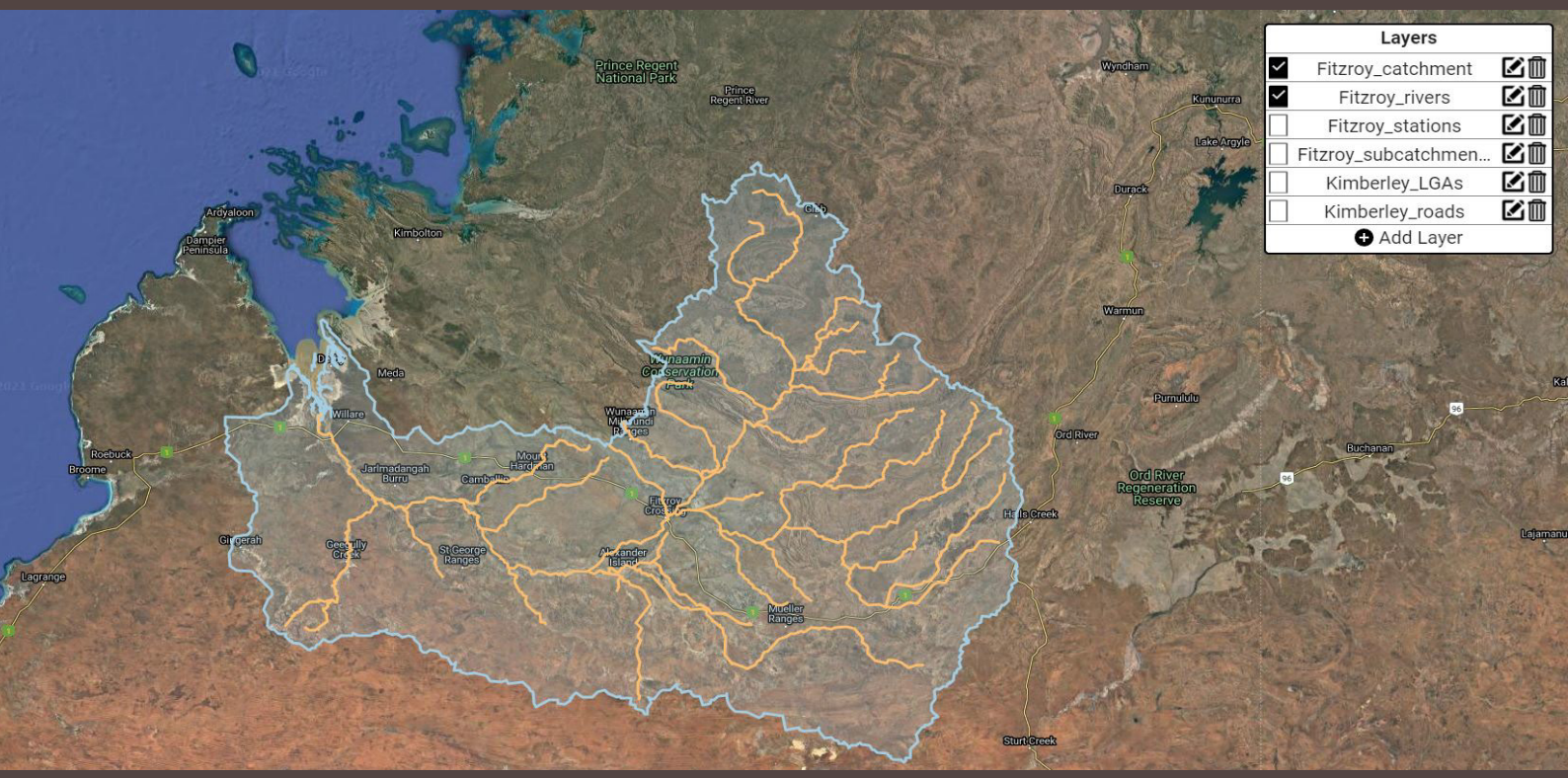
Northern Australia Environmental Resources Hub

National Environmental Science Programme



ValueMapper: an interactive web-based tool to map and visualise spatial data (Version 1.0)

Software manual

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ARC CENTRE OF EXCELLENCE Coral Reef Studies

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The software and manual are also available for download from the Northern Australia Environmental Research Portal at www.nespnorthern.edu.au/projects/nesp/multi-objective-planning-northern-australia

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Front cover: ValueMapper web-based application. © Álvarez-Romero & Osbaldiston

Back cover: Satellite image of the lower Fitzroy River catchment and King Sound. © ESRI

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Acknowledgements

We acknowledge the Traditional Owners and Custodians of Country throughout Australia and their connections to land, water, and community. We pay our respect to their Elders past, present and emerging. We extend that respect to all Aboriginal and Torres Strait Islander peoples today.

We used *Mapotron* interactive web application for spatial data (Beher and Hanson 2015) as a reference for the initial versions of the software. We thank Jeff Hanson for sharing the source code of the web-based application.

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Glossary

Area of conservation interest: areas of conservation interest are defined in numerous ways but generally refer to geographically defined areas that contain and sustain features (e.g., ecosystems, plants, animals, ecological communities and processes) valued by people (e.g., local communities, features of national importance). Mapping these areas can help guide their protection, restoration or management.

Area of cultural interest: areas of cultural interest are defined in many ways but may include sacred sites, heritage sites, bio-cultural landscapes, traditional farming/fishing landscapes, geo-landscapes, tambu areas, and others. They can be associated with cultural and spiritual values relating to local uses and issues, including social and spiritual relationships, language, songlines, stories, customary uses, plants and animals, land/water features, aesthetic, architectural, historic, and recreational areas. Mapping these areas can help guide their protection, restoration or management.

Base map: a reference map on which GIS users overlay data from layers and visualise geographic information. Base maps can be made of multiple features, raster, or web layers (e.g., Google maps base maps combine satellite imagery, place names, roads, protected areas, and other features).

CSS: Cascading Style Sheets (CSS) is a style sheet language used for describing the presentation of a document written in a mark-up language such as HTML (used to format the webpage). CSS is a cornerstone technology of the World Wide Web, alongside HTML and JavaScript. CSS is designed to separate presentation and content, including layout, colours, and fonts.

Environmental planning: a process to guide decision making to carry out land/water development that considers the natural environment, social, political, economic, and governance factors and provides a holistic framework to achieve sustainable outcomes.

Feature of interest: an area of conservation/cultural interest (above) or landscape value (below).

Field: in GIS, fields or attributes are part of a table describing the properties of a given layer in the map. Rows are known as records, and columns are referred to as fields. Each field in a table can store a specific data type, such as a number, date, or text. Fields are called *Key*s in ValueMapper.

GIS: A geographic information system (GIS) is a computer-based system for capturing, storing, checking, analysing, and displaying data related to their position on Earth's surface. GIS help users understand spatial information and the relationship between different features represented on maps.

Google maps: a web-mapping platform developed by Google that offers satellite imagery, aerial photography, street maps, and site places, among other spatial information. ValueMapper uses Google maps as the base map.

HTML application: HyperText Markup Language (HTML) is the standard mark-up language for documents designed to be displayed in a web browser (e.g., Chrome). An HTML application (HTA) is a Microsoft Windows program whose source code consists of HTML, Dynamic HTML, and one or more scripting languages supported by the browser, such as VBScript or JScript. HTML is used to generate the user interface, and the scripting language is used for the program logic.

JavaScript: JavaScript, often abbreviated as JS, is a programming language. Alongside HTML and CSS, JavaScript is one of the core technologies of the World Wide Web. All major web browsers have a dedicated JavaScript engine to execute the program on the user's device.

Key: see field (above). ValueMapper uses '*Key name*' to add and define fields in new layers.

Landscape value: landscape (place) values correspond to people's attachment or emotional bonds with places. The reasons behind this attachment vary notably and can be defined in many different ways. Examples of landscape values used in participatory mapping exercises include economic,

recreation, life sustaining, knowledge, biodiversity, spiritual, heritage, family connection, and learning. Landscape values can be used interchangeably with conservation or cultural value areas in mapping applications. In the ecosystem services literature, landscape values can be equivalent to cultural ecosystem services or socio-cultural values of ecosystem services.

Layer: Layers are the building blocks of maps. Each layer contains one type of information such as roads, towns, or Native Title boundaries. There are three types of information used to make maps: points are used for places such as towns or sites, lines are used for linear objects like roads or rivers, and shapes – also called polygons – are used for areas such as Native Title areas or National parks. A map can contain one or many layers.

Multi-objective planning: a planning approach that considers the full range of environmental, social and economic outcomes of different land/water use and management decisions and their implications for different stakeholders and rights holders (e.g., cost and benefits of different development options). It allows assessing the co-benefits or trade-offs between different objectives (e.g., economic growth, human wellbeing, biodiversity conservation). Considering multiple objectives is critical to support future effective planning for development and conservation.

NESP: The National Environmental Science Program (NESP) is a long-term commitment by the Australian Government to fund environment and climate research.

Participatory mapping: an interactive map-making process that draws on people's collective knowledge and enables participants to visualise the links between land/water and people. Participants can create and manipulate spatial data, and the maps they make, to examine and discuss environmental, social, and economic considerations around the current and future use and management of land and water resources.

Participatory scenario planning: a process in which stakeholders and rights holders are engaged in a highly collaborative process to create and investigate the outcomes of scenarios. Scenarios are stories that consider how alternative futures might unfold.

PGIS/PPGIS: Participatory GIS (PGIS) or public participation geographic information systems (PPGIS) is a participatory approach to mapping that is based on using computers to make maps. It is often used in planning, policy making and for communities to visualise their goals for land and land management.

Shapefile: A shapefile is a special file used in a GIS. It contains one layer of information and can only be of one type – either point, line, or shape (polygon). The shapefile contains the location of the object or objects on the earth, and information about each object, like its name, length, or size, and maybe a description about it. Shapefiles are made up of at least three separate files (*.shp, *.dbf, *.shx). If you move or share a shapefile it is important to include all the separate files (they will all have the same name before the dot). It is best to zip them and send the zip file.

Spatial data: spatial data is information directly or indirectly referencing a specific location or geographical area. Spatial data is often stored digitally in computers and referred to as geospatial or geographic information. This type of information can help understand what is happening where, how, when, and why.

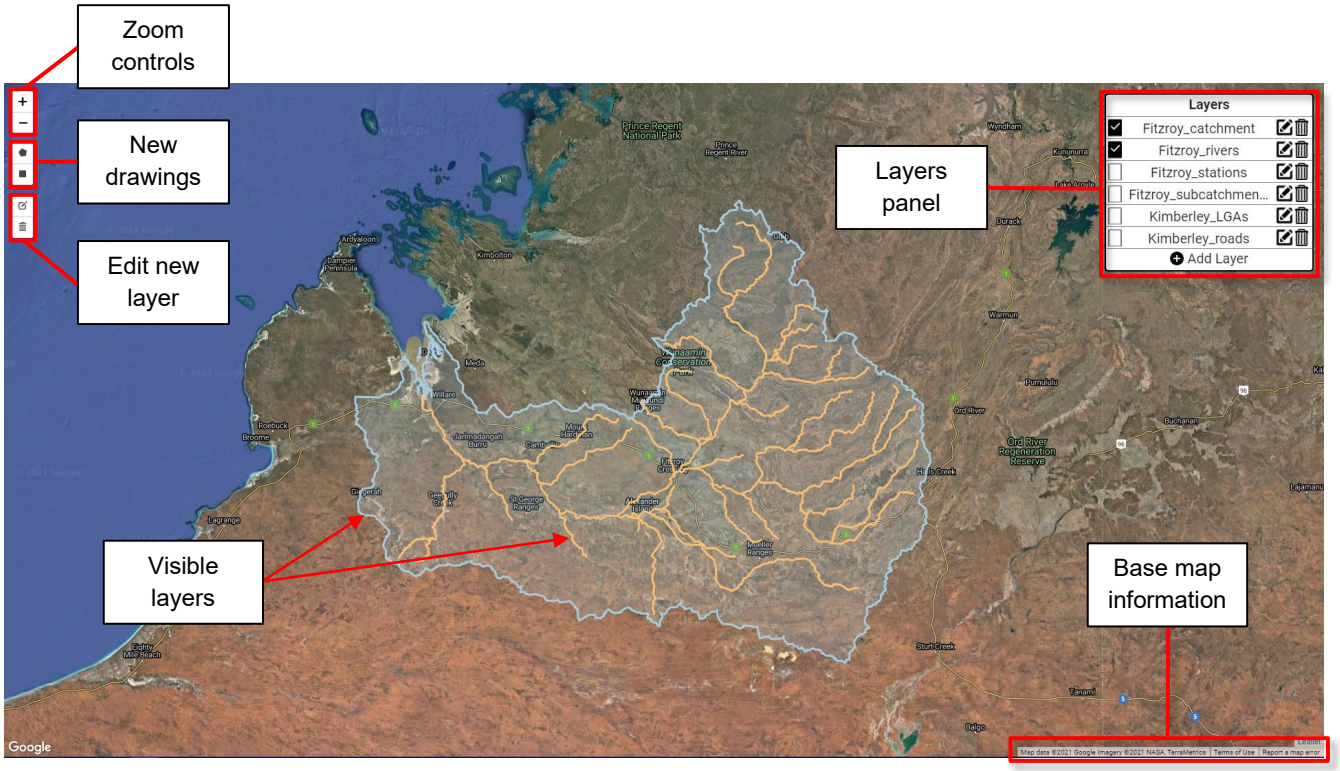
Spatial extent: The spatial extent of a map is how much of the earth it covers – this is usually a rectangle. It is described by the coordinates (e.g., latitude and longitude) in each of the four corners of the rectangle that mark its place on the earth’s surface.

Zip file: a compressed file that uses less storage space and stores multiple files.

Summary

ValueMapper is a flexible and easy-to-use web-based app (application) for mapping, visualising, and storing spatial information. The tool was developed to support mapping areas of conservation, cultural or economic interest, a.k.a. place or landscape values (Brown et al. 2020), but can be used for other purposes. The tool allows mapping, changing, describing, and saving layers in ESRI Shapefile format, which can be visualised using the tool or further edited using GIS software. The web-based interface allows users to draw and save layers with information about the features (areas) of interest. For example, documenting their name, category, description, accuracy, sensitivity, custodians, and other relevant characteristics of the mapped features of interest.

The software facilitates participatory mapping of landscape values to support environmental planning and management (Brown 2012; Brown and Kyttä 2014), including conservation and land/ water use planning initiatives. James Cook University developed the tool to support a project on multi-objective planning in northern Australia (Adams et al. 2016). The tool was developed and tested during a research project guiding participatory scenario planning to explore alternative development pathways for the Fitzroy River catchment of the Kimberley, Western Australia (Álvarez-Romero et al. 2021; Kiatkoski Kim et al. 2021). Depending on the mapping and planning exercise's goals, context, and resources, more advanced and custom-made tools may be required (Brown et al. 2017; Brown and Weber 2012; Digital-Democracy 2021; Sykora-Bodie et al. 2021). The software can be used with other tools (e.g., interactive tabletop projectors, 3D models), facilitating knowledge sharing and co-production (Hill et al. 2021).

