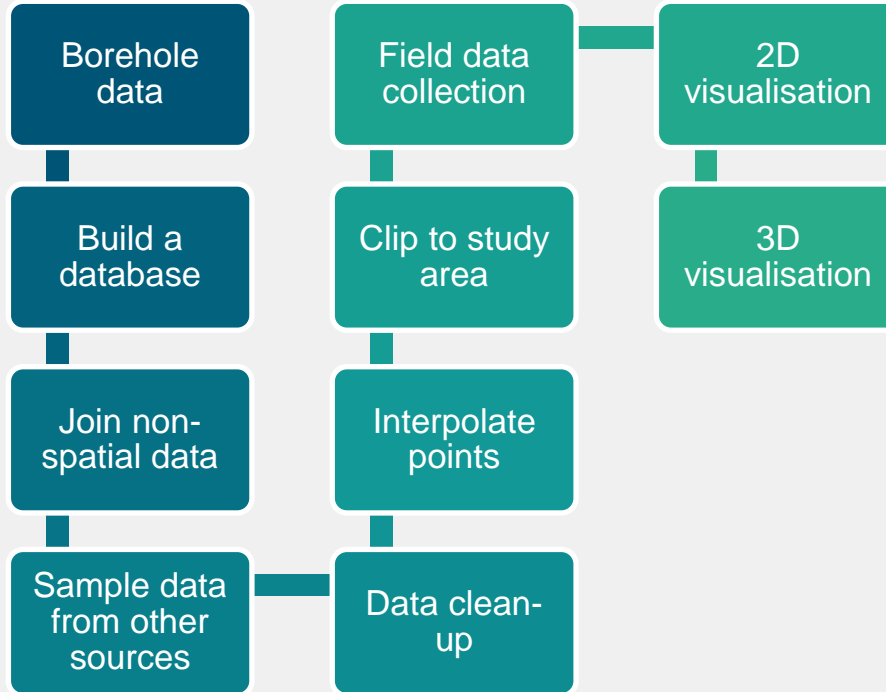


QGIS for Groundwater Applications

Preprocessing and collecting groundwater data

Hans van der Kwast (IHE Delft)

Workflow for preprocessing groundwater data



Where to get data?

Spatial Data Infrastructures (SDI)

Enabling environment that supports easy access to and utilization of geospatial data.

SDIs are more than just data repositories:

Discovery

catalogues, search engine

Visualization

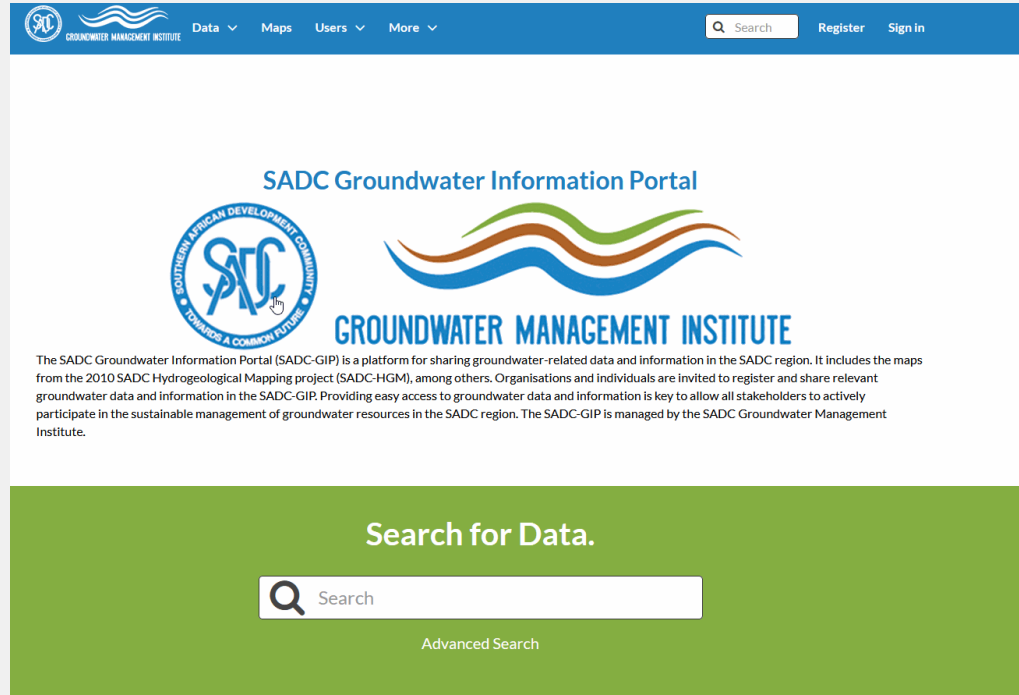
interactive maps, infographics,
real time data, etc.

Evaluation

quality, metadata

Access to geospatial data and information

web-based, apps, services, GIS



SADC Groundwater Information Portal

GROUNDWATER MANAGEMENT INSTITUTE

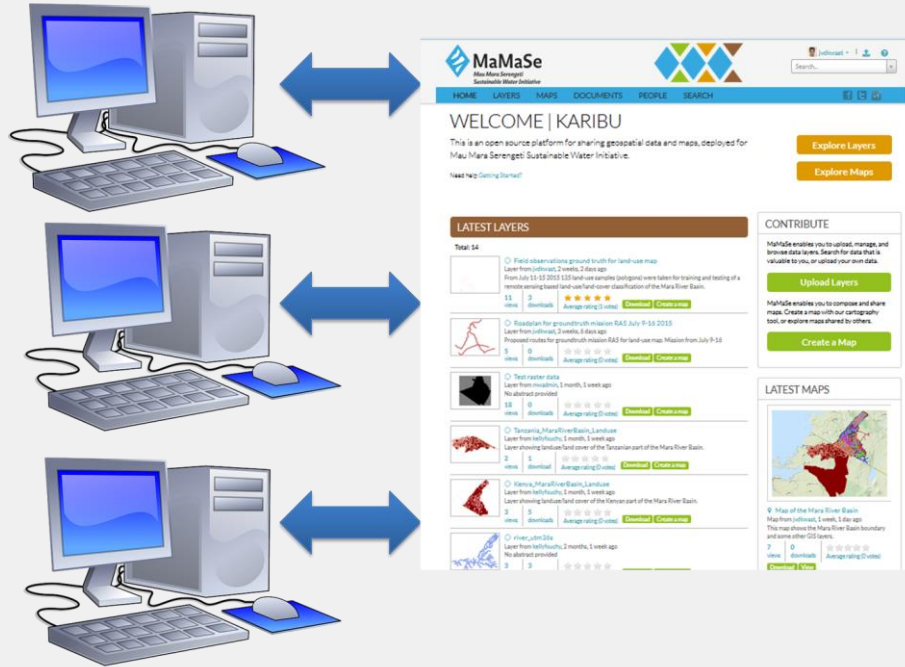
The SADC Groundwater Information Portal (SADC-GIP) is a platform for sharing groundwater-related data and information in the SADC region. It includes the maps from the 2010 SADC Hydrogeological Mapping project (SADC-HGM), among others. Organisations and individuals are invited to register and share relevant groundwater data and information in the SADC-GIP. Providing easy access to groundwater data and information is key to allow all stakeholders to actively participate in the sustainable management of groundwater resources in the SADC region. The SADC-GIP is managed by the SADC Groundwater Management Institute.

Search for Data.

