.

Source: <https://earth.google.com/web>

Creating 3D flythroughs as a video and online experience

3D tours are an easy and engaging way to communicate a sense of relationships or a journey from place to place. While Google Earth Pro and Google Earth are the easiest way to do this, StoryMaps can provide a more professional design but takes a little more effort. Live, interactive 3D experiences are more engaging than video, but sometimes you will need to create a static video snapshot of a 3D fly through. Google Earth Studio is a free web application that can be used to create frame-by-frame 'broadcast quality' 3D flythrough video. QGIS and ArcGIS desktop applications can also provide greater options for using local elevation and aerial photography at higher resolutions.

Developing an Environmental Monitoring system

Geospatial software can provide you with the tools to establish your own long-term environmental monitoring system; however, this is just one part and often the technology is the easiest part. You'll need support to map your environmental mahi (work). Consider bringing your whānau along on the journey to help you with planning, learning, and the technical work, as well as helping describe your work to others. The schematic (Fig. 5) can provide a good process to get an applied GIS project underway.

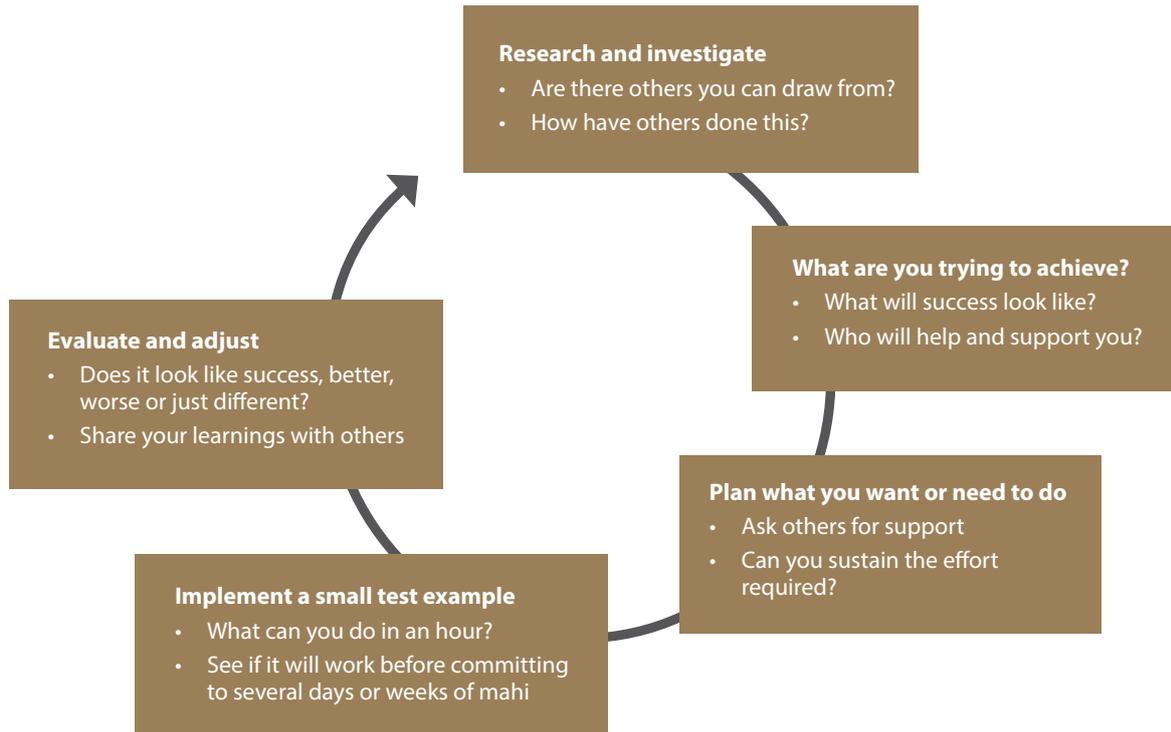


Figure 5. An iterative step-by-step approach to using GIS for environmental projects.