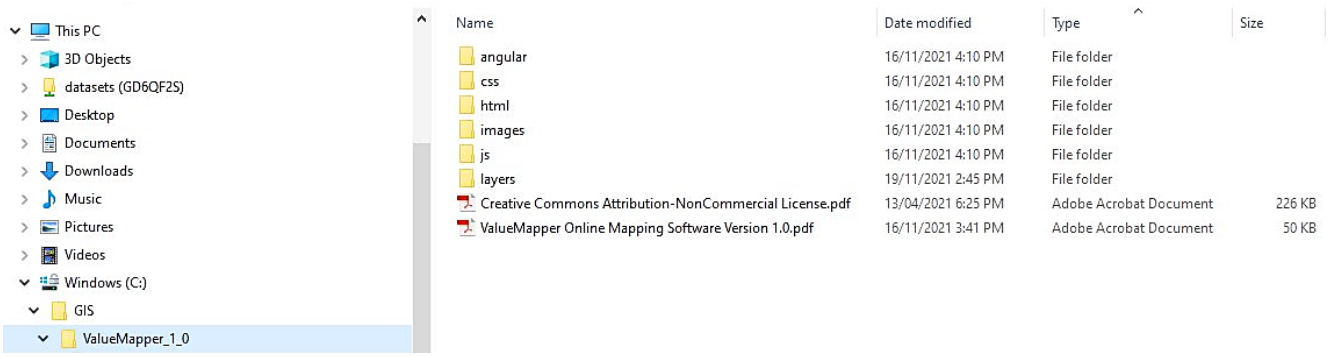


Tool features and operation

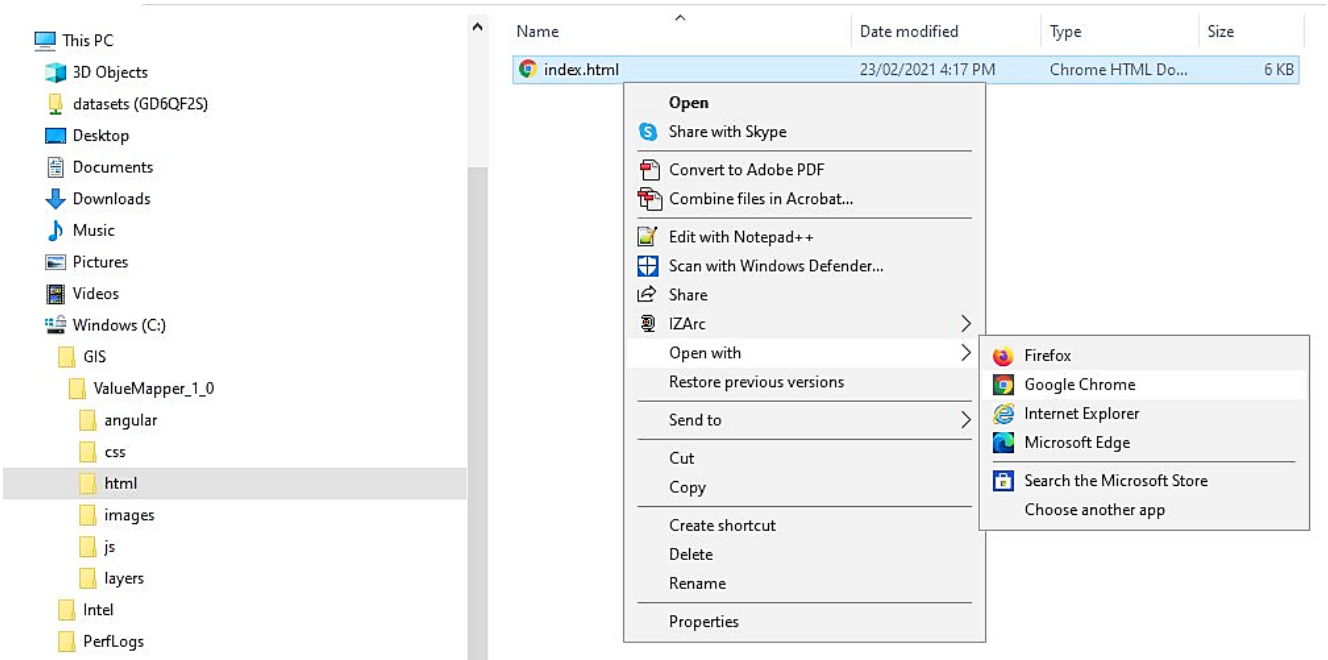
We used web development languages, HTML and CSS for the physical creation of the webpage and JavaScript for all processing and functionality. This version includes comments on the code explaining how we built the application, commenting out the functions that we considered secondary (see details in the 'Mapping new features' section below). The recommended browsers to use are Chrome or Firefox. Due to regular Google maps JavaScript API updates, users may encounter problems running the tool. If that is the case, experienced users can update the required libraries or contact the authors.

Running the tool

All the required files to run the tool are included in the downloaded zipped file (**ValueMapper.zip**). First, users need to create a folder (e.g., C:/GIS) in their computer and extract all the files (e.g., use IZArc). The folder includes a folder that contains reference layers to use with the tool (i.e. zipped Shapefiles, described below).

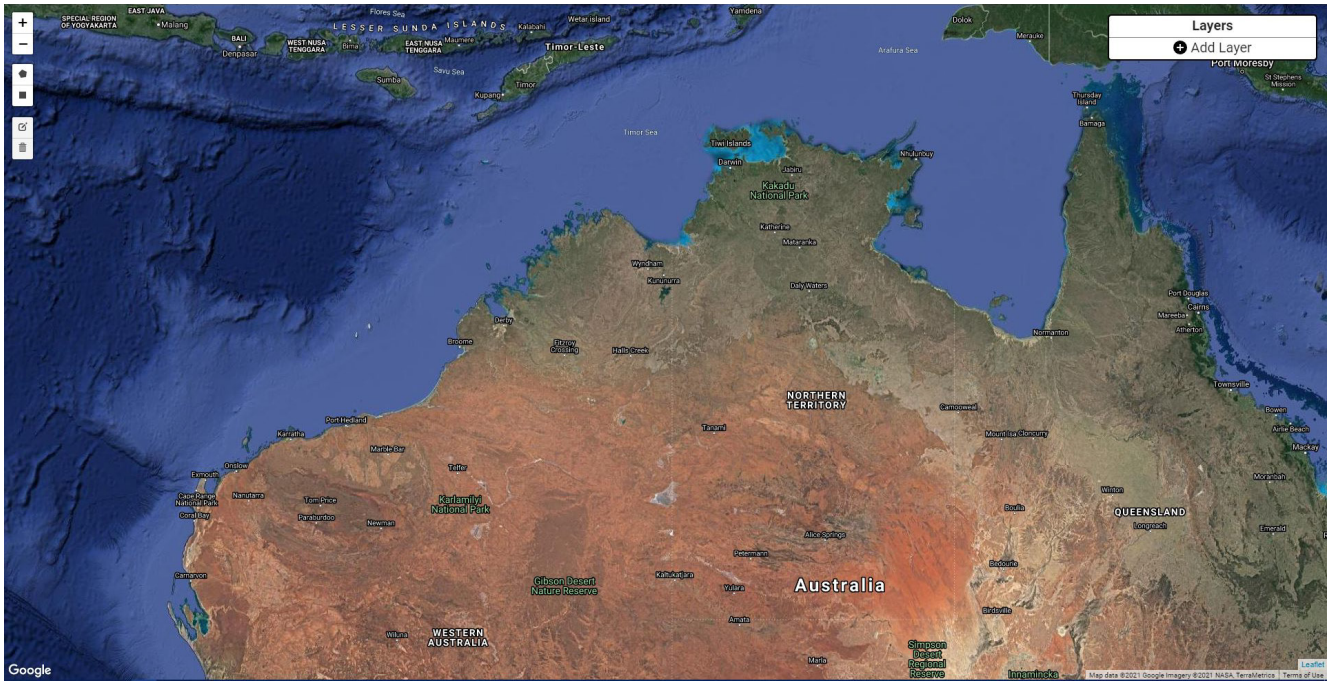


Run the tool by double-clicking on the *index.html* application found in the corresponding folder. The tool automatically opens in your preferred web browser. For best performance, we recommend using the latest version of Google Chrome to run the tool. Users may require defining the preferred program used to run HTML files on their computer. To do this, right-click on *index.html* and select Chrome.

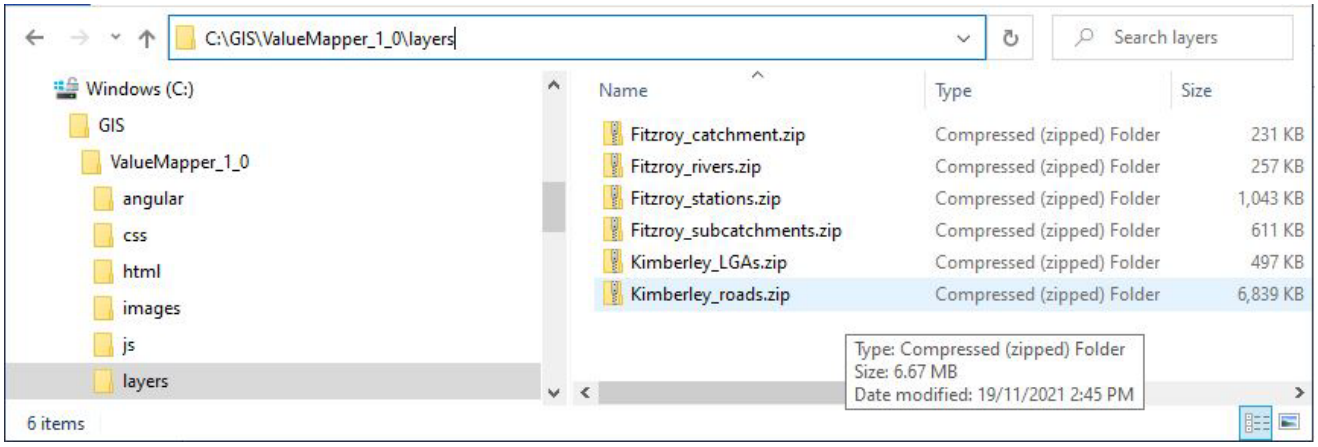


Background and reference layers

The tool pre-loads multi-resolution satellite imagery as background (reference) maps freely available online in Google maps. This base map is helpful to locate and delineate features of interest on the map. Given the project's scope, the tool opens using a predefined spatial extent (northern Australia). Users can identify the displayed satellite imagery by looking at the description on the bottom-right of the map (e.g., source, year, provider, satellite). This information is helpful to know the imagery's age and give the relevant credits if printing or taking a screenshot of the map for publication purposes. On the far bottom-right, users can click on Terms of Use to understand the conditions for using Google Maps and Google Earth maps.

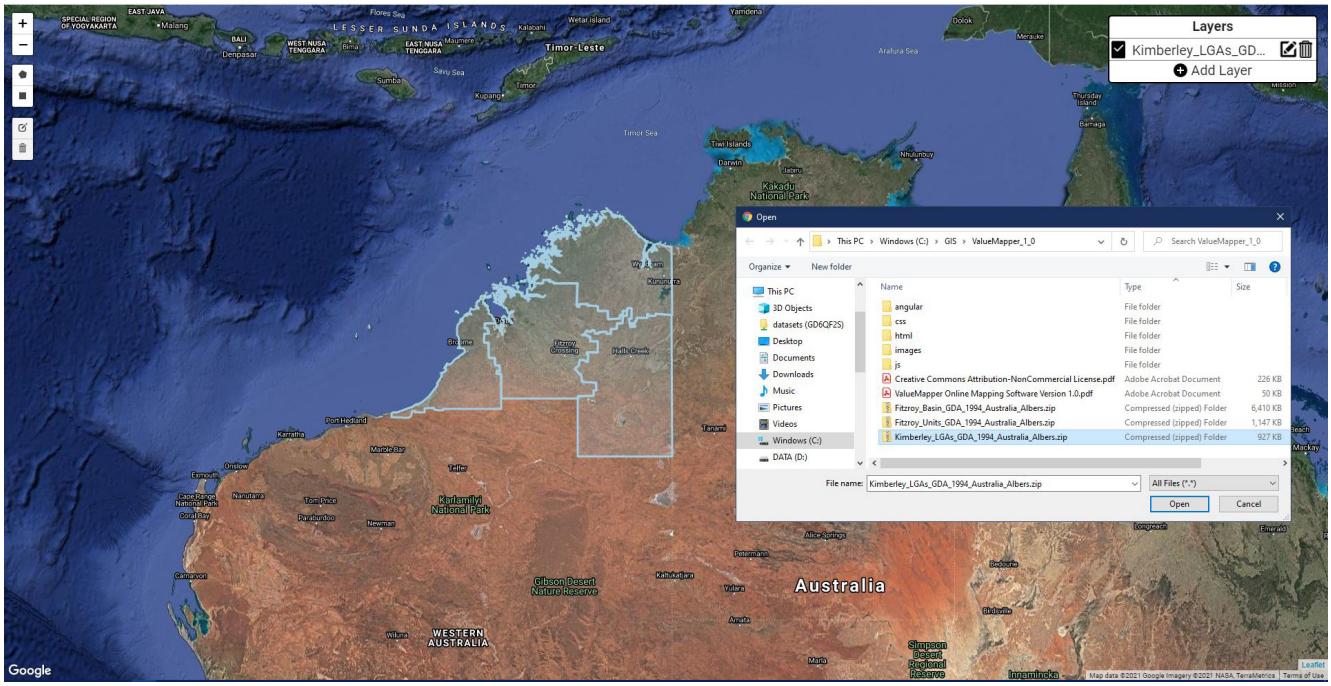


In addition to the background base map, the tool can visualise reference layers. Reference layers can be imported using the Add Layer function (top right), added as zipped Shapefiles. Each Shapefile must be zipped in advance and copied to a local directory before importing it (e.g., in the software layer folder: C:/GIS/ValueMapper/Layers/). By default, the tool includes five zipped reference layers relevant to the Fitzroy River catchment (river basin boundary, subcatchments, rivers, main roads, station boundaries, Local Government Areas). These can be found in the layers folder provided with the ValueMapper software.



Adding, removing, and renaming reference layers

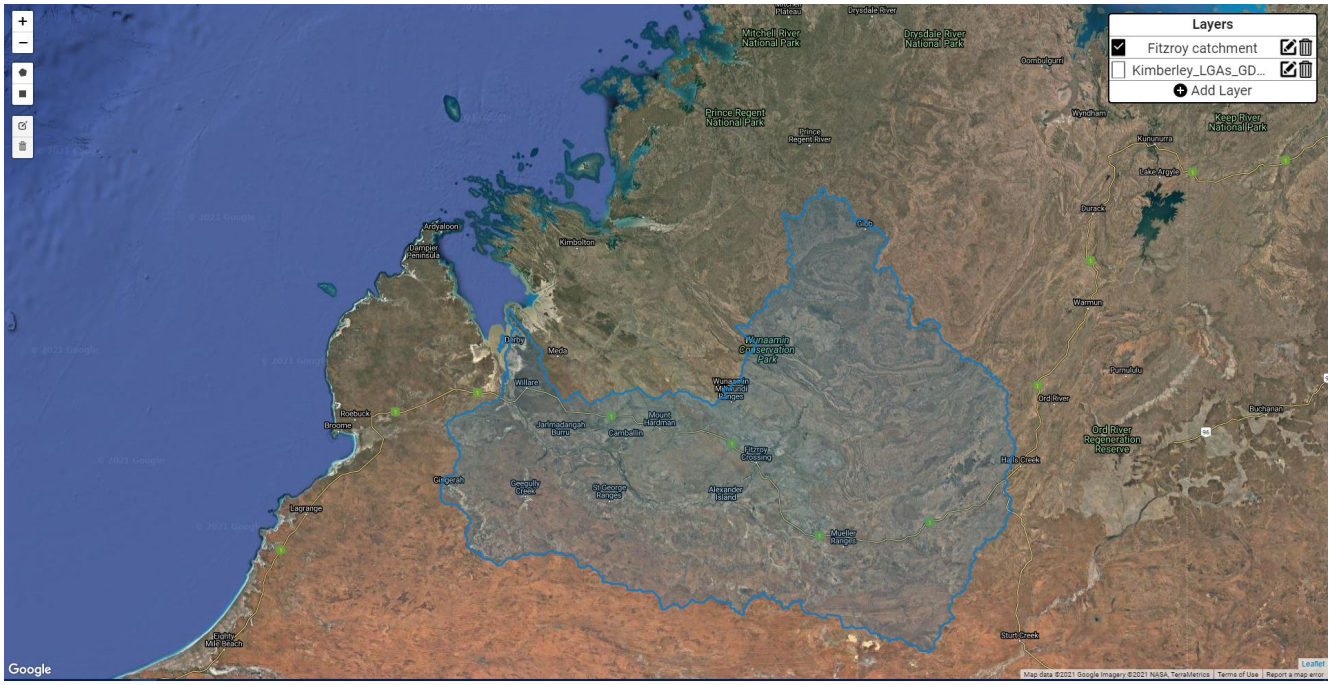
To add the default or any other reference layers, click on the **plus icon** of the **Add Layer** function (top right) and navigate to the corresponding folder containing the zipped Shapefiles. Select and import one layer at a time. The layer is automatically displayed on the map and added to the list of visible layers on the top right.