Search

Advanced Search

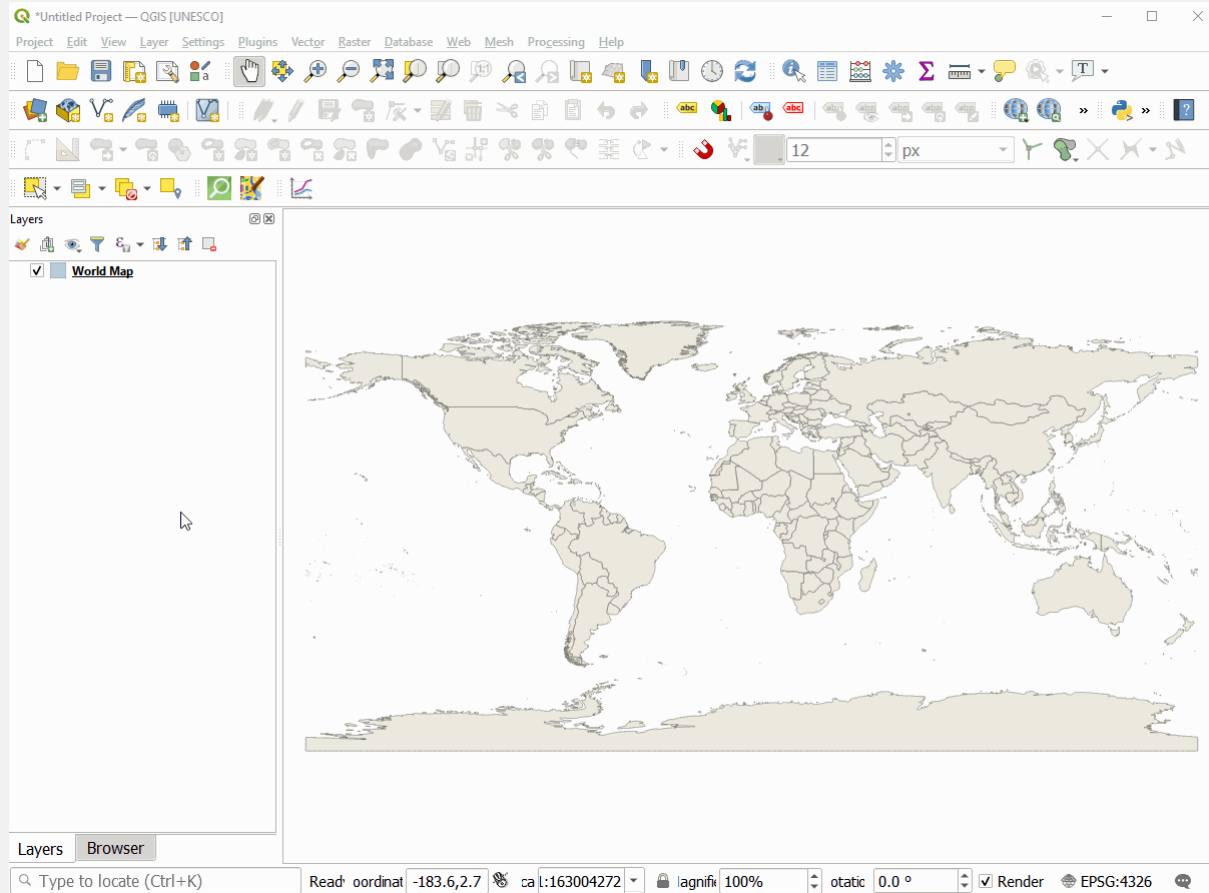
SDI and GIS



Sharing of:

- Spatial data
- Metadata
- Documents (e.g. Open Access papers)
- Profiles (social media)

SDI and QGIS



Australian Groundwater Explorer

Australian Government
Bureau of Meteorology

HOME | ABOUT | MEDIA | CONTACTS Enter search terms Search

NSW VIC QLD WA SA TAS ACT NT AUSTRALIA ANTARCTICA

Bureau Home Water Information Groundwater Information Australian Groundwater Explorer

Australian Groundwater Explorer

About FAQ Feedback

Search bore ID, road or place

Layers

- Bores
 - All bores
 - Groundwater measurements
 - Bore purpose
 - Bore logs
 - 3D aquifer models
- Water management
- Hydrology
- Hydro/Geology
- Base maps

Selectable layer: All bores

TABLE OF CONTENTS

Legend Search Download

Current Scale: 50,000,000

SEARCH RESULTS Selection Size: 0

<http://www.bom.gov.au/water/groundwater/explorer/map.shtml>

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Case study: Namoi River

Australian Groundwater Explorer

About FAQ Feedback

Search bore ID, road or place

Selectable layer: All bores

Not all selections were drawn

Download all bore data for an area including bore details, bore logs and water level and salinity measurements.

1. Select Region
State/Territory

Or
River region
Namoi River

2. Select format
Shapefile
KML
File Geodatabase

Download Zoom To Clear

Current Scale: 2,500,000

SEARCH RESULTS

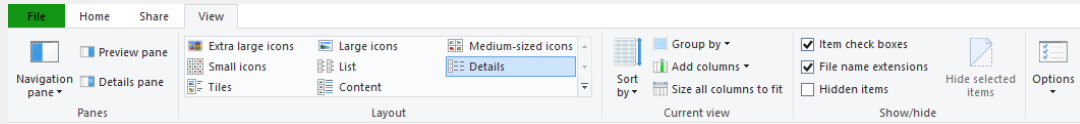
Selection Size: 20000

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Mgillaus, [CC BY-SA 3.0](#), via Wikimedia Commons

Data



Name	Date modified	Type	Size
gw_region_README.txt	06/08/2019 20:08	Text Document	14 KB
hydrochem_bore_namoi_river.csv	06/08/2019 20:08	Microsoft Excel Comma Separat...	161 KB
hydrochem_results_namoi_river.csv	06/08/2019 20:08	Microsoft Excel Comma Separat...	19,430 KB
level_namoi_river.csv	06/08/2019 20:08	Microsoft Excel Comma Separat...	25,004 KB
NGIS_Bore.cpg	06/08/2019 20:04	CPG File	1 KB
NGIS_Bore.dbf	06/08/2019 20:04	OpenOffice.org 1.1 Spreadsheet	21,846 KB
NGIS_Bore.prj	06/08/2019 20:03	PRJ File	1 KB
NGIS_Bore.sbn	06/08/2019 20:04	SBN File	204 KB
NGIS_Bore.sbx	06/08/2019 20:04	SBX File	12 KB
NGIS_Bore.shp	06/08/2019 20:04	SHP File	569 KB
NGIS_Bore.shp.xml	06/08/2019 20:04	XML Document	54 KB
NGIS_Bore.shx	06/08/2019 20:04	SHX File	163 KB
NGIS_BoreholeLog.csv	06/08/2019 20:05	Microsoft Excel Comma Separat...	209 KB
NGIS_BoreLine.cpg	06/08/2019 20:05	CPG File	1 KB
NGIS_BoreLine.dbf	06/08/2019 20:05	OpenOffice.org 1.1 Spreadsheet	251 KB
NGIS_BoreLine.prj	06/08/2019 20:05	PRJ File	1 KB
NGIS_BoreLine.sbn	06/08/2019 20:05	SBN File	17 KB
NGIS_BoreLine.sbx	06/08/2019 20:05	SBX File	1 KB
NGIS_BoreLine.shp	06/08/2019 20:05	SHP File	276 KB
NGIS_BoreLine.shp.xml	06/08/2019 20:05	XML Document	20 KB
NGIS_BoreLine.shx	06/08/2019 20:05	SHX File	15 KB
NGIS_ConstructionLine.cpg	06/08/2019 20:05	CPG File	1 KB
NGIS_ConstructionLine.dbf	06/08/2019 20:05	OpenOffice.org 1.1 Spreadsheet	3,216 KB
NGIS_ConstructionLine.prj	06/08/2019 20:05	PRJ File	1 KB
NGIS_ConstructionLine.sbn	06/08/2019 20:05	SBN File	227 KB
NGIS_ConstructionLine.sbx	06/08/2019 20:05	SBX File	11 KB
NGIS_ConstructionLine.shp	06/08/2019 20:05	SHP File	3,542 KB
NGIS_ConstructionLine.shp.xml	06/08/2019 20:05	XML Document	17 KB
NGIS_ConstructionLine.shx	06/08/2019 20:05	SHX File	187 KB
NGIS_ConstructionLog.csv	06/08/2019 20:06	Microsoft Excel Comma Separat...	5,498 KB
NGIS_HydrogeologicUnit.csv	06/08/2019 20:06	Microsoft Excel Comma Separat...	457 KB
NGIS_LithologyLog.csv	06/08/2019 20:06	Microsoft Excel Comma Separat...	14,622 KB
salinity_namoi_river.csv	06/08/2019 20:08	Microsoft Excel Comma Separat...	1,379 KB

From gw_region_README.txt:

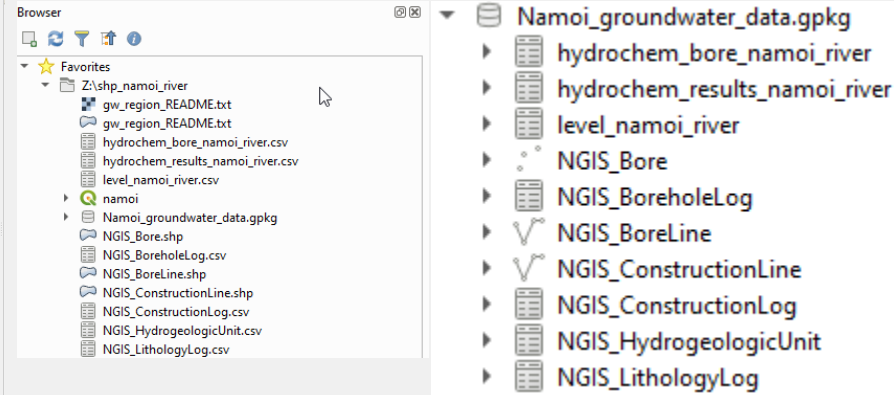
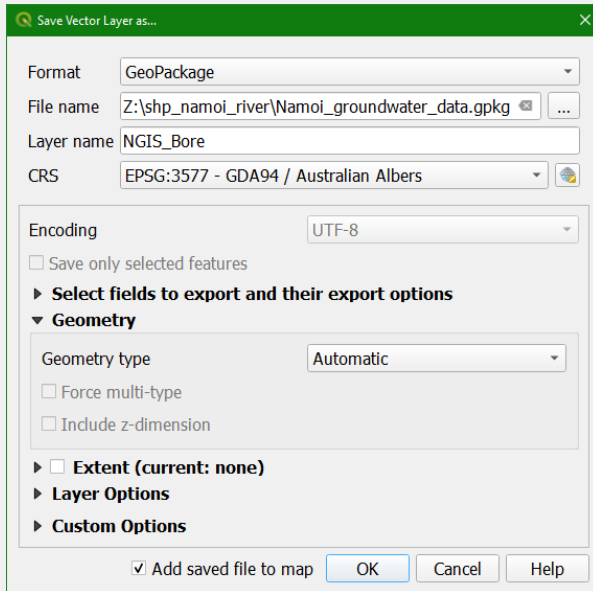
- NGIS version 1.6 extract
- Water level measurements: level_<river_region>.csv
- Salinity measurements: salinity_<river_region>.csv
- Hydrochemistry bore locations and attributes: hydrochem_bore_<river_region>.csv
- Hydrochemistry measurements: hydrochem_results_<river_region>.csv
- Product release notes: gw_river_region_README.txt (this file)