- 1. Research and investigate other projects currently underway.** Taking notes of other people's efforts can help you better identify key tasks in your own planning. Table 1 provides examples of online support, training, and resources. Use your networks to look at some previous or existing examples of mahi, and seek advice from other whānau, hapū, and iwi-led projects.
- 2. What are you trying to restore and why?** At the beginning of your journey, it may feel overwhelming, but a good first step is to consider what it is that you are trying to better understand about your wetland. You can start by having a wānanga (workshop) with your whānau about tikanga and kawa (cultural values and practices) associated with the wetland site:
 - connected landscapes like awa (rivers) or maunga (mountains)
 - the native plant and animal species that once or still reside there
 - the sounds, smells, and observations remembered by kaumātua (elders) and others as associated with a healthy wetland.

The key is to identify your goals for the site – restoring of valued taonga species (culturally important), improvements for water quality, or rejuvenation of tikanga and kawa. These goals will then become the drivers or mission for your project and make it easier to identify what could and should be mapped.
- 3. Plan what you want to do and how you might map it.** Be sure to be kind to yourselves, by setting achievable goals and actions, within a realistic timeframe. Remember that you don't have to be experts in everything. You may not even need to develop your own GIS if existing tools provide what you need. There are organisations including Manaaki Whenua – Landcare Research, Toitū Te Whenua LINZ, Te Tumu Paeroa, Te Papa Atawhai (Department of Conservation) or ngā kaunihera-a-rohe (regional councils) that can help you access maps, data, and some agencies may be able to support with funding.
- 4. Implement an example and test it.** Begin with small steps, give yourself and the whānau the space to adapt and modify as you learn new things.
- 5. Evaluate what you have done.** This links very tightly with stage 3. It is important to keep reviewing your activities so that you can adjust quickly if need be. Most important, remember to share your data and learnings. There are many other whānau out there who might also be in the same stage of your journey, and so the more data and learnings shared, the greater the benefits for the environment and our people.

WHICH SOFTWARE TO USE?

There are many different software options to choose from. If you're starting out, here are some suggestions and links to access or download the applications (Table 2).

- **Google MyMaps** is ideal for beginners. It will provide you with the essential tools to create a map of your wetland project, and help you design your first map in a matter of minutes. Your information is stored in your google account, and no-one has access unless you choose to share it.
- You can then move into **Google Earth Pro**. Download and open your KML (keyhole markup language) layer files from MyMaps. You can also access historical satellite imagery and start to compile a collection of KML files from other sources such as Manatū Mō Te Taiao (MfE) website and overlay with your own data.
- When you reach the limits of Google Earth Pro, or develop technical confidence, you will want to upgrade to **QGIS**, a free desktop GIS software. However, at this stage you'll need to considering file back-ups on external hard drives and access for others beyond your own computer.
- Alternatively, if you need a set of tools for group collaboration, you may want to consider joining the **New Zealand GIS in Conservation group (NZGiC)**, who can facilitate free access to **Esri ArcGIS Online**, and a suite of tools like Microsoft Office 365. If you

prefer to have your own ArcGIS Online account, non-profit organisation licenses are available at about \$250 per user per year.

- **KoBoToolbox** is a great starting place for building geo-enabled forms, or **Survey123** if you have access to an **ArcGIS** online subscription.
- **Arc GIS StoryMaps** is a free online tool to combine text and interactive maps with other multimedia content to tell your restoration story.
- **ODK Collect** is an open source Android app that replaces paper forms used in survey-based data gathering, and supports location, audio, images, video, barcodes, signatures, multiple-choice, free text, and numeric answers.

Every project has different needs, and you'll need several applications to achieve your goals.

Existing GIS data relevant to wetland projects

Over the past decade, agencies, and research institutes have developed commonly used geospatial datasets available for free public download, enabling users to add projects. Table 3 describes some useful datasets for all wetland types and related mapping projects. Although these sites are designed with data access in mind, you can also simply use them as sources of maps or browse the source organisations website for maps and presentations using these data sets.