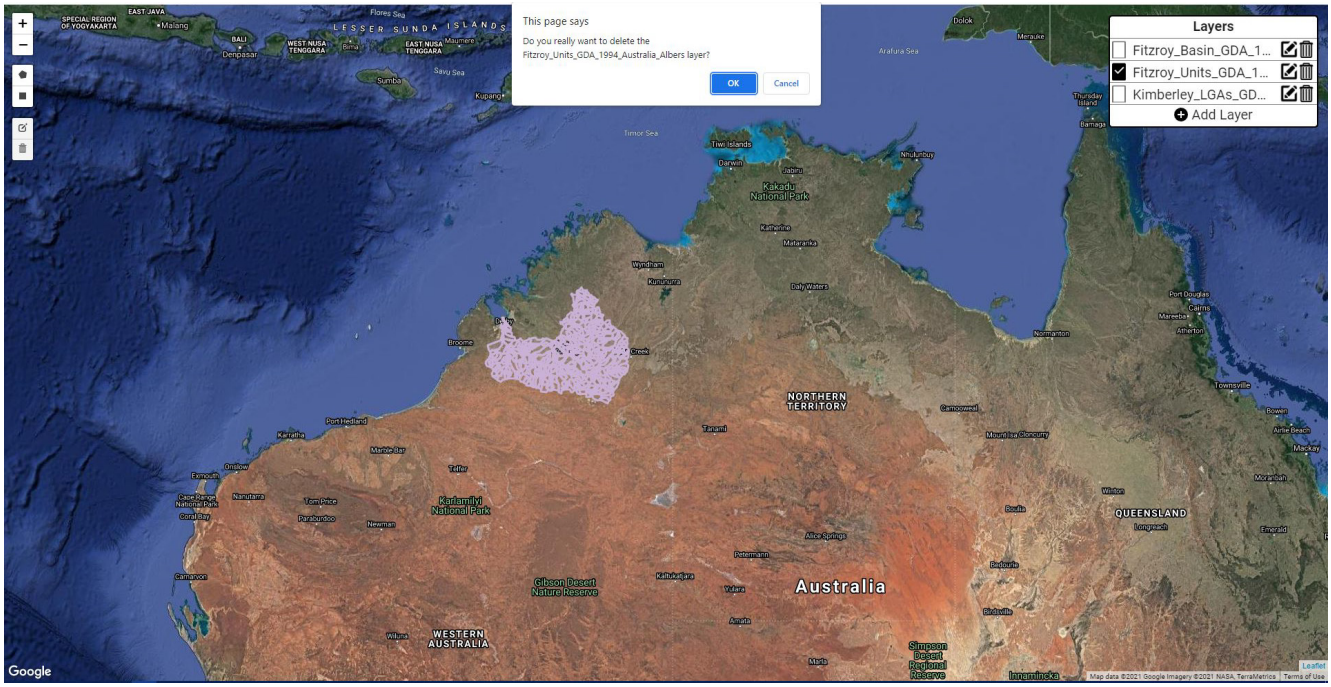
Recently added layers are automatically selected for display (tick mark on the left of the layer's name). Click on the **tick box** to unselect the corresponding layer to turn layers off.

Users can rename loaded (visible) layers to use simpler or better names to describe the layer during the mapping exercise. Renaming layers can be handy if the added layers have very long or complicated names or when working with multiple layers. To do this, click on the **edit icon (pen and**

paper) of the Layers section (top right, left of the trash icon) and enter a new name. Shorter names are preferred due to the pre-set size of the Layers box. Doing this does not modify the actual name of the zipped Shapefile, but the new name is visible in the tool.



To remove a layer, click on the trash icon (rubbish bin) on the right of the layer's name and confirm deleting the layer. The original zipped file remains in the folder but is removed from the display.



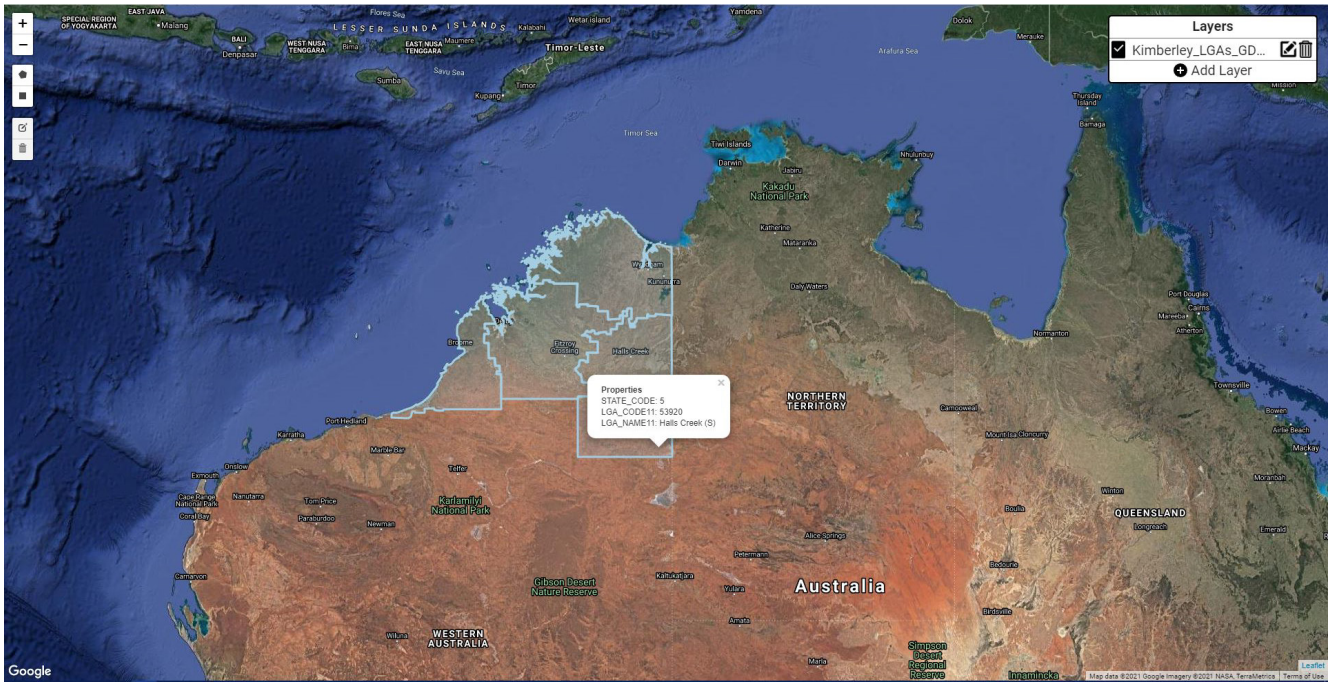
Adjusting the extent of the map

The plus/minus buttons on the top left allow users to zoom in (+) or out (-). Hovering the mouse pointer on top of these two buttons displays a pop-up help callout indicating each function. The Google map shows the highest and most up-to-date spatial resolution available, including reference locations (e.g., towns, roads, sites of interest) as users zoom in. Users can also use the mouse's

scroll wheel to zoom in (forward scroll) and out (backward scroll) or double click on any point of the map to zoom in a step-by-step manner equivalent to the plus/minus buttons. Finally, users can move the map using the mouse pointer to click (a **hand icon** appears) and "grab" and drag the map.

Visualising stored information in layers

A useful function of the tool is to enquire about the information stored in reference layers. To do this, click anywhere on the reference layer to display the stored information. This information cannot be modified using this tool, but it is helpful to know more about the reference layers. The '***properties***' pop-up callout displays all the information in the layer's attribute table, including the name of the field (left of the colon, one line per field) and the value of the field for the selected polygon (to the right of each field name). For example, suppose the layer includes multiple polygons. In that case, it may display the polygon's id, name, type, description, and size.



Mapping new features

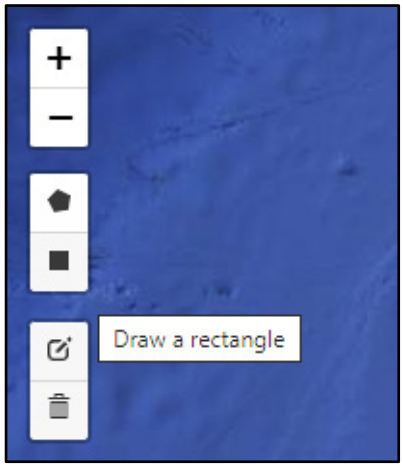
The tool's primary function is to map polygons that show the boundaries of features of interest. For example, areas of conservation value, areas sensitive to disturbance, areas with heritage value, areas of cultural significance, areas proposed for different development projects, boundaries of proposed or existing management or protection, among others.

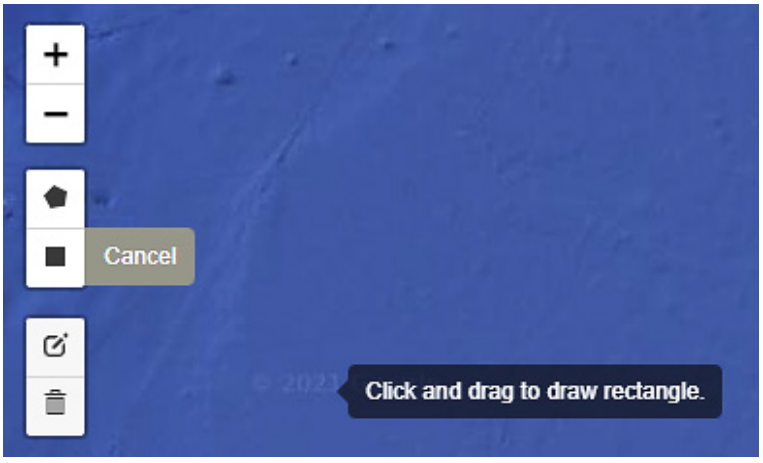
The tool allows drawing two types of polygons (rectangles and multi-vertex polygons), which can be combined into a single layer. Users can draw as many polygons as needed and save them into a single layer. The tool does not allow drawing lines or points because these features imply a high level of spatial accuracy in mapping, which is unlikely. Further, this could be undesirable in value mapping exercises (e.g., protecting the exact location of culturally sensitive sites). Shapefiles cannot combine points or lines with polygons, which would require exporting one file for each type of feature. The tool also excludes circles because they essentially represent buffered points. However, the code includes these functions, which could be integrated into future app versions.

Rectangles

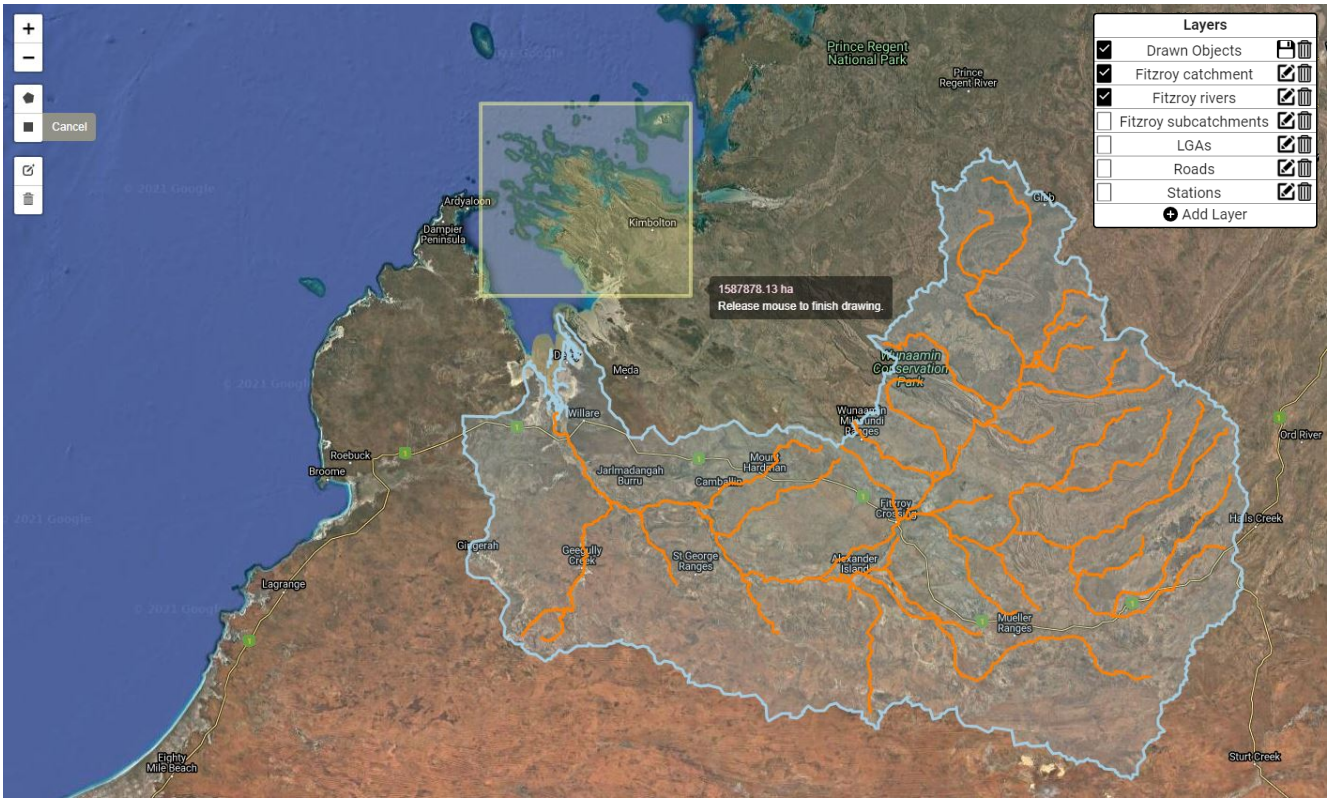
To draw a new rectangle, use the mouse left button to click on the **grey square button** below the zoom +/- icons (top left). Hovering the mouse pointer on top of the square displays a pop-up callout indicating the *draw a rectangle* function of the tool. Clicking on this function opens a pop-up callout next to the mouse pointer indicating users can *click and drag to draw a rectangle*. A light grey box with white text next to the square button gives users the option to cancel; clicking on this button stops the rectangle drawing function.

Users can start drawing by clicking anywhere on the map; the first click defines the rectangle's top-left corner. Users can then drag the mouse to select the size and shape of the rectangle that includes the boundaries of the feature of interest.





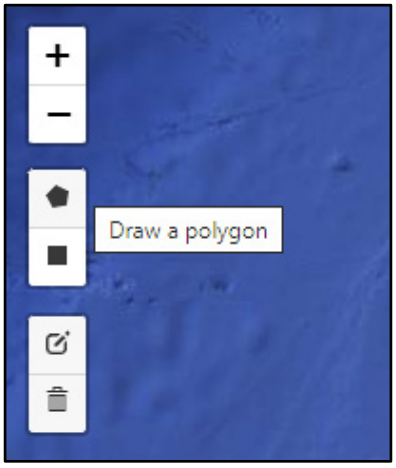
As users drag the mouse pointer, the tool displays the size of the rectangle (in hectares) and a pop-up callout next to the mouse pointer indicating to *release mouse to finish the drawing*. When the mouse's left button is released, the tool creates a new feature of rectangular shape (polygon geometry) and a new layer named drawn objects. At this point, the only feature (polygonal geometry) in the new layer is the first drawn rectangle. However, users can add as many rectangles as needed, which can be added until users save the layer (see next page).