For shapefile format, the following NGIS data is available:

- bores
- lithology logs
- construction logs
- hydrostratigraphy (bore) logs
- hydrogeologic unit table
- management zones
- aquifers

Build database

- Create a new GeoPackage



Join non-spatial data

Namoi_groundwater_data NGIS_Bore — Features Total: 20788, Filtered: 20788, Selected: 0

	fid	HydroID	HydroCode	StateBorel	StatePipeI	StateTe
1	1	10144296	GW901973.1.1	GW901973	1.1	
2	2	10119087	GW966369.1.1	GW966369	1.1	
3	3	10000129	GW004912.1.1	GW004912	1.1	
4	4	10021216	GW007922.1.1	GW007922	1.1	

Show All Features

Namoi_groundwater_data NGIS_Bore — Features Total: 20788, Filtered: 20788, Selected: 0

level_namoi_river — Features Total: 400321, Filtered: 400321, Selected: 0

Add Vector Join

Join layer: level_namoi_river

Join field: abc_hydroid

Target field: 123_HydroID

Cache join layer in memory

Create attribute index on join field

Dynamic form

Editable join layer

Joined fields

- fid
- hydroid
- bore_id
- data_owner
- bore_date
- obs_point_datum
- result
- quality_flag

Custom field name prefix

OK Cancel

Layer Properties — Namoi_groundwater_data NGIS_Bore — Joins

Setting	Value
Join layer	level_namoi_river
Join field	hydroid
Target field	HydroID
Cache join layer in virtual memory	<input checked="" type="checkbox"/>
Dynamic form	
Editable join layer	
Upsert on edit	
Delete cascade	
Custom field name prefix	
Joined fields	1

Style

OK Cancel Apply Help

Join non-spatial data

Namoi_groundwater_data NGIS_Bore — Features Total: 20788, Filtered: 20788, Selected: 0

	fid	HydroID	HydroCode	StateBorel	StatePipeI	StateTe
1	1	10144296	GW901973.1.1	GW901973	1.1	
2	2	10119087	GW966369.1.1	GW966369	1.1	
3	3	10000129	GW004912.1.1	GW004912	1.1	
4	4	10021216	GW007922.1.1	GW007922	1.1	

Show All Features

Namoi_groundwater_data NGIS_Bore — Features Total: 20788, Filtered: 20788, Selected: 0

NGIS_HydrogeologicUnit — Features Total: 2062, Filtered: 2062, Selected: 0

Add Vector Join

Join layer: NGIS_HydrogeologicUnit

Join field: abc HydroID

Target field: 123 HydroID

Cache join layer in memory

Create attribute index on join field

Dynamic form

Editable join layer

Joined fields

- HGUCODE
- HGUNumber
- ProvName
- StateTerritory
- HGUDescription
- HGUAquiferType
- HGUConfinedType
- HGUTransmissivity
- HGUBorel

Custom field name prefix

OK Cancel

Layer Properties — Namoi_groundwater_data NGIS_Bore — Joins

Setting Value

Join layer level_namoi_river

Join field hydroid

Target field HydroID

Cache join layer in virtual memory

Dynamic form

Editable join layer

Upsert on edit

Delete cascade

Custom field name prefix

Joined fields 1

Join layer NGIS_HydrogeologicUnit

Join field HydroID

Target field HydroID

Cache join layer in virtual memory

Dynamic form

Editable join layer

Upsert on edit

Delete cascade

Custom field name prefix

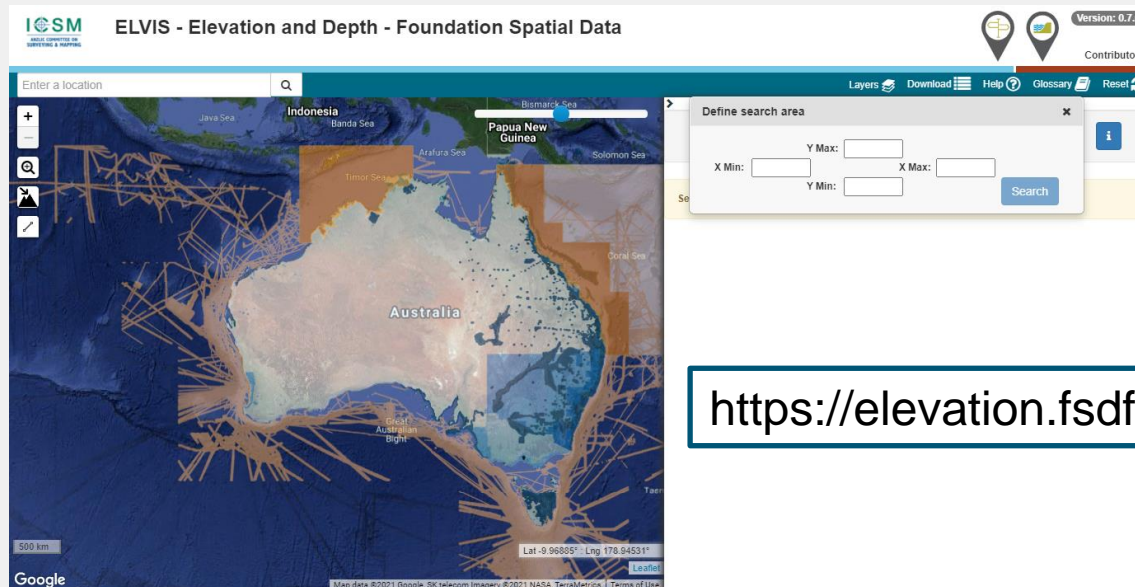
Joined fields 10

Style

OK Cancel Apply Help

Sample data from other sources

- TsRefElev: 0 = no data
- Replace with elevation from DEM



<https://elevation.fsdf.org.au/>

Extract layer extent

The screenshot illustrates the 'Extract layer extent' workflow in QGIS. The main map shows a layer of green circles (representing groundwater data) contained within a red dashed rectangular bounding box. The 'Layers' panel on the left lists the active layers: 'Extent', 'level_namoi_river', 'Namoi_groundwater_data NGIS_Bore', and 'World Map'. The 'Processing Toolbox' on the right shows the 'Extract layer extent' tool selected under the 'Layer tools' category. Two dialog boxes are open:

- Save Vector Layer as...:** This dialog is used to save the extracted extent as a new vector layer. The 'Format' is set to 'GeoPackage', the 'File name' is 'Z:\ghp_namoi_river\Namoi_groundwater_data.gpkg', the 'Layer name' is 'Extent', and the 'CRS' is 'Project CRS: EPSG:4326 - WGS 84'. The 'Encoding' is set to 'UTF-8'. The 'Add saved file to map' checkbox is checked.
- Layer Properties - Namoi_groundwater_data Extent - Information:** This dialog provides metadata for the newly created 'Extent' layer. The 'Name' is 'Namoi_groundwater_data Extent', the 'Path' is 'Z:\ghp_namoi_river\Namoi_groundwater_data.gpkg', and the 'Source' is 'Z:\ghp_namoi_river\Namoi_groundwater_data.gpkg|layername=Extent'. The 'Geometry' is 'Polygon (Polygon)', the 'CRS' is 'EPSG:4326 - WGS 84 - Geographic', and the 'Extent' is '148.0899238567380110, -32.0793907142529022, 151.6982062203769885, -29.45993148204966013 degrees'. The 'Feature count' is 1.

