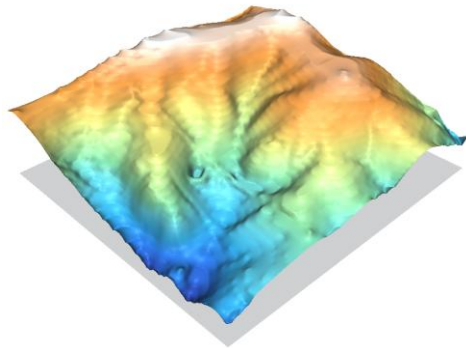


GRASS GIS 8.x Crash course



Giorgio Agugiaro

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Brief overview of GRASS GIS

Some history

- Developed since 1982, first version as GRASS in 1985
- Licensed under GPL since 1999
- Written in C, but portable (and already ported) to many platforms
- Homepage: <https://grass.osgeo.org>
- Short movie about GRASS GIS (1987) narrated by William Shatner (Capt. Kirk!) <https://www.youtube.com/watch?v=U3Hf0qI4JLc> (14:27)

Intro

GRASS modules

GRASS GIS DB

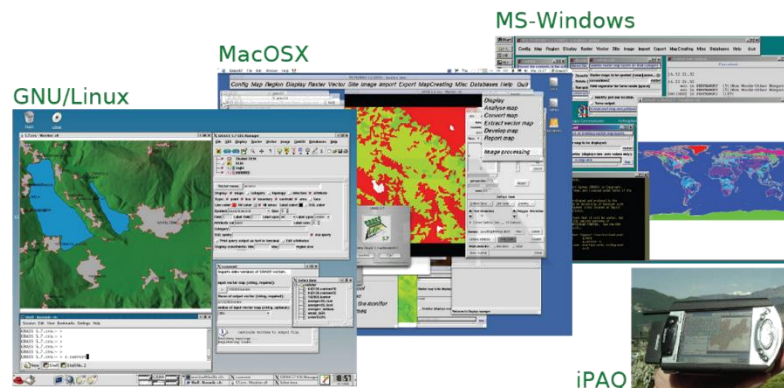
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New setup

Running modules

Test data

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GRASS GIS modules

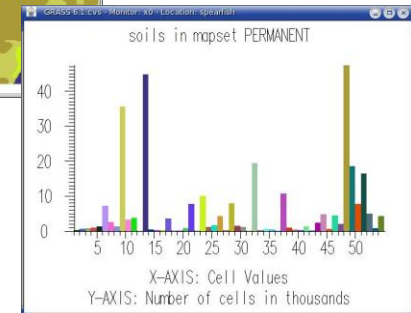
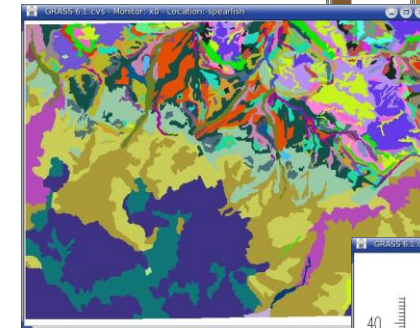
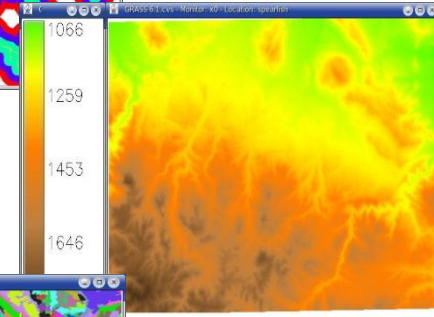
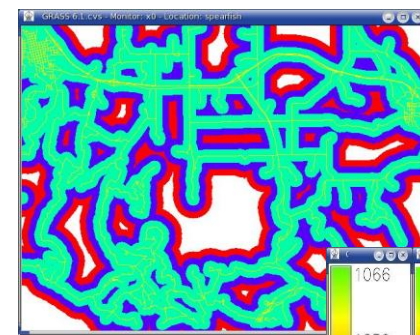
- GRASS GIS commands (or **modules**) are generally thematically grouped according to prefixes in the command name
- They can be used either from the command line, or the GRASS GUI, or from QGIS