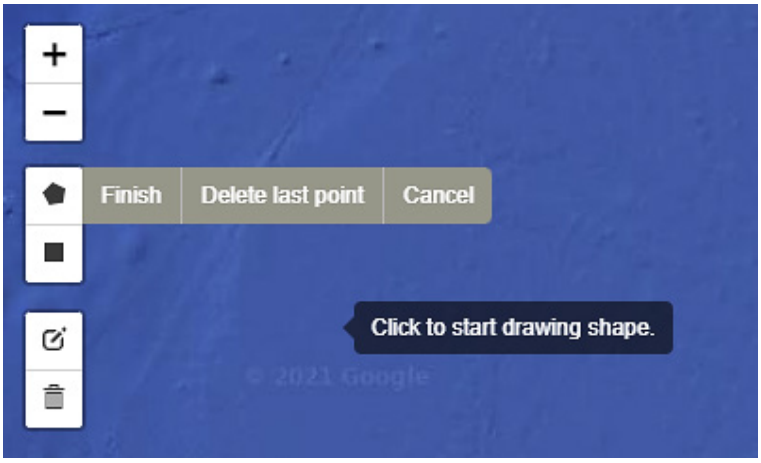


Multi-vertex polygons

To draw a multi-vertex polygon, use the mouse left button to click on the **grey pentagon** below the zoom +/- functions (top left). Hovering the mouse pointer on top of the pentagon displays a pop-up callout indicating the *draw a polygon* function of the tool. When the user clicks on this function, a pop-up callout next to the mouse pointer indicates the user can *click to start drawing shape*.

The user can start drawing by clicking anywhere on the map; the first click determines the starting or first vertex of the polygon. The user can then move the mouse pointer and click along to add new vertices to define the polygon's boundary.





After the first click, the tool shows a pop-up callout asking the user to *click to continue drawing the shape* and show a dashed coloured line connecting the first and second vertices. After three points, the tool displays a pop-up callout indicating the user can *click the first point to close this shape*. Three is the minimum number of vertices required for a triangular polygon. The user can then add more points or finish (close) the polygon by clicking on the first point (see next page).

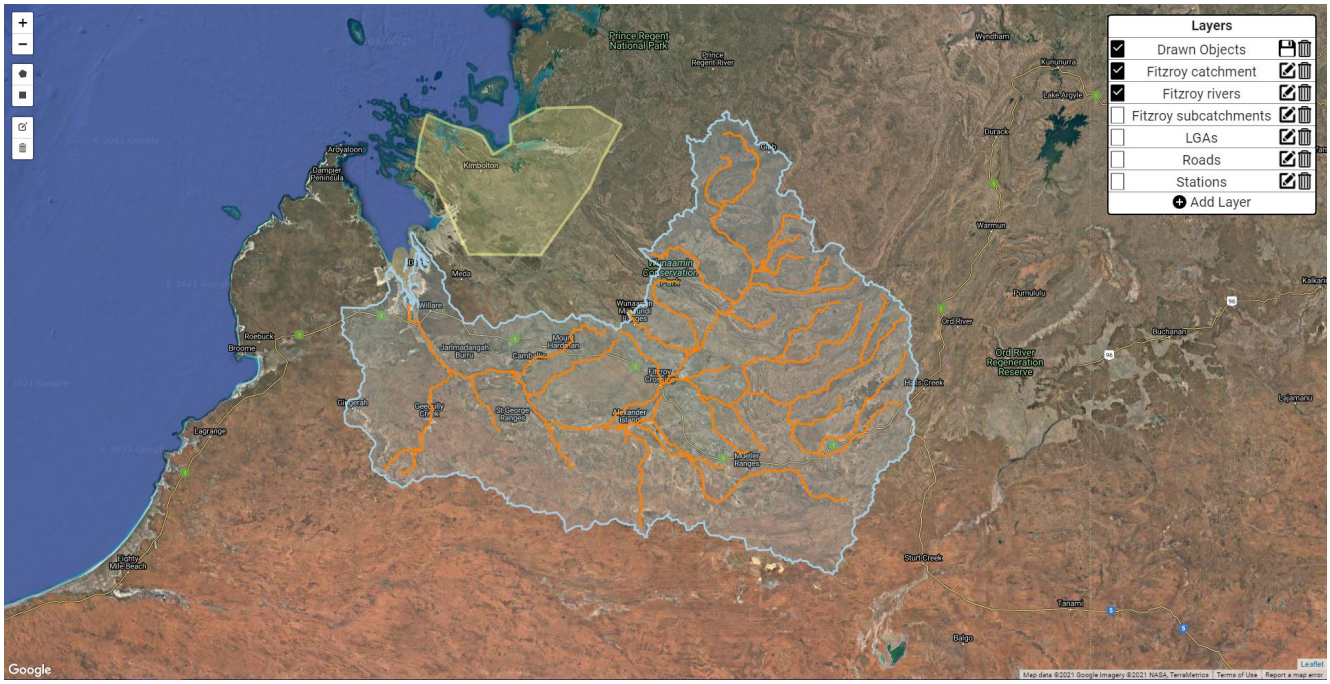
The drawing multi-vertex polygon function also provides users with three options, displayed in a light grey box with white text next to the pentagon:

a) Finish: click on this button to finish drawing the polygon, instead of clicking on the first point, to automatically select the first point and close the polygon, thus creating a new feature. The function only works if the user clicks (defines) at least three points. This function is handy to draw complex polygons with several vertices.

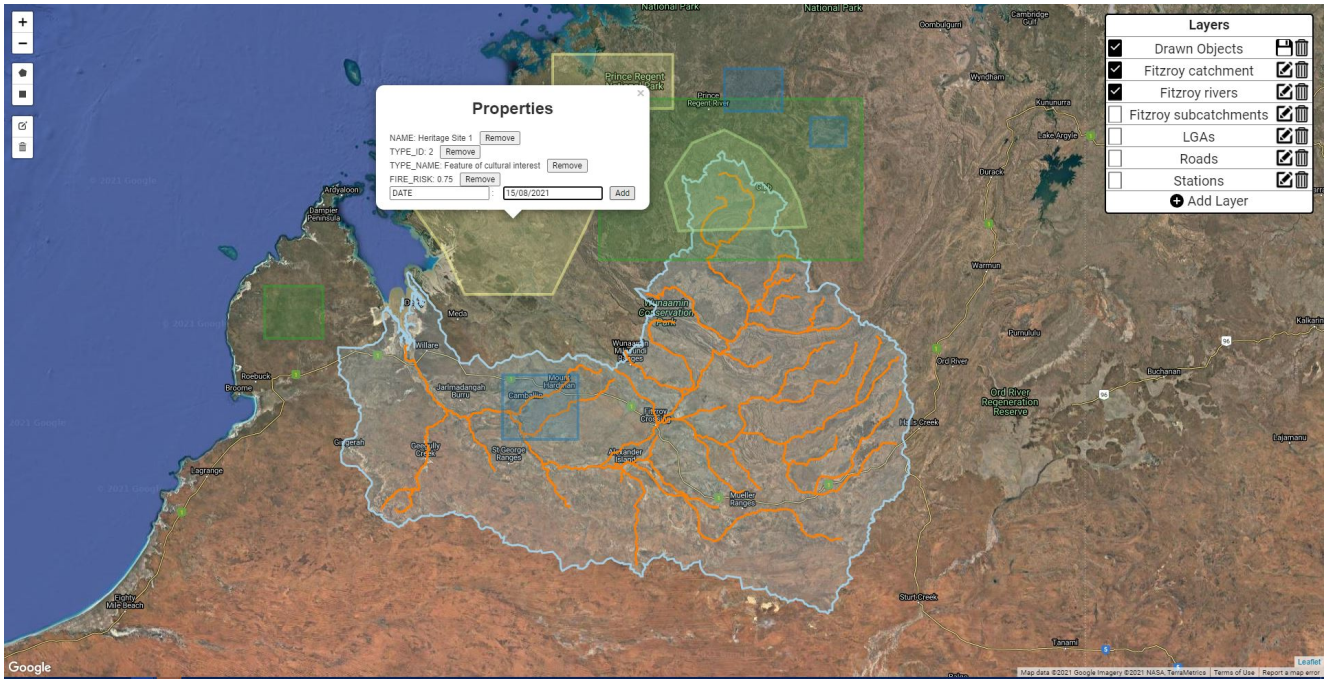
b) Delete the last point: click on this button to remove the last drawn point; clicking it multiple times deletes previously drawn points sequentially.

c) Cancel: click on this button to stop the multi-vertex polygon drawing function and start again.

When the user clicks on the first point or the Finish function, the tool creates a new multi-vertex shape (polygon geometry) and a new layer named drawn objects. At this point, the only feature (polygonal geometry) in the new layer is the first drawn polygon. Users can add as many polygons as needed, which are added to the layer until the user saves the layer (described below).



Users can draw as many polygons as needed before saving the new layer. Each feature in the new layer is automatically given a sequential number (**id**). Users can also combine rectangles and multi-vertex polygons in any order. Each new drawn feature is represented using different colours until the layer is saved.



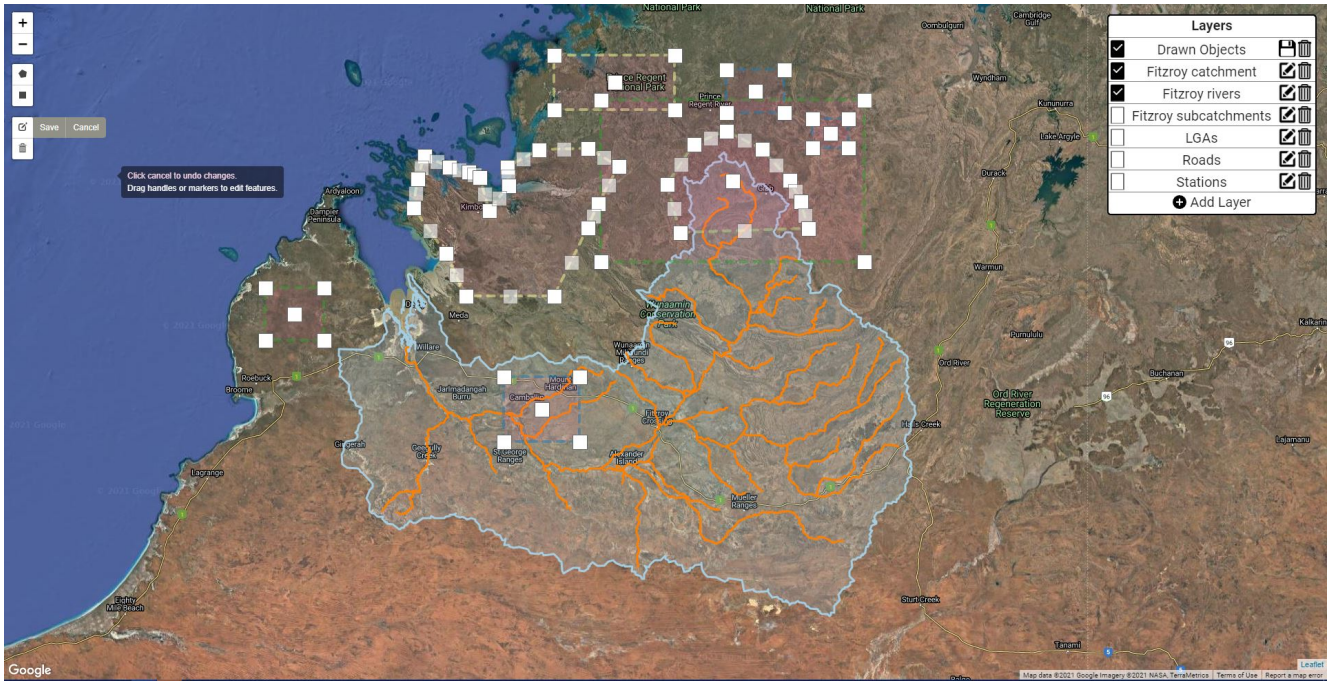
The tool allows creating overlapping polygons, for example, when features of interest share areas. This option could be helpful if users want to define a broad area of interest with one or more internal features of interest or zones. Users should be aware that the tool will not automatically intersect the two polygons but shows them as individual overlapping features within a single layer. In this case, users should consider noting when the overlapping features are related to each other and how by using the attributes function (described below).

After drawing features and any time before saving the layer, users can adjust the boundaries of the drawn features by clicking on the **edit icon (pencil and paper)** on the top left, below the mapping functions. Hovering the mouse pointer on top of the edit icon displays a pop-up callout indicating the user can *edit layers*. A pop-up callout next to the mouse pointer indicates users can *click cancel to undo any changes* or *Drag handles or markers to edit features*. At this point, all the features drawn during the mapping session and before saving the new layer appear with a white square in the middle (handle) and marking the position of their vertices (markers).

Clicking on the square (handle) allows moving the whole feature into a new position. Hovering the mouse pointer on top of the handle displays a pop-up multi-arrow (move) pointer, indicating users can click and shift its position. The feature retains its shape and size.

Clicking on the boundary squares (markers) allows modifying the shape and size of the feature. Hovering the mouse pointer on top of the handle displays a pop-up hand and finger (link) pointer, indicating users can click and adjust the position of individual vertices. Note that moving one vertex automatically adjusts the position of the closest neighbouring vertices.

After modifying the feature(s) using this function, users can click on Cancel and disregard all the edits or click Save to retain the modifications. These functions appear in the light grey box with white text next to the edit icon (top left, below the mapping functions).



Adding attributes to mapped features

One of the tool's key features is its flexibility to add information about the mapped features in the most appropriate and valuable ways for users. Given that there are no pre-set categories, users can map different types of features, and only document attributes that are context-specific and fit for purpose. Users can add as many attributes as needed and give attributes meaningful names (see restrictions below). The tool allows reshaping the mapped features and renaming and editing attributes through the mapping session. Once the layer is finalised, users can save and visualise the layer in the tool. After saving the layer, the user can modify the Shapefile and attribute table using any GIS software.

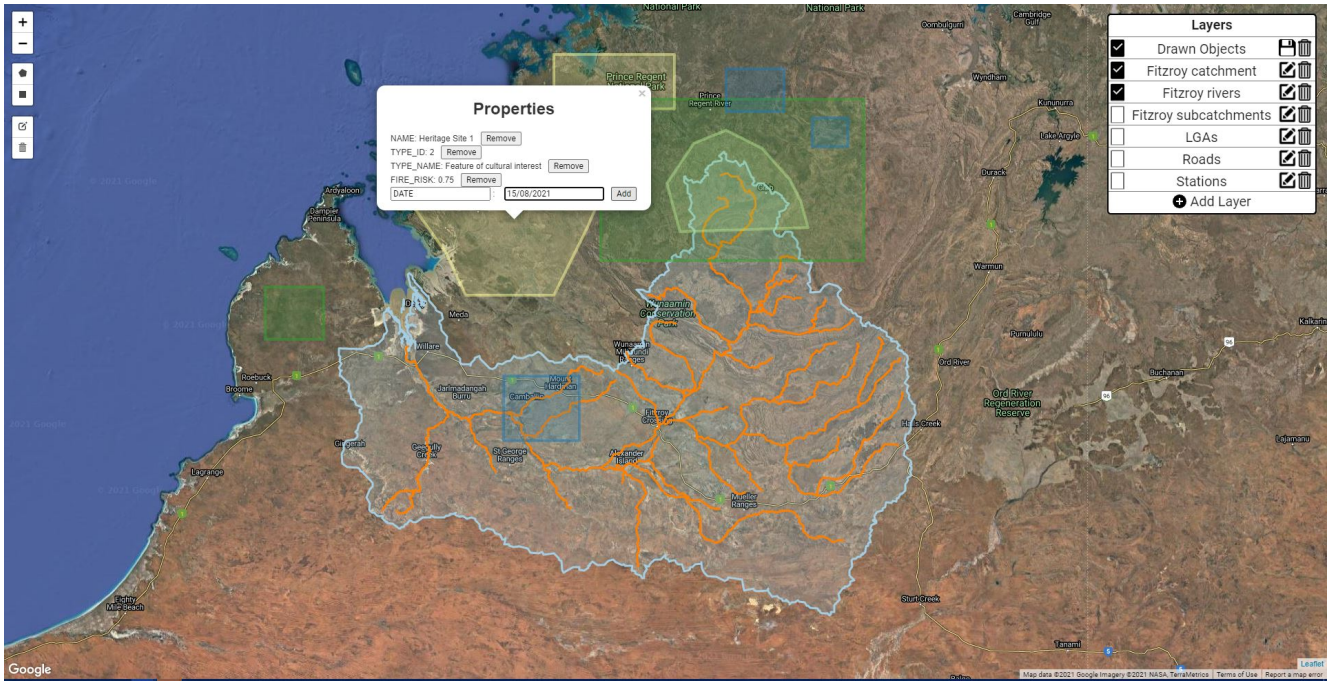
Users can add attributes to each new drawn feature or edit and add information for multiple features before saving the layer. We suggest adjusting the shape and adding any attributes right after drawing each feature, especially if users plan to draw several or features of different types. However, users can rename and edit attributes during the mapping session if the layer is not saved.