DEM tiles




Selecting an area

Select an area of interest. By hitting one of the "Draw" buttons an area on the map can be selected with the mouse by drawing a bounding box, drawing a polygon or manually typing in the minimum and maximum of latitude and longitude. Hover over the buttons to see more information. Clicking one of the "Draw" buttons again allows replacing a previous area selection.

Notes:


- The data does not cover all of Australia.
- Restrict a search area to below 1.5 degrees square. eg 2x0.75 or 1x1.5

Hint: If the map has focus, you can use the arrow keys to pan the map. You can zoom in and out using the mouse wheel or the "+" and "-" map control on the top left of the map. If you don't like the position of your drawn area, hit the one of the "Draw" buttons to draw a new search area.

Select area by:   

Selected bounds: 148.0000° west, -29.5000° north, 149.5000° east, -31.0000° south

Select all AND (Showing 0,422 of 0,422) [show list]

 **Geoscience Australia** (Showing 26,494 of 26,494)

DEMs

Select all 1 Metre (Showing 9,952 of 9,952) [show list]

Select all 5 Metre (Showing 1 of 1) [show list]

Select all 1 Second (Showing 3 of 3) [show list]

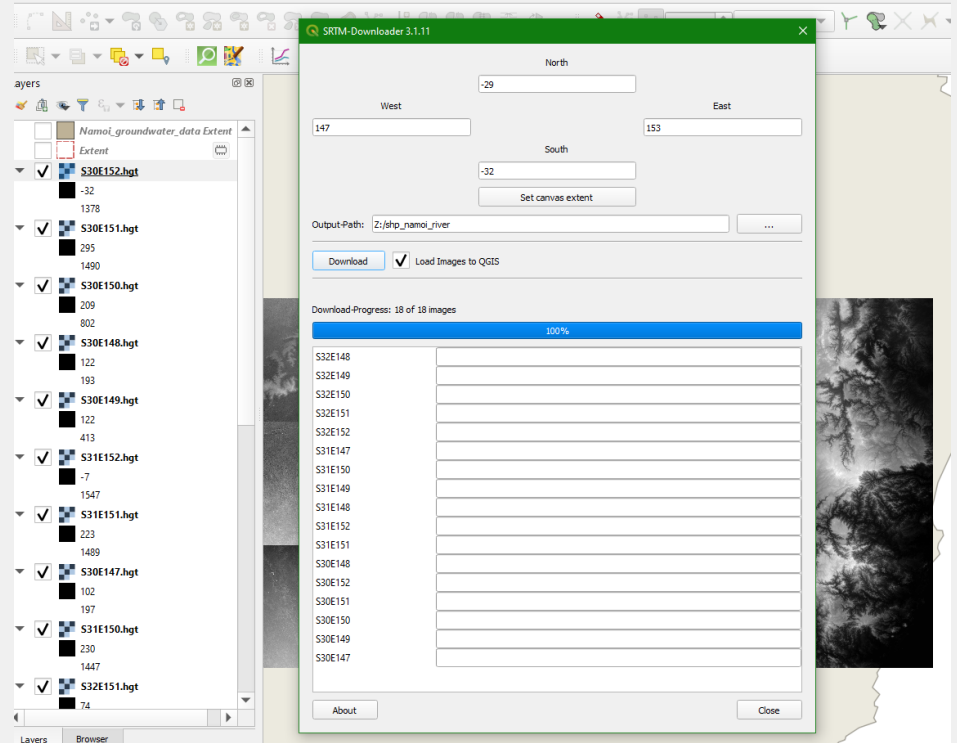
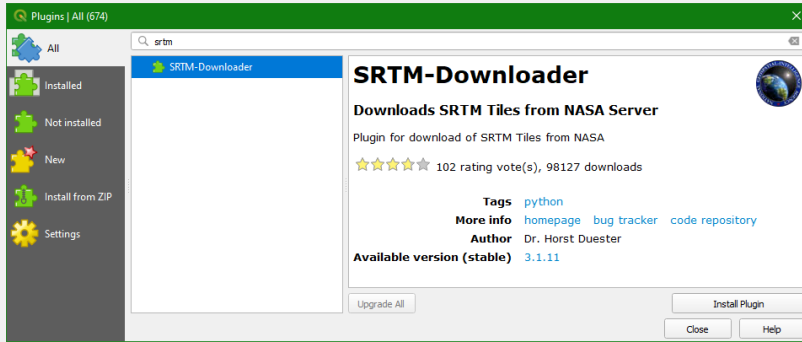
DSMs

Select all 1 Second (Showing 1 of 1) [show list]

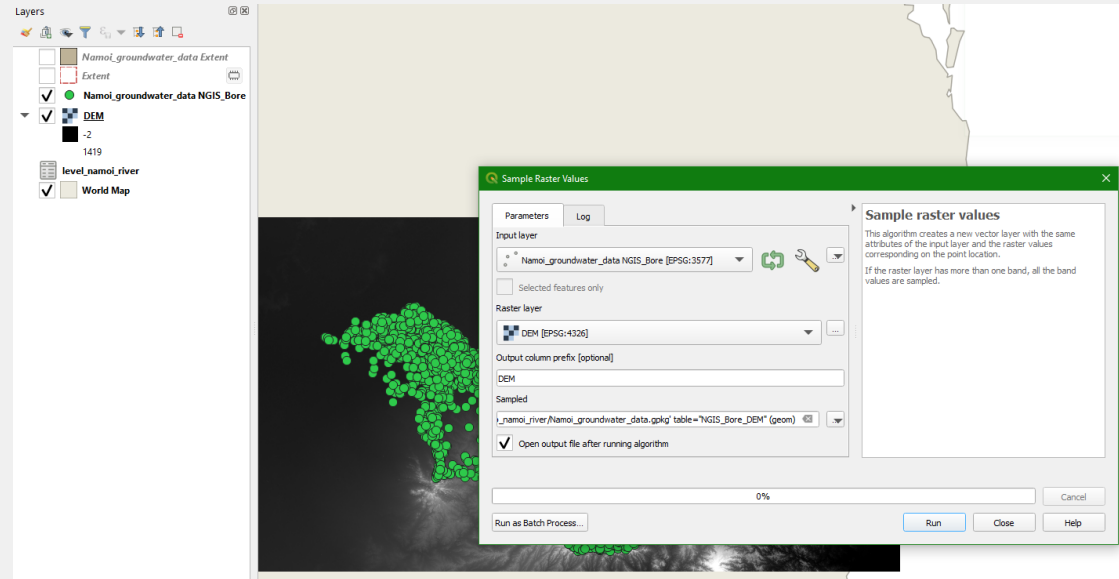
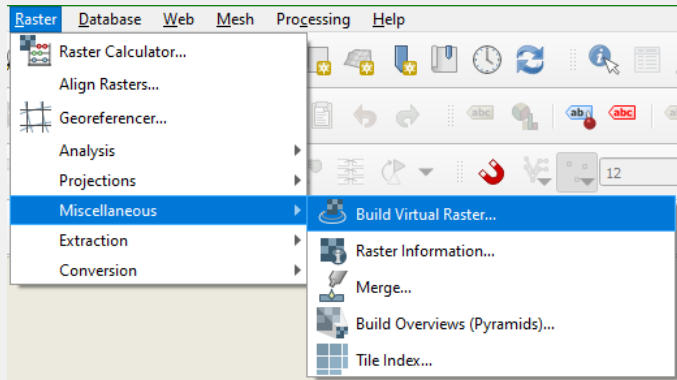
Point Clouds

Select all Ellipsoidal (Showing 8,003 of 8,003) [show list]