<i>GRASS Command Overview</i>			
<i>prefix</i>	<i>function class</i>	<i>type of command</i>	<i>example</i>
d.*	display	graphical output	d.rast: views raster map d.vect: views vector map
db.*	database	database management	db.select: selects value(s) from table
g.*	general	general file operations	g.rename: renames map
i.*	imagery	image processing	i.smap: image classifier
ps.*	postscript	map creation in Postscript format	ps.map: map creation
r.*	raster	raster data processing	r.buffer: buffer around raster features r.mapcalc: map algebra
r3.*	voxel	raster voxel data processing	r3.mapcalc: volume map algebra
v.*	vector	vector data processing	v.overlay: vector map intersections

GRASS GIS modules

Typical **raster** operations

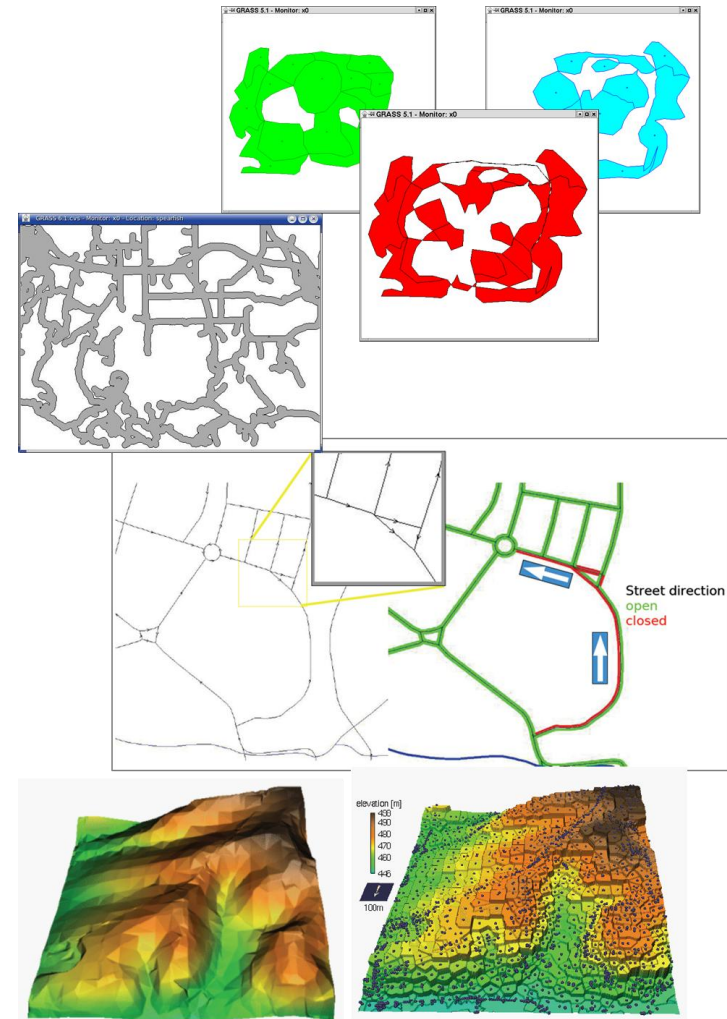
- Vectorization
 - r.to.vect
 - r.contour (creates contour lines)
- Digitalization
 - r.digit
- Creation of buffers
 - r.buffer
- Classification
 - r.reclass, r.recode
- Map algebra
 - r.mapcalc, r.stats, r.neighbors, ...
- DEM creation and analysis
 - interpolation (IDW, spline, ...)
 - slope, aspect, shaded relief maps, etc.
- Surface cost analysis
 - r.cost, r.drain
- Specific analyses (astronomy, hydrology, ...)
 - r.sun, r.watershed, ...



GRASS GIS modules

Typical **vector** operations

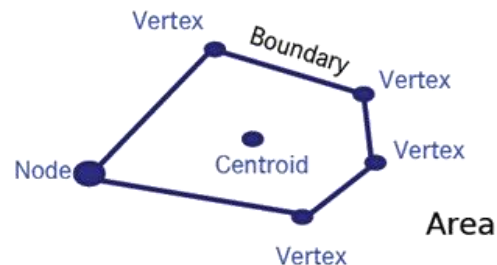
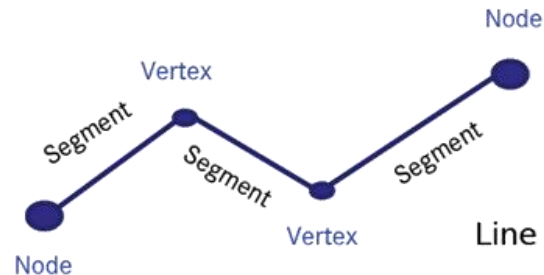
- Rasterization
 - v.to.rast, ...
- Digitalization (with input of attributes)
 - v.digit
- Creation of buffers
 - v.buffer
- Classification and attribute management
 - v.reclass, v.category
- Overlay
 - v.overlay, v.patch
- Network analysis
 - v.net.xxx (several modules)
- Interpolation
 - v.voronoi, v.delaunay