To add and edit attributes, hover over the feature (this displays the mouse select/link pointer) and click anywhere on top of the polygon. This function opens a pop-up with the **properties** of the feature, including two empty text boxes:

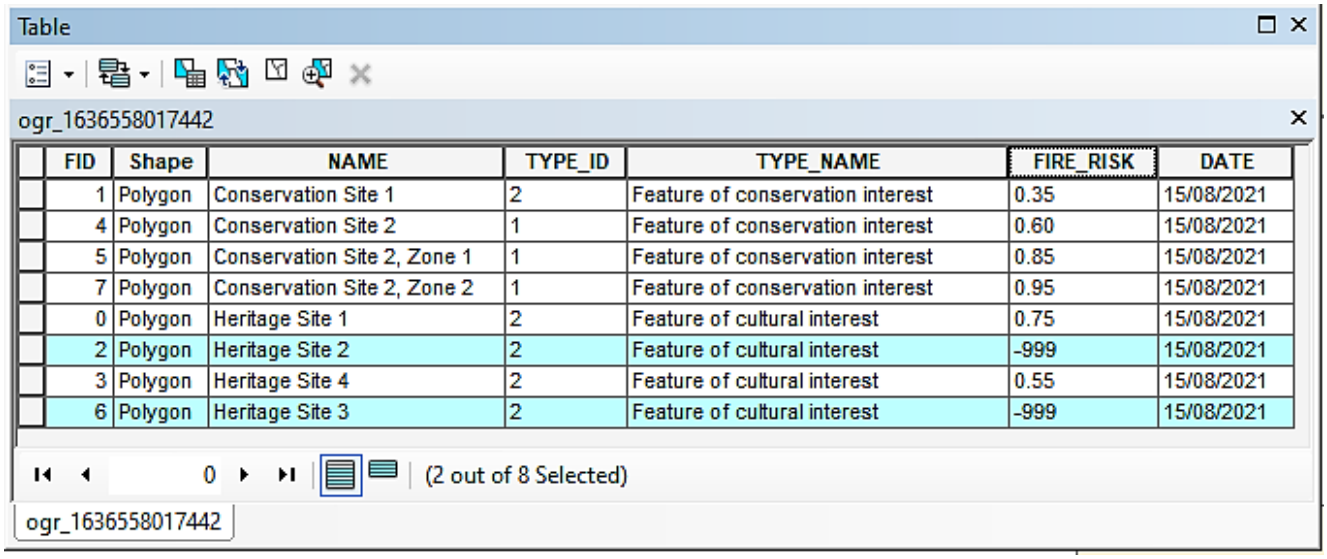
a) *New key (field name)*: use this to add and assign a new attribute (field) name. Keys define the type of attribute (e.g., name, category, date, description, quantity, importance, sensitivity, notes), which is equivalent to a field name. Key names must be alphanumeric (letters A/a to Z/z or numbers 0 to 9) and less than 10 characters in length, but they can include underscore (e.g., *Name_short, Name_local*). Key names cannot include spaces or special characters, such as points, commas, hyphens, brackets, colon, and exclamation marks. Never start the key name with an underscore or a number.

b) *New value (field value)*: use this to assign the value for the given key. For example, if the key is called '*Name_local*', users could include here the name of the feature in the local language. If, for example, the key is category, possible values are 'feature of conservation interest' or 'feature of cultural interest'. Every time users add a new key and corresponding value, it is necessary to click *Add* to save the new information in the layer's attribute table.

   Field values can be of any type, including text, numerical (integer, decimal), and date. Depending on the type of information entered in the *new value* text box, the tool automatically identifies and allocates the field type when saving the layer. For example, if users enter the following **keys** (*values*): (a) **NAME** (*Heritage Site 1*); (b) **TYPE_ID** (*2*); (c) **TYPE_NAME** (*Feature of cultural interest*); (d) **FIRE_RISK** (0.75); and (e) **DATE** (*15/08/2021*), the tool will classify these fields as (a) text; (b) numerical (integer); (c) text; (d) numerical (decimal); and (e) date.



The tool automatically recognises fields as equivalent when new keys in different features have the same name and type of values. If users do not add all the keys to all features, the tool leaves those fields blank for those features. Leaving blank fields can be appropriate if users have no information about specific attributes for some features. However, it is advisable to add values that indicate this is the case, for example, *-999* for numerical fields and N/A (not available) for text fields.



FID	Shape	NAME	TYPE_ID	TYPE_NAME	FIRE_RISK	DATE
1	Polygon	Conservation Site 1	2	Feature of conservation interest	0.35	15/08/2021
4	Polygon	Conservation Site 2	1	Feature of conservation interest	0.60	15/08/2021
5	Polygon	Conservation Site 2, Zone 1	1	Feature of conservation interest	0.85	15/08/2021
7	Polygon	Conservation Site 2, Zone 2	1	Feature of conservation interest	0.95	15/08/2021
0	Polygon	Heritage Site 1	2	Feature of cultural interest	0.75	15/08/2021
2	Polygon	Heritage Site 2	2	Feature of cultural interest	-999	15/08/2021
3	Polygon	Heritage Site 4	2	Feature of cultural interest	0.55	15/08/2021
6	Polygon	Heritage Site 3	2	Feature of cultural interest	-999	15/08/2021

New fields (keys) can be deleted from the attribute table at any time while editing the Properties of the feature by clicking the *Remove* button next to the key. Once all the keys and information is entered for a feature, users should click the **close icon (X)** at the top right of Properties.

Users need to be careful to use the exact spelling when referring to the same attribute. For example, using '*Category*' for some features and '*Categories*' for others results in two fields in the attribute table containing the same type of information. Each feature only has information in the field used for that feature. Depending on(Pert et al. 2015) the field name used to add the information, the other field remains empty.

We recommend creating a list of fields to avoid problems with invalid field names, such as incomplete information, multiple fields containing the same type of information, and inconsistent field names. The list must include the names (following GIS naming requirements described above) and the type of information that could be included (or not), as well as the value to indicate lack of information.

Defining the keys should be part of a broader process by which tool users (e.g., local organisations, communities) discuss and define an appropriate framework to guide the design of the mapping exercise (Brown and Kyttä 2014; Fagerholm et al. 2021), preferably in collaboration with social scientists and people with experience in PPGIS. Users can classify features using a new purpose-built classification (including clear definitions) or adapt an existing landscape value typology (e.g., Brown and Weber 2012; Munro et al. 2017).

In designing the mapping process, it is critical to ensure the recognition of knowledge holders (based on prior informed consent and protection of Intellectual Property Rights) and the development of respectful partnerships throughout the process (Ens et al. 2015). This process may include the following: defining what users want to map and why; what type of information could be collected (or not); who needs to be involved; potential uses (and users) of the data (including post hoc spatial analysis, e.g., Brown et al. 2017; Noble et al. 2020; Potter et al. 2016); and possible misuses and sensitivity of the data. This process should be guided by existing protocols for working with local communities and Indigenous groups, ensuring that mapping cultural values adequately engage the Traditional Owners (Davies et al. 2020; Jackson et al. 2012; Leavy 2007; Pert et al. 2015).

Finally, this process should include conversations about the ownership and custodianship of the data and the technical, legal, and financial implications of storing, backing up, maintaining, providing access, and sharing the collected spatial information.

Guiding these aspects is beyond the scope of this manual. However, we provide a draft list of fields to exemplify the type of information (including valid names) collected for previous landscape values mapping exercises. The following list is an example, but there are different ways to document spatial data. Not every field is valid, relevant or obtainable for all mapping exercises.

a) **NAME**: Name of each drawn feature within a layer. Depending on the type of mapped features, this could be split into different types, e.g., NAME_SHORT (short name valid for queries and data analysis); NAME_LONG (descriptive name of the feature); NAME_LOC (e.g., name in local language), NAME_SCI (e.g., scientific name), and NAME_ENG (e.g., common name in English).

b) **TYPE**: Indicate the type of feature, preferably based on a custom-made or pre-existing typology for landscape values (as discussed above). This field can be split into multiple fields defining sub-classes (e.g., TYPE_I, TYPE_II or CLASS, SUBCLASS).

c) **ECOSYSTEM**: Indicate the type of ecosystem(s) or environment(s) relevant to or included within the mapped feature (e.g., Terrestrial, Freshwater, Riparian, Coastal, Estuarine, Marine).

d) **DESCRIBE**: Provide a summary describing the mapped feature and the most significant characteristics, including the rationale or main criteria used to define its boundaries.

e) **PRECISION**: Enter additional information about how precise or confident the mapper is about the feature's boundaries. Simple categorical classifications may be sufficient (e.g., high, medium, low). However, numerical values are possible if they can be justified and determined systematically.

f) **MAPPER**: In some cases, individual features could be related to individuals if they choose to do so. Usually, each dataset (new layer) is associated with a list of contributors participating in the mapping exercise (at the individual or group level), which can be public or not.

g) **ACCESS**: Generally, access is defined for a whole layer. However, there could be specific restrictions associated with some features due to their sensitivity. If this is the case, users can allocate specific access permissions/ restrictions to particular features by adding an access field. For example, if the mapping session includes different types of data saved within a single layer. Examples of access levels with increasing restrictions to access include:

    a. *Open access*: the data is freely available data license (e.g., Green Open Access or Creative Commons licenses)
    b. *Open access (via publisher)*: the data is freely available from the publisher
    c. *Embargoed*: the data become Open Access after the expiration of an embargo period
    d. *Restricted*: the data cannot be made available due to sensitivity or other restrictions

h) **ACCESS_EXP**: Note explaining or providing more details on the data/mapped feature access and the rationale behind the classification.

i) **SENSITIVE**: as above, this can be defined for the layer or individual features, as needed. Examples of access levels with increasing sensitivity include:

    a. Not Sensitive
    b. Commercially Sensitive
    c. Culturally Sensitive
    d. Non-Public
    e. Commercially Sensitive and Culturally Sensitive
    f. Commercially Sensitive and Non Public
    g. Culturally Sensitive and Non Public
    h. Commercially Sensitive, Culturally Sensitive, and Non-Public

j) **SENSIT_EXP**: Note explaining or providing more details on the sensitivity of the data/mapped feature and the rationale behind the classification.

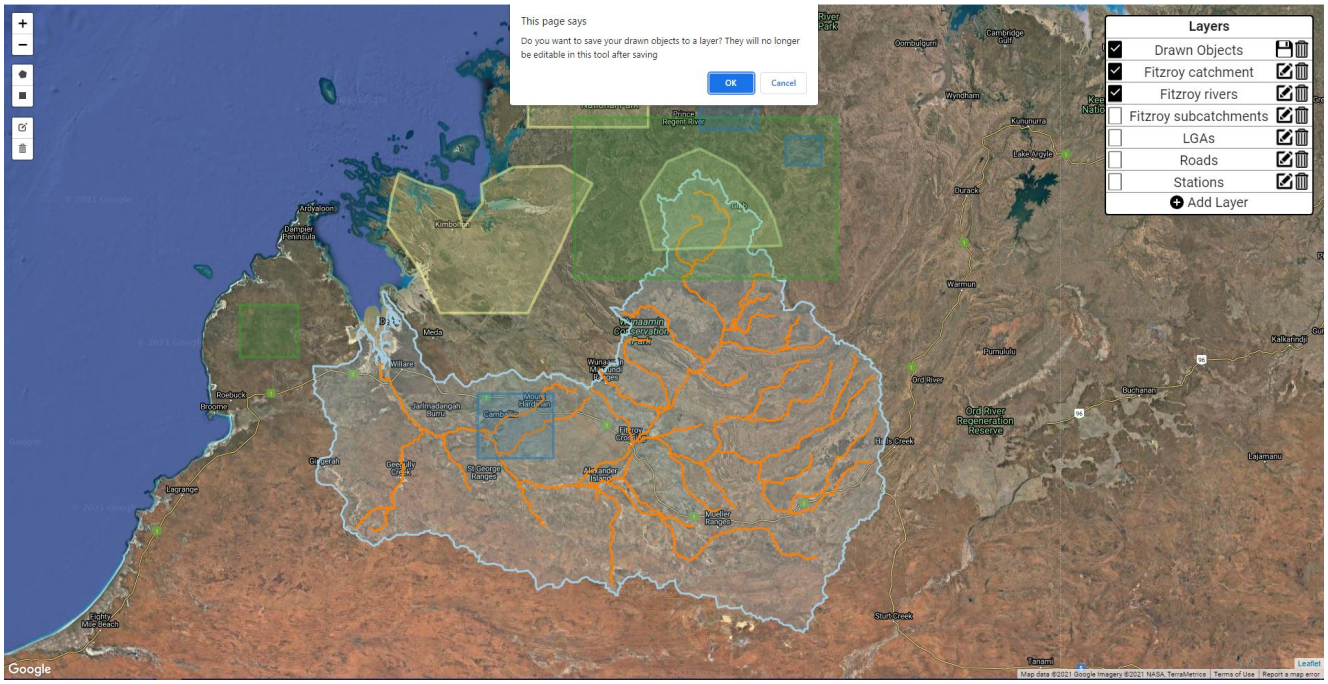
k) **OWNER**: Open text field to describe the owner(s) of the knowledge reflected in the mapped feature(s). In cases where all the participants identify as part of the same group (e.g., cultural group), this can be documented at the layer level. In multi-stakeholder and cross-cultural mapping exercises, this field can specify the contributing group/individual.

l) **CUSTODIAN**: Open text field to describe the group(s), organisation(s), or individual(s) that are custodians of the knowledge included in the map. Custodianship is usually defined at the layer level. However, if needed, it could be added as a field to define custodians of specific features.

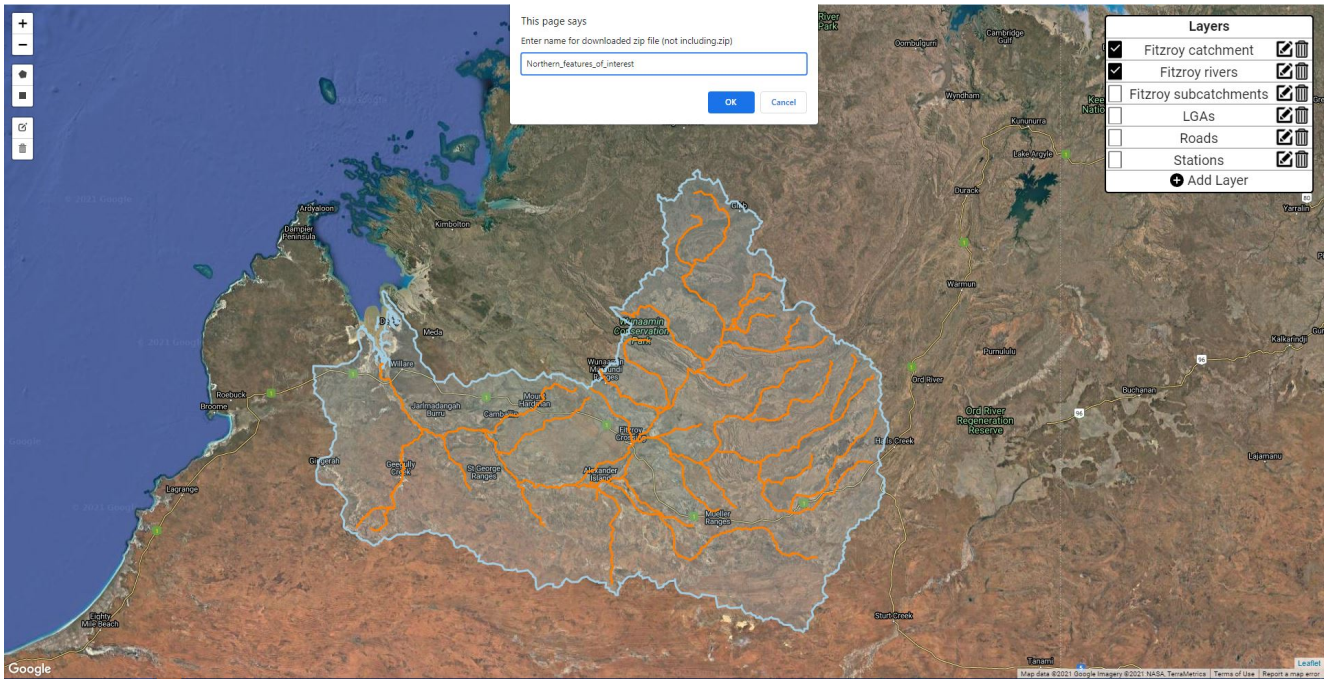
m) **NOTES**: Open text field to include any additional information about the mapped feature.