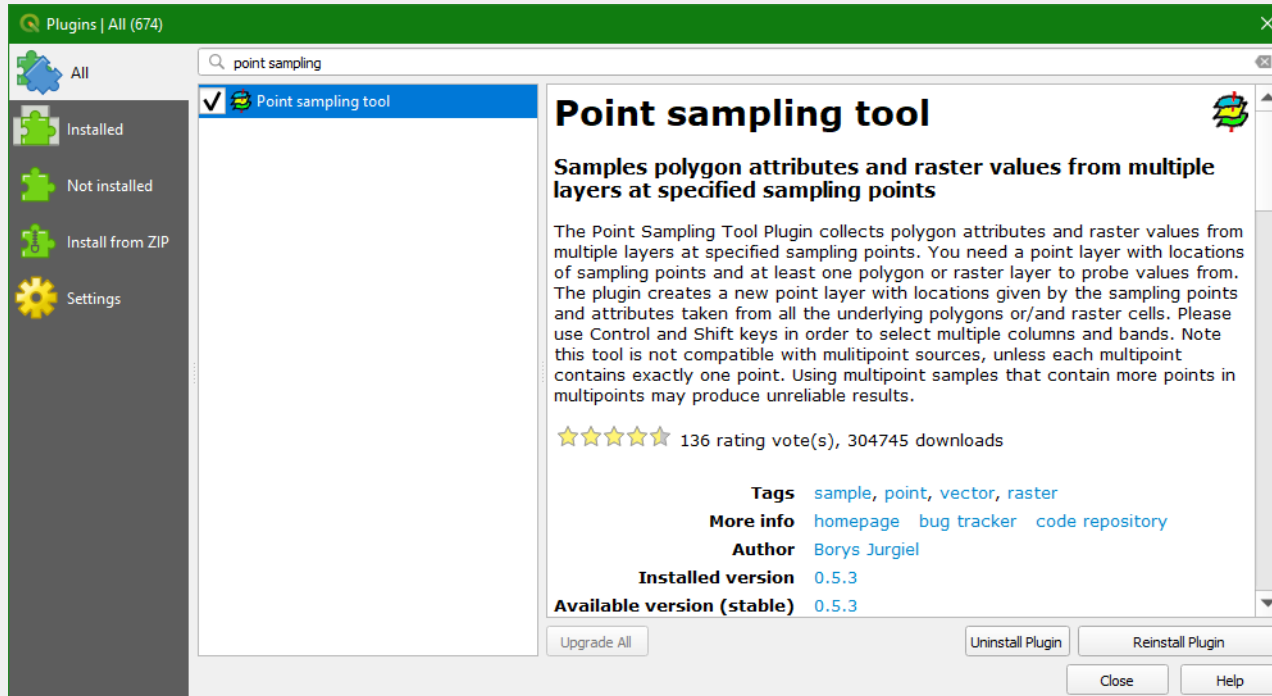
SRTM-Downloader plugin



Build Virtual Raster




Point sampling tool



The screenshot shows the QGIS Plugins Manager window with the search term 'point sampling'. The 'Point sampling tool' plugin is selected and its details are displayed on the right. The details include a description, a 5-star rating, 136 rating votes, and 304745 downloads. The tags are 'sample', 'point', 'vector', and 'raster'. The author is 'Borys Jurgiel'. The installed and available versions are both '0.5.3'. The buttons at the bottom are 'Upgrade All', 'Uninstall Plugin', 'Reinstall Plugin', 'Close', and 'Help'.

Plugins | All (674)

point sampling

✓  Point sampling tool

Point sampling tool

Samples polygon attributes and raster values from multiple layers at specified sampling points

The Point Sampling Tool Plugin collects polygon attributes and raster values from multiple layers at specified sampling points. You need a point layer with locations of sampling points and at least one polygon or raster layer to probe values from. The plugin creates a new point layer with locations given by the sampling points and attributes taken from all the underlying polygons or/and raster cells. Please use Control and Shift keys in order to select multiple columns and bands. Note this tool is not compatible with multipoint sources, unless each multipoint contains exactly one point. Using multipoint samples that contain more points in multipoints may produce unreliable results.

★★★★★ 136 rating vote(s), 304745 downloads

Tags [sample](#), [point](#), [vector](#), [raster](#)

More info [homepage](#) [bug tracker](#) [code repository](#)

Author [Borys Jurgiel](#)

Installed version 0.5.3

Available version (stable) 0.5.3

Upgrade All Uninstall Plugin Reinstall Plugin Close Help

Sample Raster Values

Sample Raster Values

Parameters Log

Input layer
Namoi_groundwater_data NGIS_Bore [EPSG:3577]

Selected features only

Raster layer
DEM [EPSG:4326]

Output column prefix [optional]
DEM

Sampled
_namoi_river/Namoi_groundwater_data.gpkg' table="NGIS_Bore_DEM" (geom)

Open output file after running algorithm

0%

Run Close Help

Sample raster values

This algorithm creates a new vector layer with the same attributes of the input layer and the raster values corresponding on the point location.

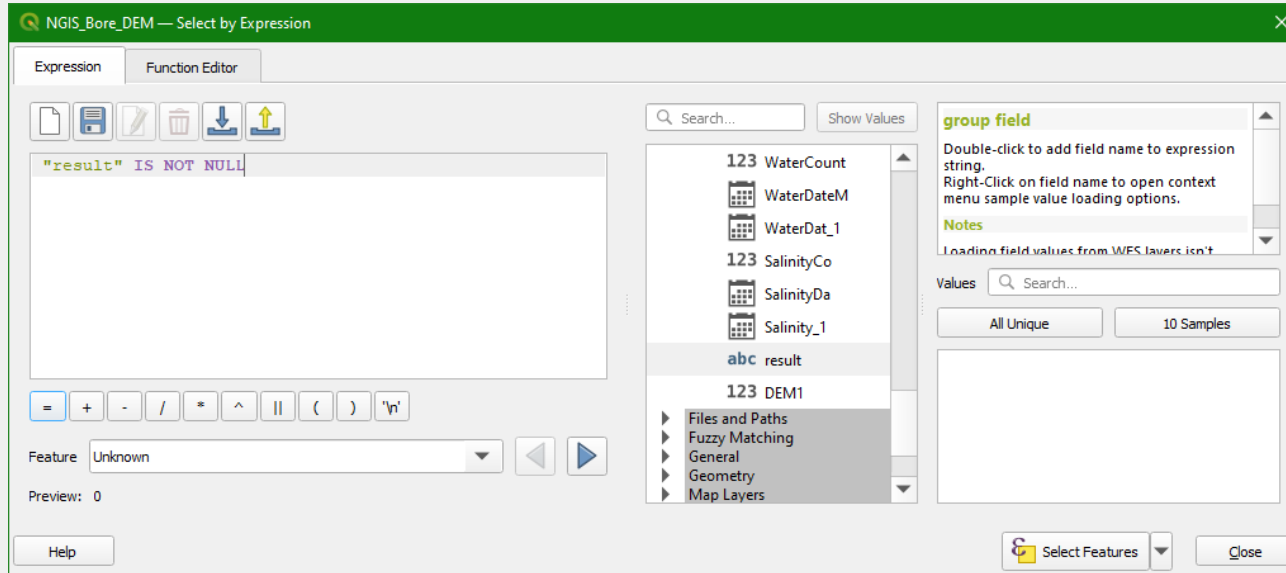
If the raster layer has more than one band, all the band values are sampled.

NGIS_Bore_DEM — Features Total: 20788, Filtered: 20788, Selected: 0

	steM	WaterDat_1	SalinityCo	SalinityDa	Salinity_1	result	DEM1
1	NULL	NULL	0	NULL	NULL	NULL	442
2	NULL	NULL	0	NULL	NULL	NULL	312
3	NULL	NULL	0	NULL	NULL	NULL	585
4	NULL	NULL	0	NULL	NULL	NULL	327
5	2015-05-08	2019-07-14	0	NULL	NULL	10.32	205
6	1993-05-07	1997-05-21	0	NULL	NULL	0.86	333
7	NULL	NULL	0	NULL	NULL	NULL	264
8	NULL	NULL	0	NULL	NULL	NULL	304
9	NULL	NULL	0	NULL	NULL	NULL	302
10	NULL	NULL	0	NULL	NULL	NULL	272

Show All Features

Data Clean Up – remove NULL values



1. Select all water levels
2. Export selected features to GeoPackage

Data Clean Up – Replace 0 elevation values

Expression Dialog

Expression Function Editor

```
CASE  
WHEN "TsRefElev" = 0 THEN "DEM1" ELSE "TsRefElev"  
END
```

Feature: Unknown


Preview: 205.04

Search... Show Values

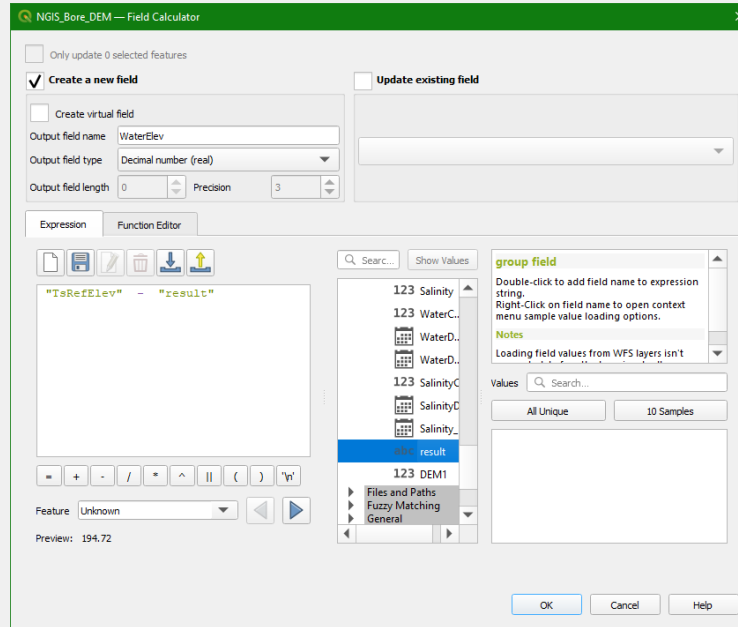
- abc RefElevDes
- abc RefElevMet
- 1.2 TsRefElev**
- abc TsRefElevD
- abc TsRefElevM
- 1.2 LandElev
- abc LandElevMe
- 123 IsMultiPip
- abc BoreLineCo
- 123 WorksID
- 123 LicenceExt