Table 1. Finding support and training

Organisation	Support, training, and resources
Manaaki Whenua – Landcare Research	<ul style="list-style-type: none"> • A range of websites and tools to help get you started https://www.landcareresearch.co.nz/tools-and-resources/mapping
NZ GIS in Conservation (NZGiC)	<ul style="list-style-type: none"> • GIS Volunteers who can provide one-to-one guidance https://nzgic-gicnz.hub.arcgis.com
Ngā Kaunihera-ā-Rohe Regional Councils	<ul style="list-style-type: none"> • Asking for guidance, advice, and support can give you a running start
Te Kāhui Manu Hōkai National Māori GIS Association	<ul style="list-style-type: none"> • Follow National Māori GIS Association on Facebook https://www.facebook.com/groups/TeKahuiManuHokai
Te Papa Atawhai Department of Conservation (DOC) Geospatial Services Team	<ul style="list-style-type: none"> • Make a request with local staff for maps, data, and guidance
Toitū Te Whenua Land Information New Zealand (LINZ) Capability Team and Business with Maori	<ul style="list-style-type: none"> • Ngā Poutama Matawhenua – Practical Māori GIS Mapping Wānanga https://www.linz.govt.nz/poutama • Follow Grow GIS NZ on Facebook https://www.facebook.com/growgisnz • Right of First Refusal (RFR) portal https://www.linz.govt.nz/crown-property/acquisition-and-disposal-land/crown-property-disposal-process/right-first-refusal-rfr
YouTube	<ul style="list-style-type: none"> • Tutorials exist for wide variety of workflows on almost all software types • Try a variety of different key search terms, include Indigenous Peoples and First Nations

Table 2. Available online GIS software and weblinks

GIS Software		Weblinks
Esri ArcGIS applications	<ul style="list-style-type: none"> • ArcGIS Online web maps and applications • ArcGIS StoryMaps • Survey123 geo-enabled forms • ArcGIS Pro desktop software (advanced) 	<ul style="list-style-type: none"> • https://www.arcgis.com • https://storymaps.arcgis.com • https://survey123.arcgis.com • https://www.esri.com/pro
Google Mapping applications	<ul style="list-style-type: none"> • Google Earth Pro • Google Earth on the web • Google Earth Studio • MyMaps 	<ul style="list-style-type: none"> • https://www.google.com/earth/versions • https://earth.google.com/web • https://www.google.com/earth/studio • http://mymaps.google.com
KoBoToolbox	<ul style="list-style-type: none"> • Open source sponsored hosted mobile and web from data capture, collation, and mapping 	<ul style="list-style-type: none"> • https://www.kobotoolbox.org
ODK Collect	<ul style="list-style-type: none"> • Open source, self-hosting mobile data capture 	<ul style="list-style-type: none"> • https://play.google.com/store/apps/details?id=org.odk.collect.android
QGIS	<ul style="list-style-type: none"> • Free open-source desktop GIS software (advanced, also available for Mac) 	<ul style="list-style-type: none"> • https://qgis.org

Table 3. Organisations and GIS data sets available for free download

Organisation	GIS Data Layers of interest	Link
data.govt.nz	<ul style="list-style-type: none"> • A wide collection of references to map data and research documents (Links to other download sources). 	<ul style="list-style-type: none"> • https://catalogue.data.govt.nz/dataset?q=Wetlands
Manaaki Whenua – Landcare Research	<ul style="list-style-type: none"> • NZ Land Use Capability Assessment • Land Cover Database v5.0 1996–2018 • Various detailed soil layers • Various detailed environmental layers 	<ul style="list-style-type: none"> • https://iris.scinfo.org.nz • https://whenuaviz.landcareresearch.co.nz/
Manatū Mō Te Taiao Ministry for the Environment (MfE)	<ul style="list-style-type: none"> • Current wetland extent • River Environment Classification 2010 • Watersheds based on catchment orders • River flows, and sea draining catchments • Lake water quality trends 2004–2013 	<ul style="list-style-type: none"> • https://data.mfe.govt.nz
Retrolens NZ	<ul style="list-style-type: none"> • Historical aerial photography from 1936–2005 	<ul style="list-style-type: none"> • https://Retrolens.nz
Taihoru Nukurangi NIWA	<ul style="list-style-type: none"> • Research and wetland inventory 	<ul style="list-style-type: none"> • https://niwa.co.nz/research-subject/wetland
Te Kooti Whenua Māori Māori Land Court	<ul style="list-style-type: none"> • Māori Land Spatial Dataset (2017) • Trustees and management structures 	<ul style="list-style-type: none"> • https://maorilandcourt.govt.nz/your-maori-land/
Te Papa Atawhai (DOC)	<ul style="list-style-type: none"> • Protected Conservation Areas • Marine Reserves • Coastal Marine data Ecosystem management units • Campsites, huts, and tracks 	<ul style="list-style-type: none"> • https://maps.doc.govt.nz
Toitū Te Whenua (LINZ)	<ul style="list-style-type: none"> • Labelled river lines and areas • Swamps, drains, ponds, estuaries • Property boundaries, titles, and ownership • Survey plan points and survey markers • 1-m elevation data derived from LiDAR • Current aerial imagery, topographical maps, and marine charts 	<ul style="list-style-type: none"> • https://data.linz.govt.nz