Saving the new layer

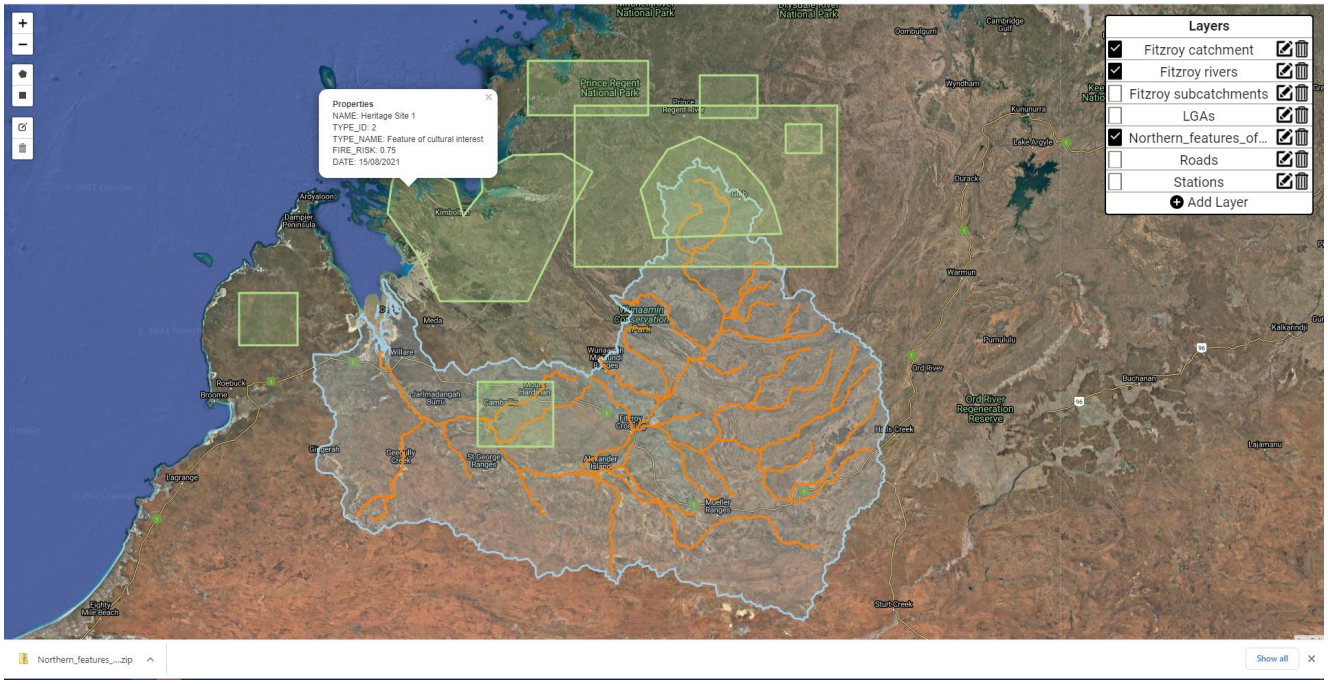
Once participants consider that the mapping session is complete for the layer, users can save the file as zipped Shapefile. To do this, click on the **saving icon (floppy disk)** to the right of the **Drawn Objects** (working) layer on the top-right of the map. The tool opens a dialogue box asking users to confirm that the new layer is complete. There is no opportunity to modify it further after saving. New layers must be created one by one, but users can create many layers during a mapping session.



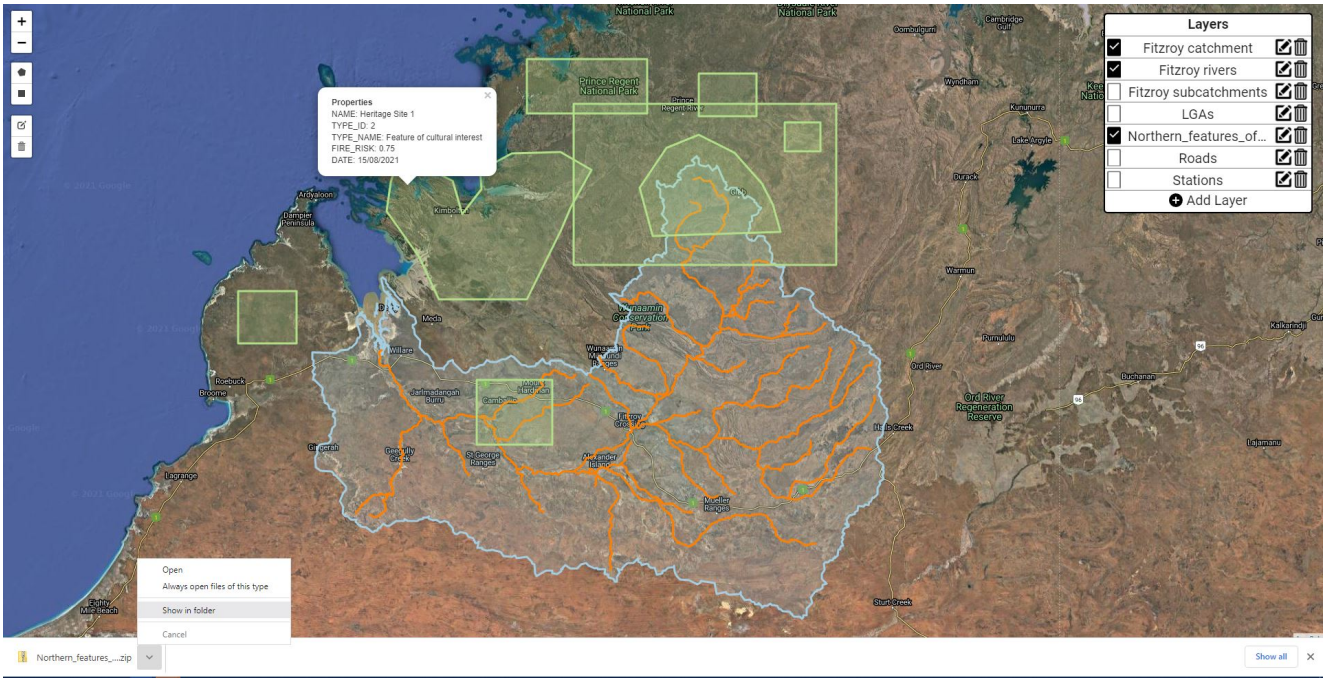
After clicking the OK button, the tool asks users to enter a name for the layer. This name is used to name the zip file. However, each Shapefile file is named using an automatic prefix (described below). It is desirable to use short and meaningful names suitable to the mapping exercise. Depending on the scope of the mapping exercise, layer names can combine the extent of the mapped region (e.g., Kimberley, Fitzroy), type of mapped features (e.g., cultural, natural), and the relevant group(s) associated with the mapped features (e.g., cultural group, community). The data is saved using the Geographic Coordinate System used by most GPS devices (GCS WGS 1984).



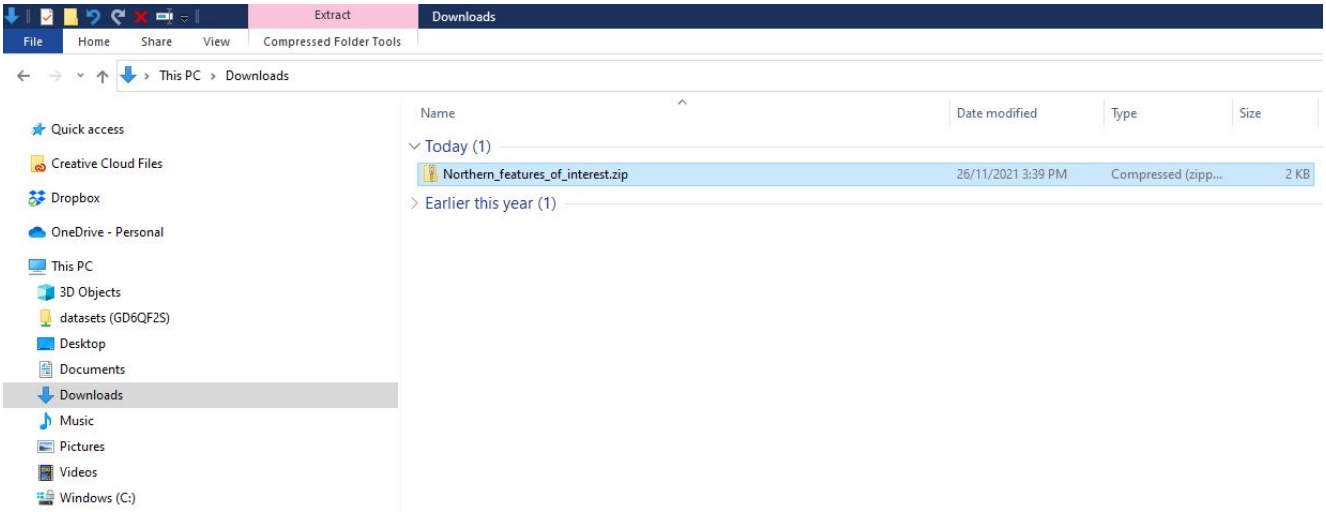
Once the name is entered and clicked on OK, the new layer is saved, automatically added to the Layers section (using the given name), and selected for display (tick mark on the left). All the layer features are drawn using the same colour (allocated by the tool), which is helpful to distinguish the new layer from reference layers and new drawings. The new layer can be turned on/off using the tick mark box like any reference layer. Clicking on any of the features displays the properties entered by users for that feature. However, these cannot be modified further using the tool. The Shapefile associated with the layer can be unzipped and imported for editing in GIS software.



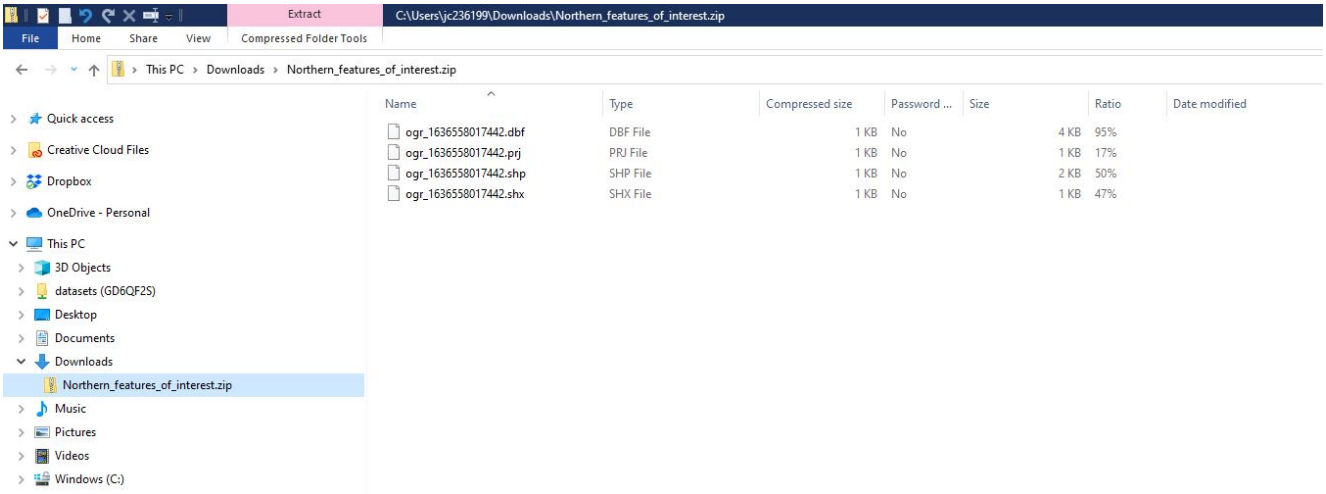
The tool automatically saves the layer in the **Downloads folder** of the computer. A small icon with a zipped folder and the new layer's name appears at the bottom-left of the map or screen (see next page).



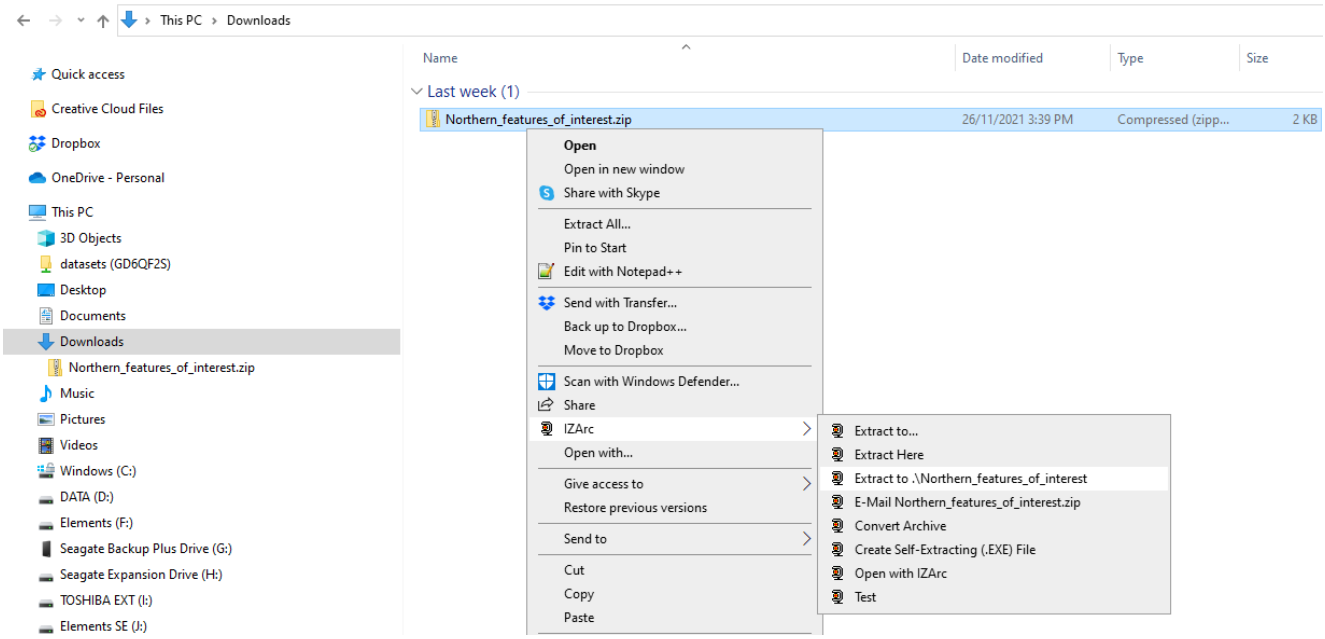
Users can access this file by navigating to the Downloads folder or right-clicking the zipped file icon on the bottom-left and clicking on ‘Show in folder’ from the drop-down list. Users are directed to the folder where the tool automatically saves the new layer. When a new layer is saved, users can open the Downloads folder, copy the new zipped file, and paste it into the folder where the new layers are saved (e.g., *C:\GIS\ValueMapper\layers\new*). Moving the layer from the downloads folder is essential to ensure the data is not lost. Moving the layer to a protected folder is needed to ensure other computer users do not access the layer if the information is sensitive. If the users want to delete the copy in the Downloads folder, the layer must be removed first by clicking on the **trash icon** on the right of the layer's name (top right). After, the layer can be imported again like any other reference layer by navigating to the folder where the layer was saved (see opening reference layers section).