Namoi_groundwater_data_NGIS_Bore — Features Total: 20788, Filtered: 20788, Selected: 0

feightDatu	RefElev	RefElevDes	RefElevMet	TsRefElev	TsRefElevD	TsRefElevM	LandElev
19	0	UNK	UNK	336.197	UNK	UNK	
20	0	UNK	UNK	336.197	UNK	UNK	
21	0	UNK	UNK	336.197	UNK	UNK	
22	0	UNK	UNK	314.893	UNK	UNK	
23	0	UNK	UNK	314.893	UNK	UNK	
24	0	UNK	UNK	314.893	UNK	UNK	
25	0	UNK	UNK	320.534	UNK	UNK	
26	0	UNK	UNK	318.315	UNK	UNK	
27	0	UNK	UNK	291.526	UNK	UNK	
28	0	UNK	UNK	0	UNK	UNK	
29	0	UNK	UNK	0	UNK	UNK	
30	0	UNK	UNK	0	UNK	UNK	
31	0	UNK	UNK	0	UNK	UNK	
32	0	UNK	UNK	0	UNK	UNK	
33	0	UNK	UNK	0	UNK	UNK	
34	0	UNK	UNK	0	UNK	UNK	
35	0	UNK	UNK	0	UNK	UNK	

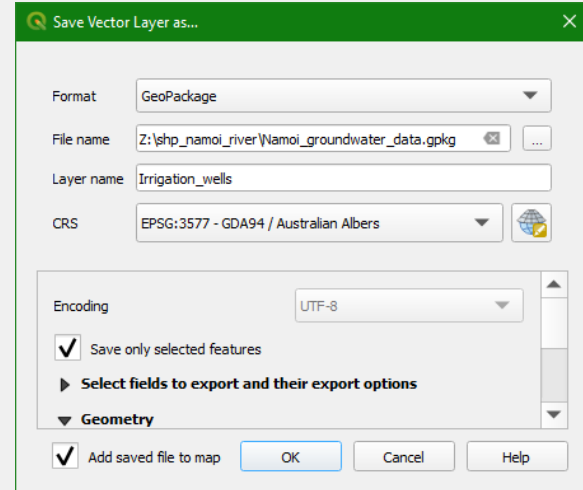
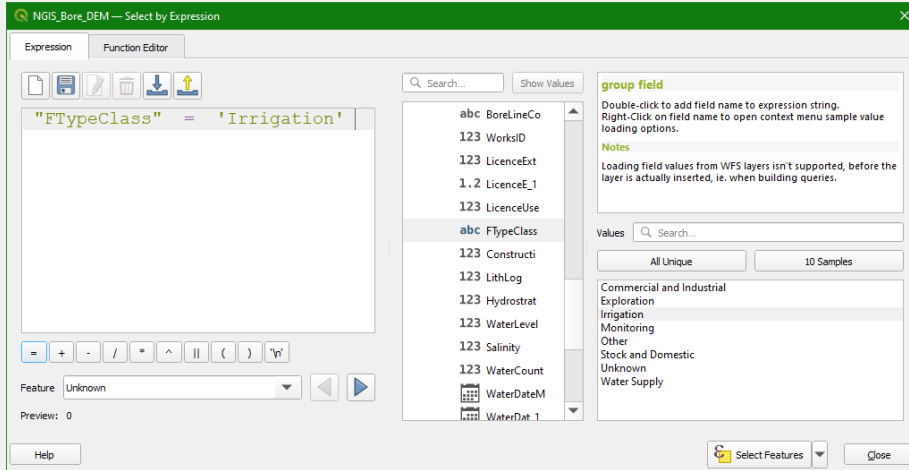


Calculate Water Elevation

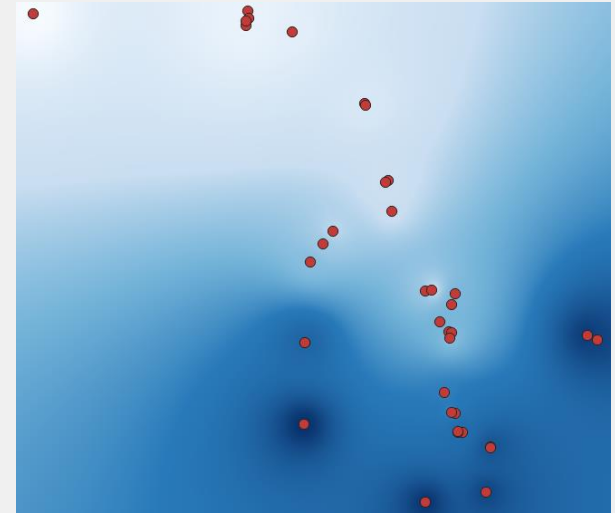
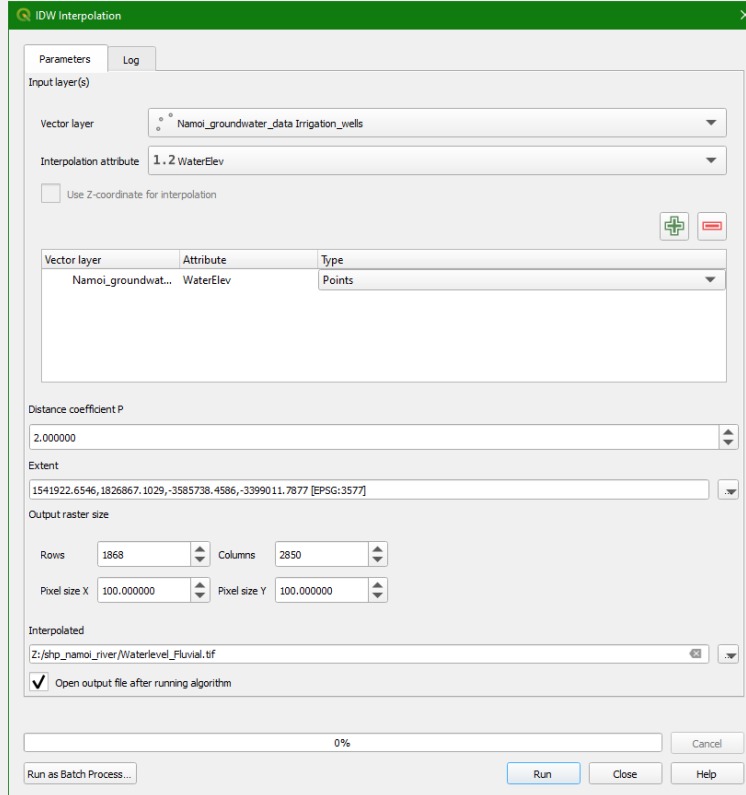
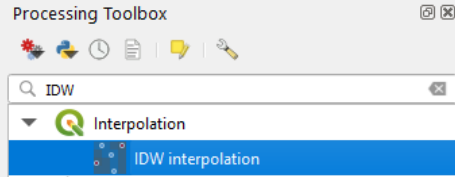


$$\text{WaterElev} = \text{TsRefElev} - \text{Water_Level}$$

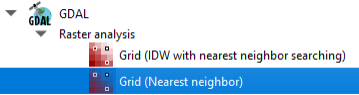
Select boreholes



Spatial Interpolation (IDW)



Spatial Interpolation (Thiessen)



Grid (Nearest Neighbor)

Parameters Log

0.000000

Advanced Parameters

Z value from field [optional]
1. Z WaterElev

Additional creation options [optional]

Profile

Name	Value
------	-------

Validate Help

Additional command-line parameters [optional]

Output data type
Float32

Interpolated (Nearest neighbor)
Z:/shp_namoi_river/WaterLevel_Fluvial_Thiessen.tif

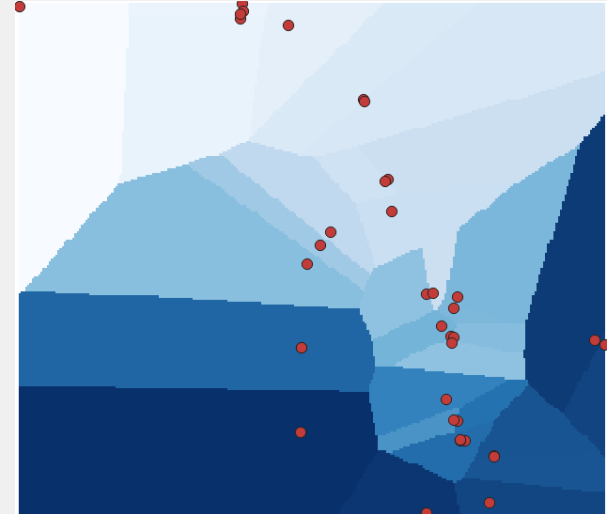
Open output file after running algorithm