KEY TIPS FOR GIS BEGINNERS

- Every good GIS project starts with a group discussion – seek support and help from your peers, and avoid taking all the burden on yourself
- Make use of the free online GIS tutorials available for all the most common workflows and software tools on YouTube
- Start small and simple, complete small point datasets before expanding your scope
- 3D visualisations can help get you started quickly and aid in communication with others to understand the context
- Avoid drawing areas and creating points in 3D; use a 2D view for data capture and creation (for viewing in 3D afterward)
- Don't be afraid to ask for help and support from other GIS practitioners
- Label your files with useful names using a formula like 'project_topic_date_version'
- Store your data in a grouped folder structure by theme or project name. This helps you make file back-ups and share files easily with others
- Make copies of your important GIS content files and store them in a secure external hard drive or use secured cloud storage.



HELPFUL GLOSSARY

Understanding GIS terminology

Aerial photography – images, like those sourced from Retrolens.nz, are taken using analogue film and digitally scanned from prints. More recent images, like those sourced from the Land Information NZ data service, were captured using high resolution digital cameras.

Coordinate Systems

- **Latitude, Longitude (WGS84)**

Latitude/Longitude is a global coordinate system used by GPS, mapping software like Google Earth, and all GPS enabled smartphones. Where possible, use the decimal degrees format 'DD.DDDDD', like this: -37.412813, 175.559631

Avoid DD° MM'SS" Degrees Minutes and Seconds: 37°24'46.1"S 175°33'34.7"E, as these must always be converted to decimal format before they can be used in GIS software.

- **Easting and Northing (NZTM)**

Map grid references are a way to reference a location using a metric grid in metres. All map grid coordinate pairs must be a positive number of at least 7 numbers each, which reference a positive distance from a false map origin in the south Tasman Sea.

For example: the same location above in NZTM Map Grid is described as **E 1826555, N 5856365**. <https://www.topomap.co.nz> is a good site to check this map reference system. LINZ has a very detailed web-based coordinate converter for more technical users.

Geographic Information System GIS – a Geographic Information System, or suite of tools, software. Data, people, and processes that create a mapping system. Examples are QGIS, ArcGIS, or Google Earth.

Global Positioning System GPS – initially deployed by the US military but recognised as an important means for locating a place on your map. Many phones have these as part of the media apps, so when taking photos, the GPS automatically identifies where in the world the photo was taken.

Light Detection and Ranging LiDAR – elevation data created from point sources using laser light. The data are transformed into square grid elevation surface images called Digital Elevation Models and used to create 3D effects.

Open Data – open data are data anyone can access, use, and share. Most agencies ask to be referenced in reports when their data are used. <https://data.govt.nz> is a useful catalogue.

Qualitative data – data that approximate and characterise based on interpretation, for example, 'There's so many hungry tuna here this morning, it freaked me out!'

Quantitative data – data that can be observed and recorded in a repeatable manner, for example, 'I counted 14 tuna at X site at 4am on 1 February 2021!'

Satellite imagery – from satellites in space from low earth orbit, formatted and provided for use as base-maps.

WANT TO LEARN MORE?

Note: If you are having problems with the hyperlinks below try copying and pasting the web address into your browser search bar.

References

Tipa G, Teirney L 2006. *A cultural health index for streams and waterways: a tool for nationwide use*. Report prepared for the Ministry for the Environment.
<https://www.environment.govt.nz/assets/Publications/Files/cultural-health-index-for-streams-and-waterways-tech-report-apr06.pdf>

Toitū Te Whenua – Land Information NZ

Toitū Te Whenua facilitates a programme of short, online mapping wānanga to help you learn how to map your whenua and tell your stories through GIS mapping. These interactive wānanga, specifically tailored to those working for iwi, Māori trusts, and environmental groups, are all recorded for on-demand viewing.

Ngā Poutama Matawhenua – Practical Māori GIS Mapping Wānanga
<https://www.linz.govt.nz/poutama>

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