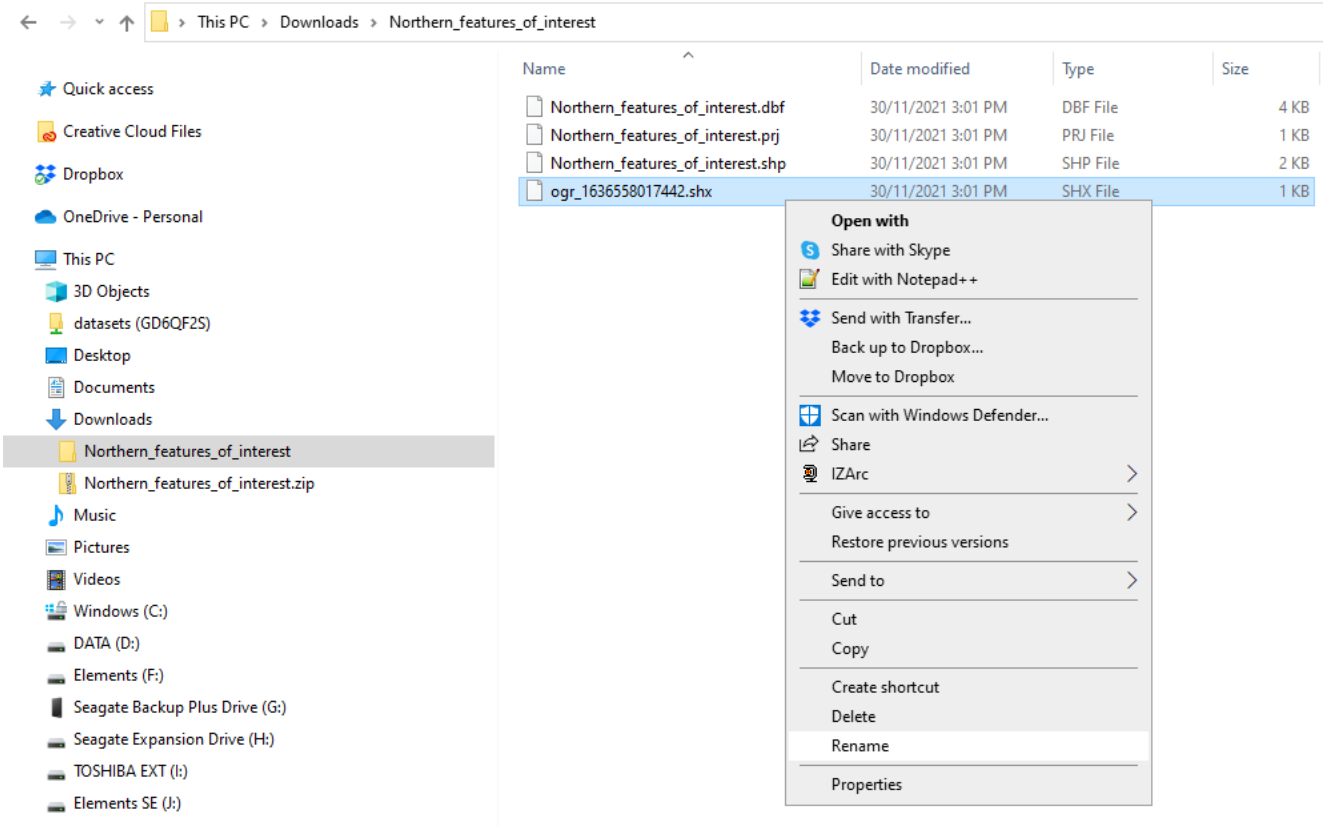
After inspecting (by double-clicking or unzipping) the layer, users can see the name of the Shapefile automatically given by the tool. Each of the four files comprising the Shapefile includes a common prefix ‘***ogr***’ and a random number given by the tool (e.g., ogr_1636558017442); see next page.



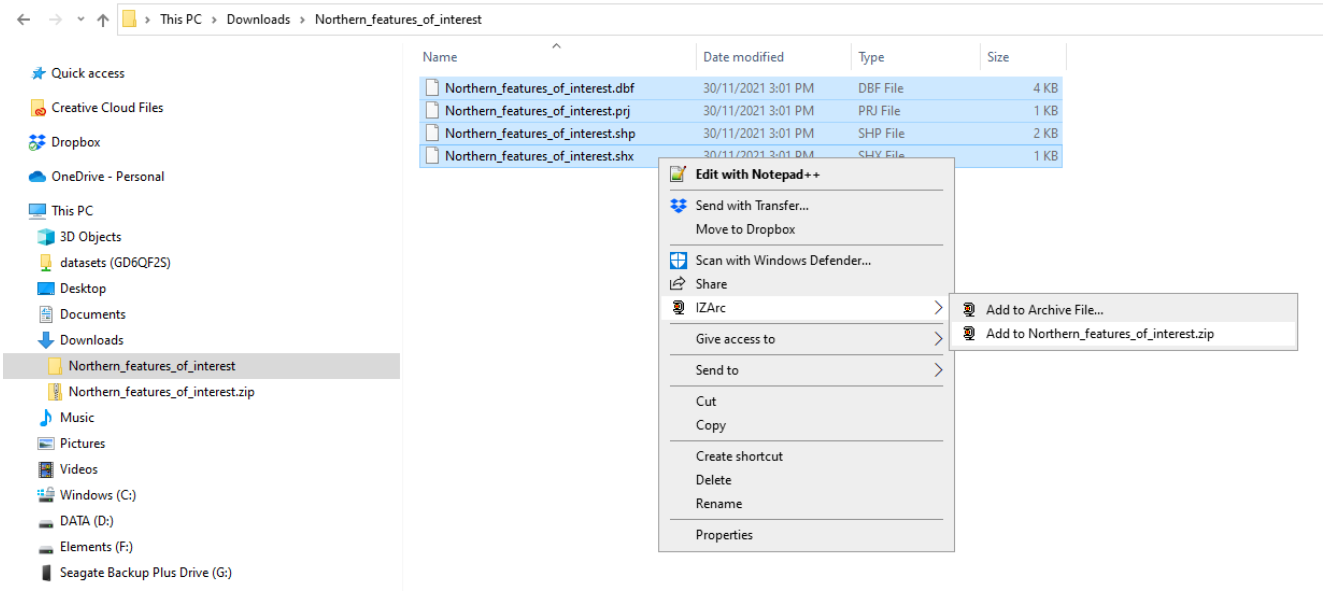
Users can change the Shapefile name to match the name of the layer. Changing the name can be helpful to work with the Shapefile in GIS software or share the data with others. Before changing the name, users must unzip the layer into a folder with the same name to ensure all the required Shapefile files are kept in the same folder. At this point, users can delete the zipped Shapefile.



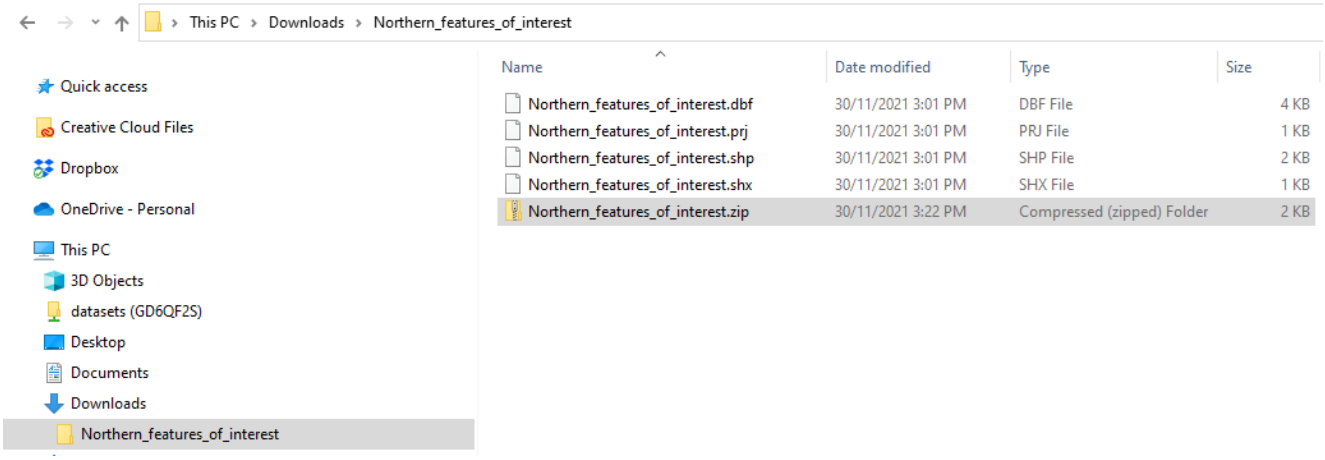
Users can change the name once all the files are unzipped and included in the new folder. Users must be careful to use the same name for each of the four files included in the folder without changing the extensions. Users can right-click on each of the four files and select ‘Rename’ from the drop-down list to do this (see next page).



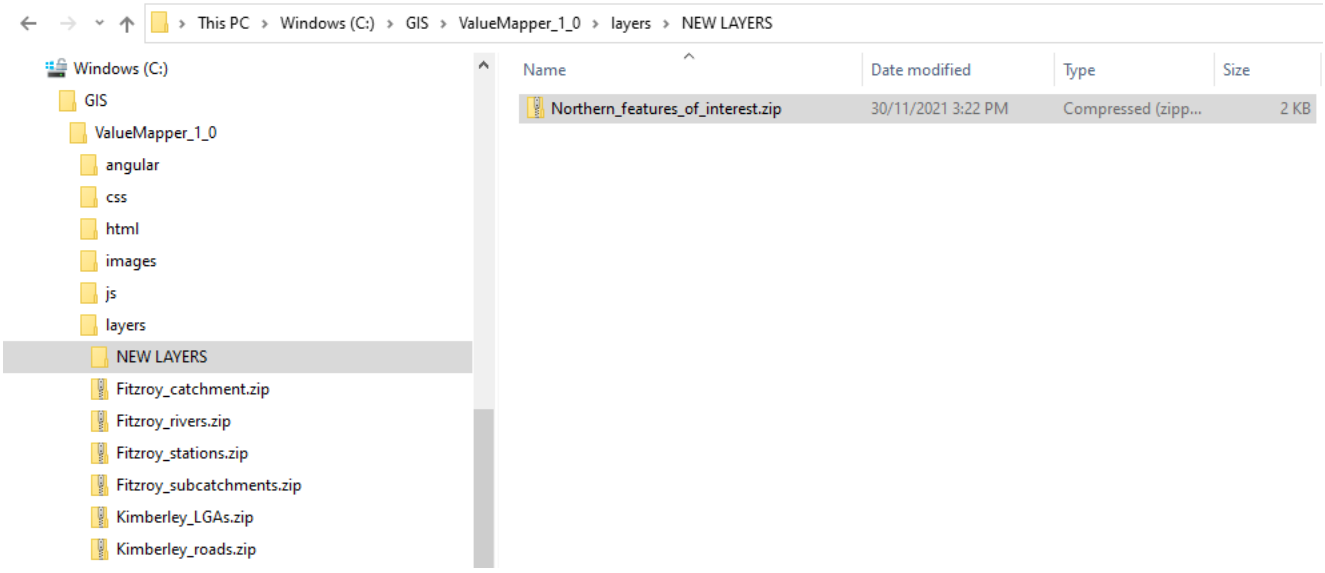
After changing the name of the four files, users can recreate the zipped Shapefile for use with the tool. Simply select all four files, right-click, and zip using any pre-loaded software on the computer (e.g., IZArc). The easiest way is to select the default compressing (zipping/unzipping) program, which appears in the drop-down list and then select the '***Add to…***' command.



The new zipped file now appears in the folder along with the four files of the Shapefile (see next page).



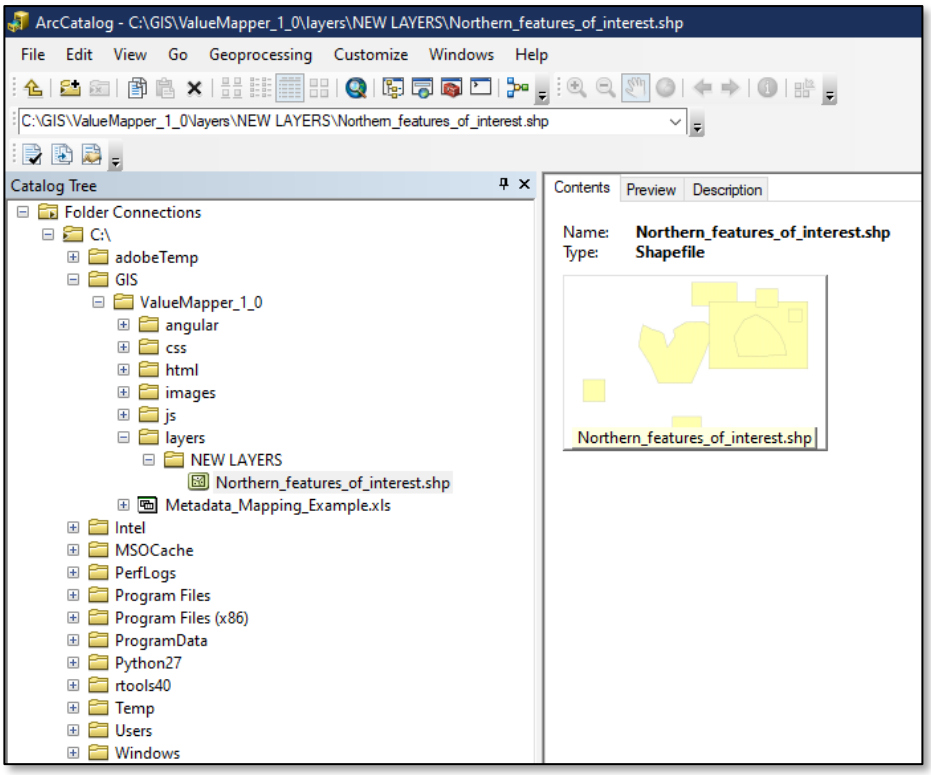
The next step is to move (cut and paste) the zipped folder into the same folder where all the new layers are saved (e.g., *C:\GIS\ValueMapper\layers\NEW LAYERS*). For example, create a folder named '**NEW LAYERS**' inside the '**layers**' folder provided with the tool. Creating a sub-folder in the layers folder can facilitate accessing the reference and new layers for the mapping exercise.

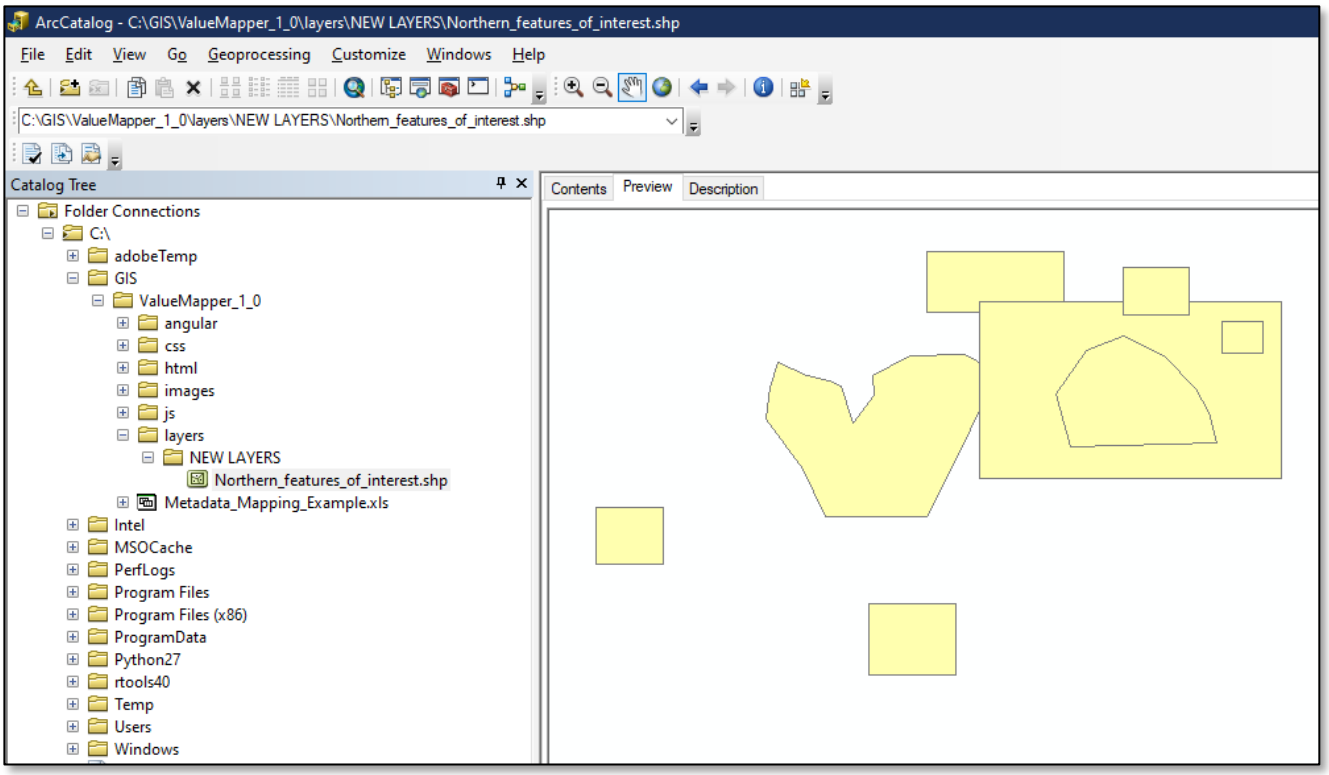


Creating a metadata record

The final step of the mapping exercise is to create a **metadata record** for each of the new layers. Creating a metadata record is critical to ensure spatial information is adequately described and protected for using, editing, and sharing the data. Creating a good record help others to find and appropriately use the data for further applications, especially when shared publicly. There are many ways to create metadata records for spatial data. However, it is preferable to follow the current standards for this information. The Australian Foundation Spatial Data Framework (FSDF) is the most current, standardised and quality-controlled authoritative source. Following FSDF, the ANZLIC Spatial Information Council website provides all the relevant information regarding the current metadata standards, including good practices guides. Further, the website also provides general guidance on collecting and using spatial data based on best-practice approaches. Other important aspects of metadata include data freshness (age and currency), and the need to update or consider its validity for different mapping and spatial analyses (Murray et al. 2021).