GDAL/OGR console call

```
gdal_grid -i Irrigation_wells -zfield WaterElev -a nearest:radius1=0.0:radius2=0.0:angle=0.0:nodata=0.0 -ot Float32 -of GTiff Z:  
shp_namoi_river/Namoi_groundwater_data.gpkg Z:/shp_namoi_river/WaterLevel_Fluvial_Thiessen.tif
```

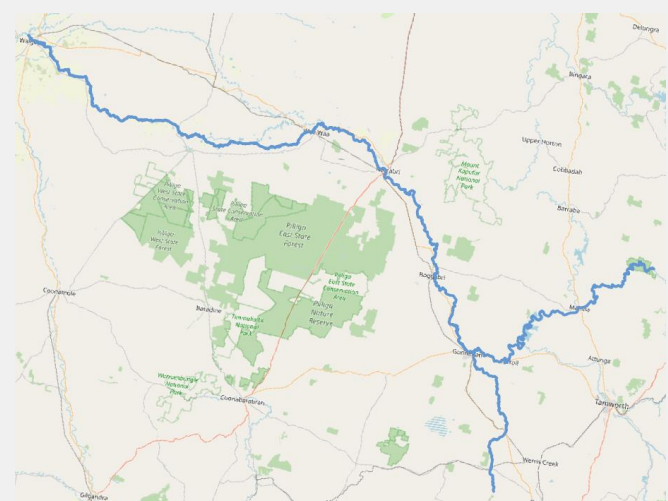
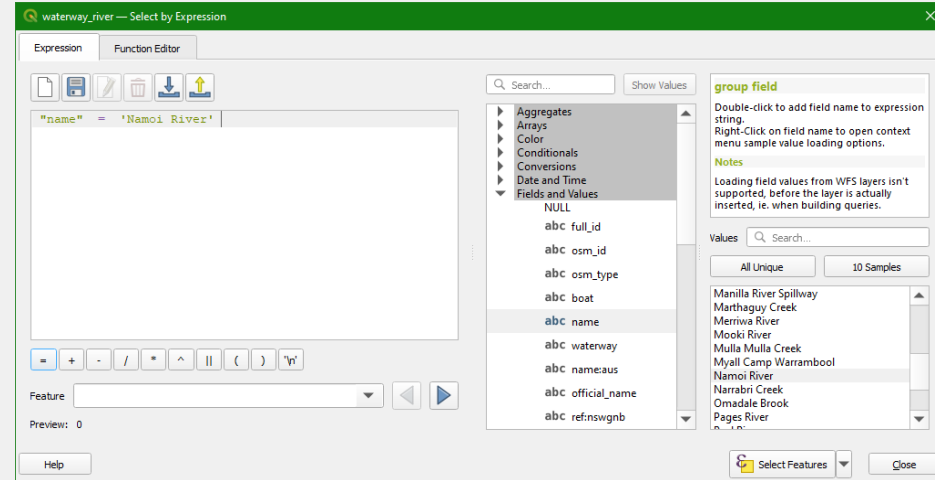
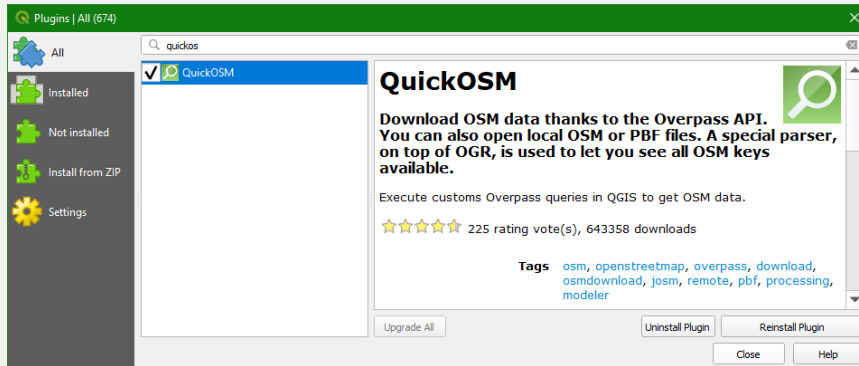
0%

Run as Batch Process... Run Close Help

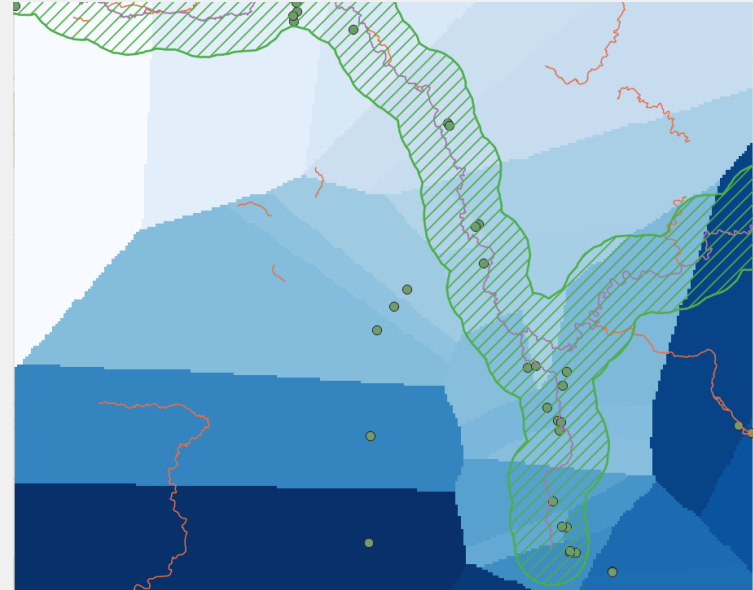
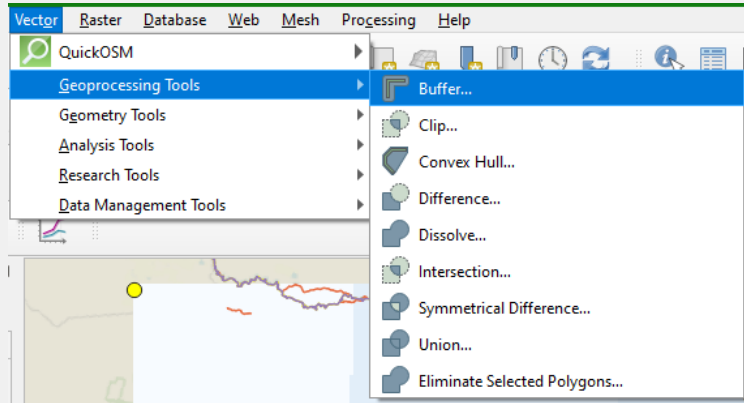