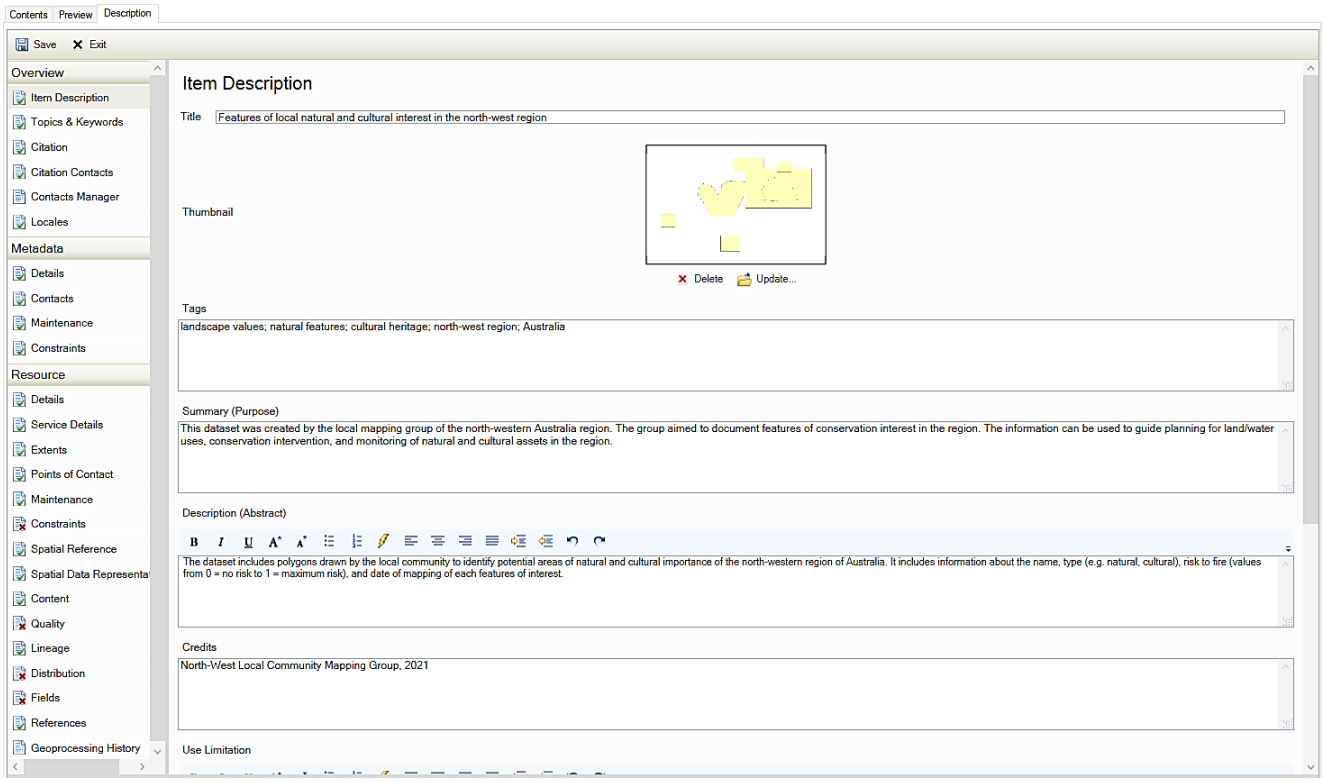
Following is a screenshot of the metadata created for the example Shapefile using ArcCatalog[1]. Creating metadata using GIS software is more accessible and ensures the metadata is directly linked to the Shapefile. To edit the metadata, navigate to the folder containing the unzipped and renamed Shapefile (e.g., *Northern_features_of_interest.shp*) and click on it. Users can only see one of the four Shapefile files (extension *.shp). The application displays the icon of the data (**Contents tab**) or the spatial data layer (**Preview tab**) for exploration via ArcCatalog.



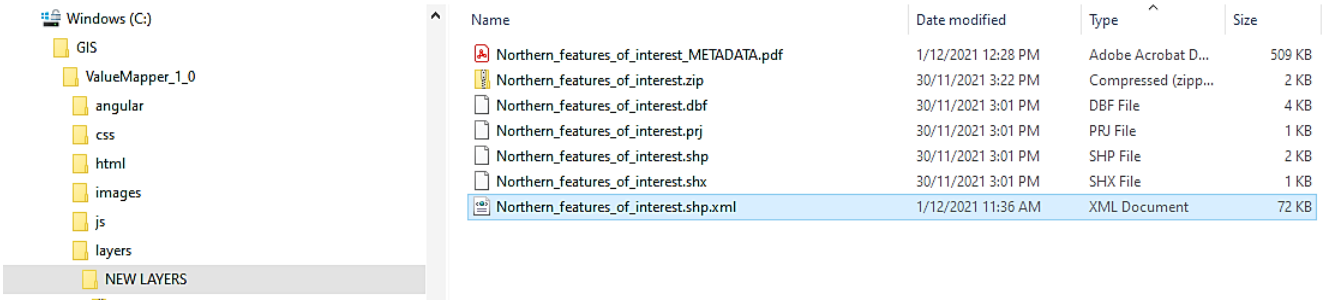


[1] The ArcCatalog application provides a catalogue window that is used to visualise, organise and manage various types of geographic information for ArcGIS for Desktop, including editing metadata of spatial data.

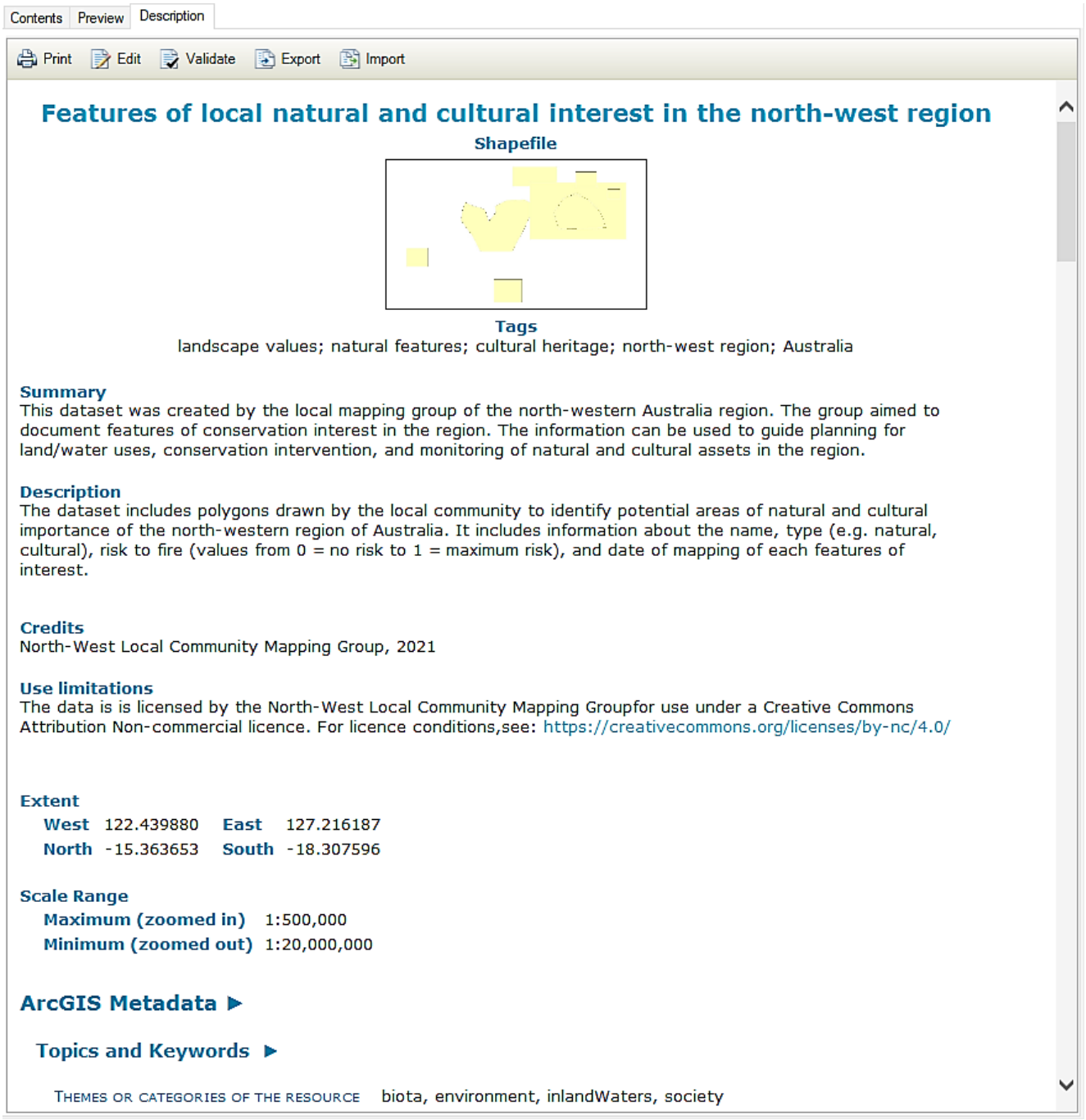
Users can now click on the **Description tab** and the **edit icon (paper and pencil)**. Opening the editing window allows users to add and modify different sections and attributes of the metadata. The minimum information required to document a dataset is included in **Overview → Item Description**. However, it is advisable to include as much information as possible for the following three categories in Overview (Topics and Keywords, Citation, Citation contacts) and the recommended **maintenance frequency** in Metadata → Maintenance section. All sections of the metadata records are accessible via the list on the left. Users can also include a **thumbnail image** of the data by taking a screenshot of the preview (above) and saving it as a JPG image file. Click on the **Update icon (yellow folder)** below the thumbnail icon and navigate to the folder containing the saved JPG file.



Once all the available information is entered, click **save (disk icon)** on the window's top-left. A new file with the ***.xml** extension is automatically created in the same folder. The new file appears to have two extensions, ***.shp** and ***.xml**; the first is part of the file name and indicates the metadata file corresponds to the Shapefile with the same name (e.g., *Northern_features_of_interest.shp*).



Users can now visualise the updated metadata using ArcCatalog (below) or any GIS software.



Users with no access or experience with GIS software can use MS Excel to create a metadata record of each new layer created with the tool. Users can use the definitions and sample metadata table provided with the tool (**Spatial_data_metadata_definitions_and_example.xls**) as a reference and example. The fields and information are the same as those presented above using ArcCatalog.

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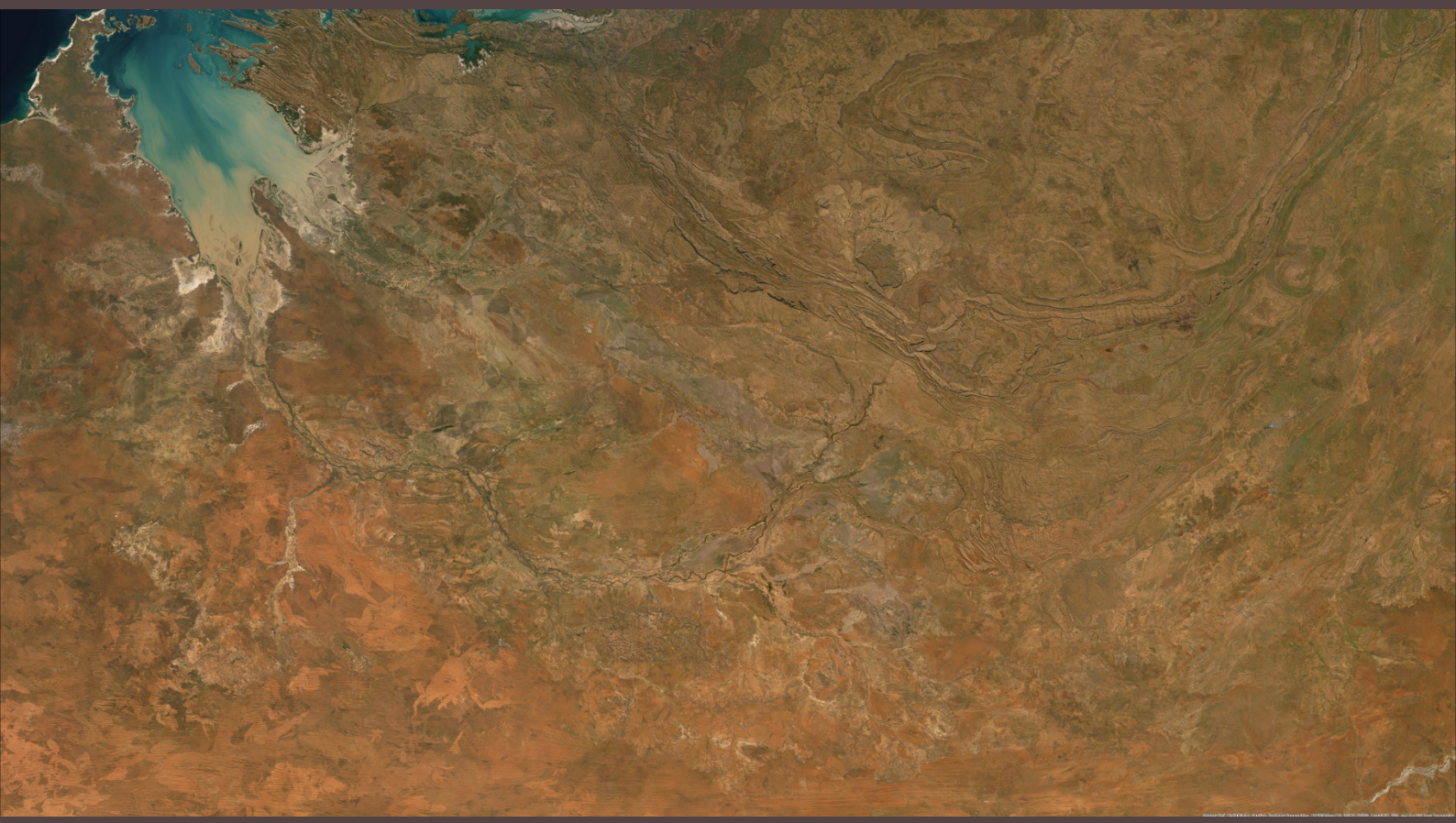

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