Clip to study area

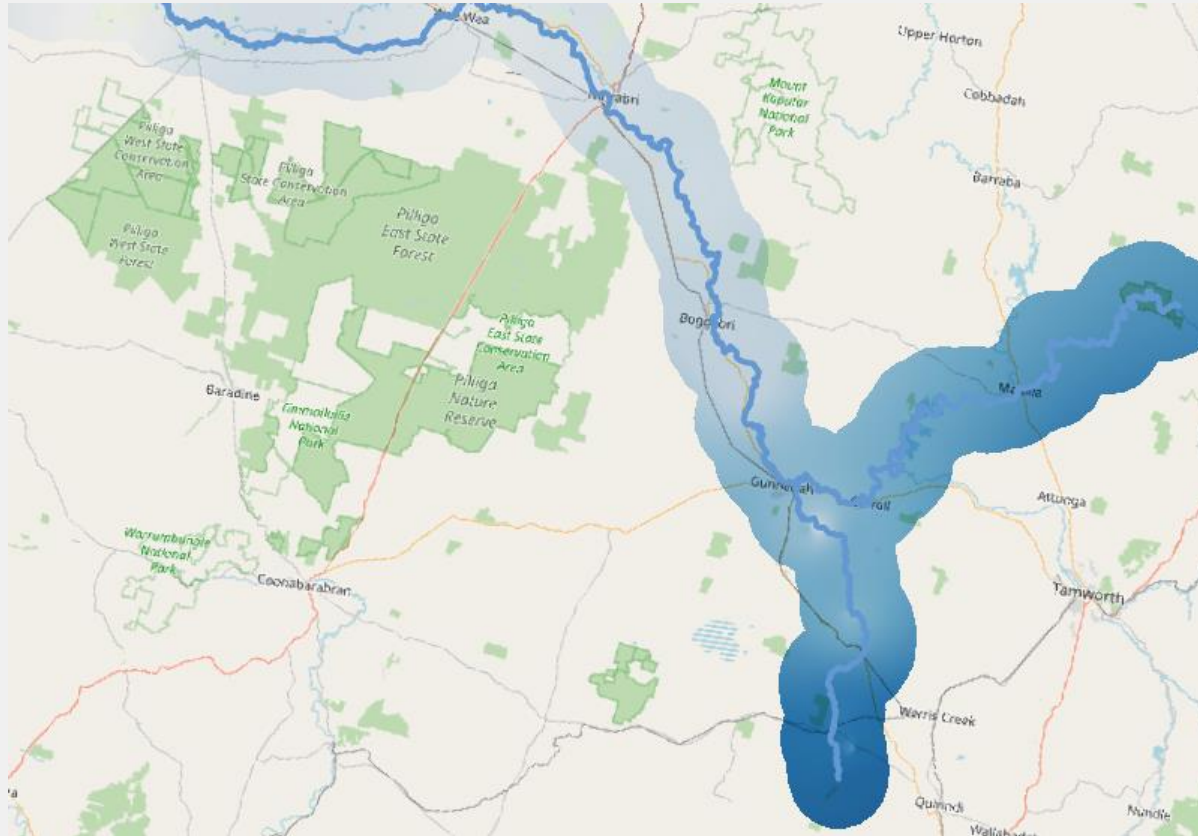
- Aquifer
- Alluvial deposits → Buffer



Buffer of 10 km



Goundwater level in the study area



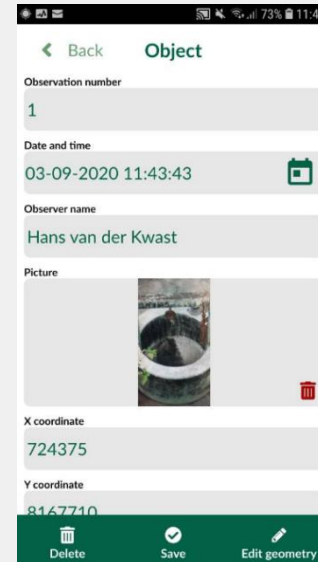
Field data collection for groundwater studies

- For groundwater studies we often need to map features in the field, such as:
 - Springs
 - Wells
 - Boreholes
- We also want to map properties of these features, such as:
 - Unprotected/protected springs
 - Depth of the well/borehole
 - Water level of well/borehole
 - Water quality



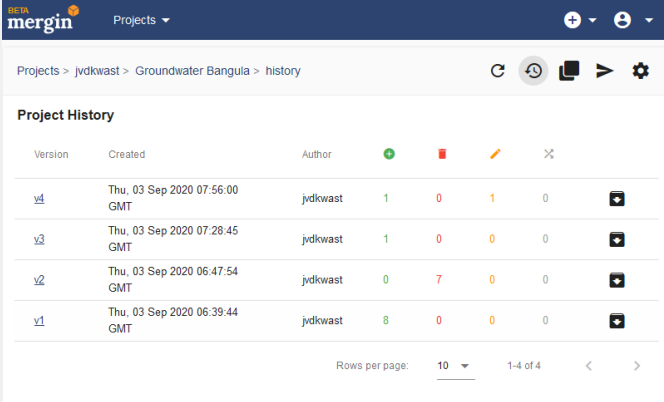
Input App

- Developed by Lutra Consulting (<https://www.lutraconsulting.co.uk/>)
- Designed to be compatible with all mobile devices
- Available in Google Play Store and App store
- Free and Open Source
- Support for custom forms
- Capture location-related media (photos/video)
- User friendly
- Support for external GPS receivers
- GPS accuracy setting



Mergin cloud service

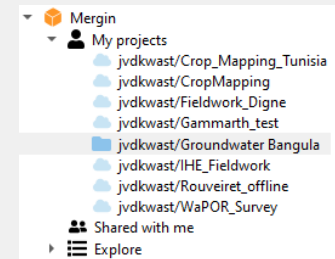
- Collaborative space allowing you to store and synchronise projects across multiple mobile and desktop clients
- Version management
- Clone projects
- Share projects with other users
- Web client
- QGIS plugin



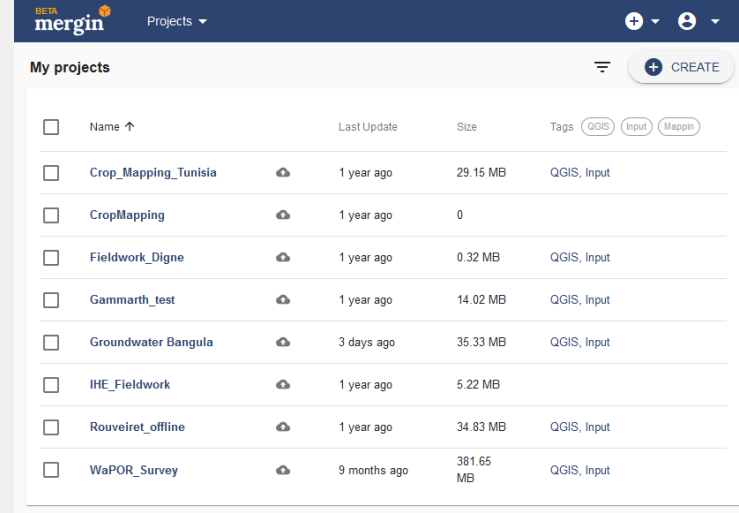
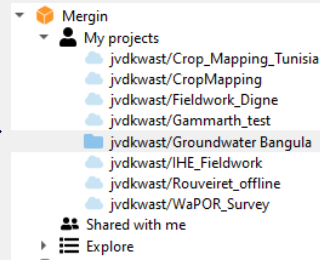
The screenshot shows the Mergin web interface. The breadcrumb path is 'Projects > jvdkwast > Groundwater Bangula > history'. The 'Project History' table lists the following data:

Version	Created	Author	+	-	✎	✕	
v4	Thu, 03 Sep 2020 07:56:00 GMT	jvdkwast	1	0	1	0	📄
v3	Thu, 03 Sep 2020 07:28:45 GMT	jvdkwast	1	0	0	0	📄
v2	Thu, 03 Sep 2020 06:47:54 GMT	jvdkwast	0	7	0	0	📄
v1	Thu, 03 Sep 2020 06:39:44 GMT	jvdkwast	8	0	0	0	📄

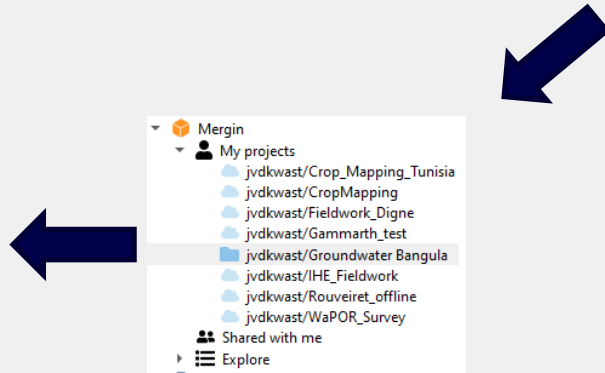
At the bottom right of the table, it says 'Rows per page: 10' and '1-4 of 4'.



Workflow QGIS – Mergin - Input



Workflow QGIS – Mergin - Input



- ▼ Mergin
 - ▼ My projects
 - jvdkwast/Crop_Mapping_Tunisia
 - jvdkwast/CropMapping
 - jvdkwast/Fieldwork_Digne
 - jvdkwast/Gammarth_test
 - jvdkwast/Groundwater Bangula
 - jvdkwast/IHE_Fieldwork
 - jvdkwast/Rouveiret_offline
 - jvdkwast/WaPOR_Survey
 - Shared with me
 - ▶ Explore

BETA mergin Projects

My projects

<input type="checkbox"/>	Name ↑		Last Update	Size	Tags
<input type="checkbox"/>	Crop_Mapping_Tunisia	☁	1 year ago	29.15 MB	QGIS, Input
<input type="checkbox"/>	CropMapping	☁	1 year ago	0	
<input type="checkbox"/>	Fieldwork_Digne	☁	1 year ago	0.32 MB	QGIS, Input
<input type="checkbox"/>	Gammarth_test	☁	1 year ago	14.02 MB	QGIS, Input
<input type="checkbox"/>	Groundwater Bangula	☁	3 days ago	35.33 MB	QGIS, Input
<input type="checkbox"/>	IHE_Fieldwork	☁	1 year ago	5.22 MB	
<input type="checkbox"/>	Rouveiret_offline	☁	1 year ago	34.83 MB	QGIS, Input
<input type="checkbox"/>	WaPOR_Survey	☁	9 months ago	381.65 MB	QGIS, Input



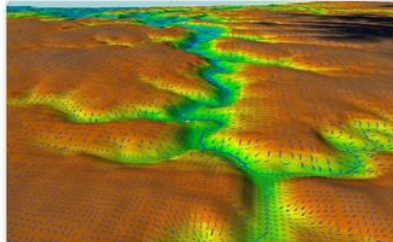
GIS OpenCourseWare

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Questions?