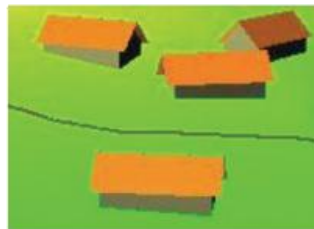
GRASS GIS vector data

- Point – 3Dpoint
- Centroid
- Line
- Boundary
- Area (boundary + centroid)
- Face (3D area)
- Kernel (3D centroid)
- Volumes (faces + kernel)

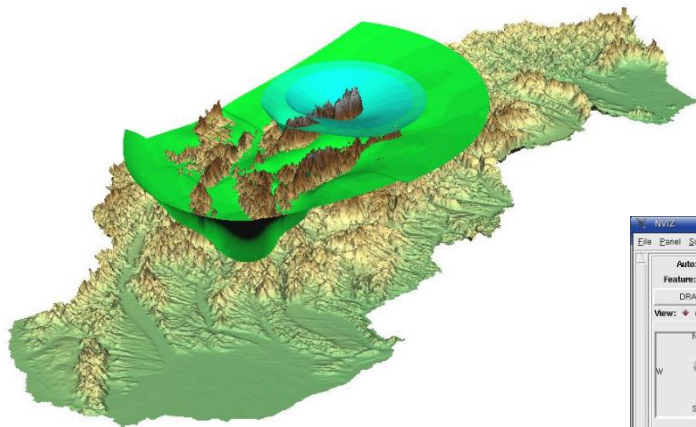
NOTA BENE: Unlike shapefiles, in GRASS different vector entities can co-exist in the same layer!



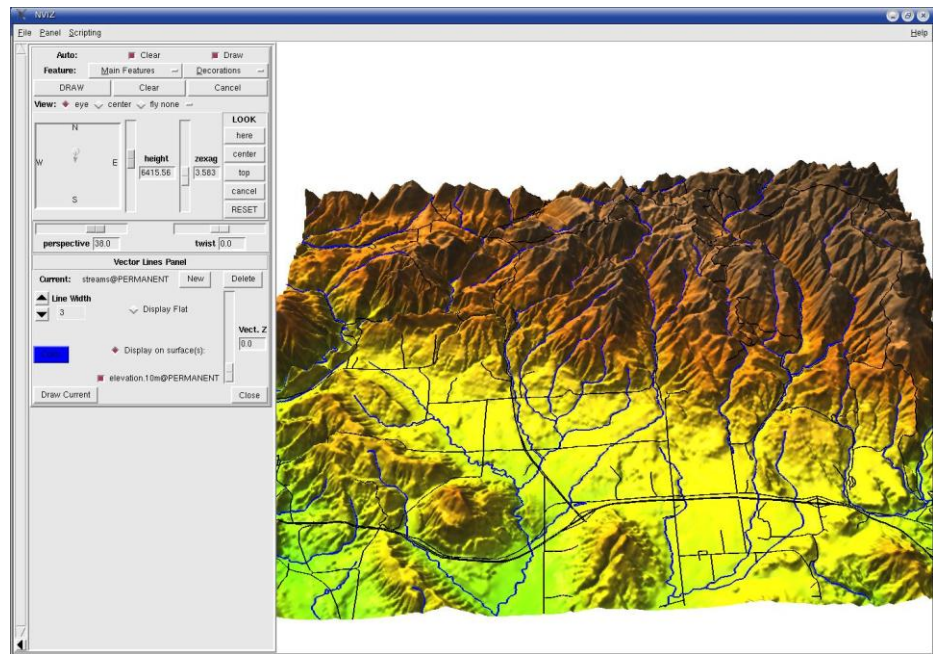
Faces



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NVIZ is a 3D visualization module within GRASS GIS for 2D/3D vector, raster and voxel data

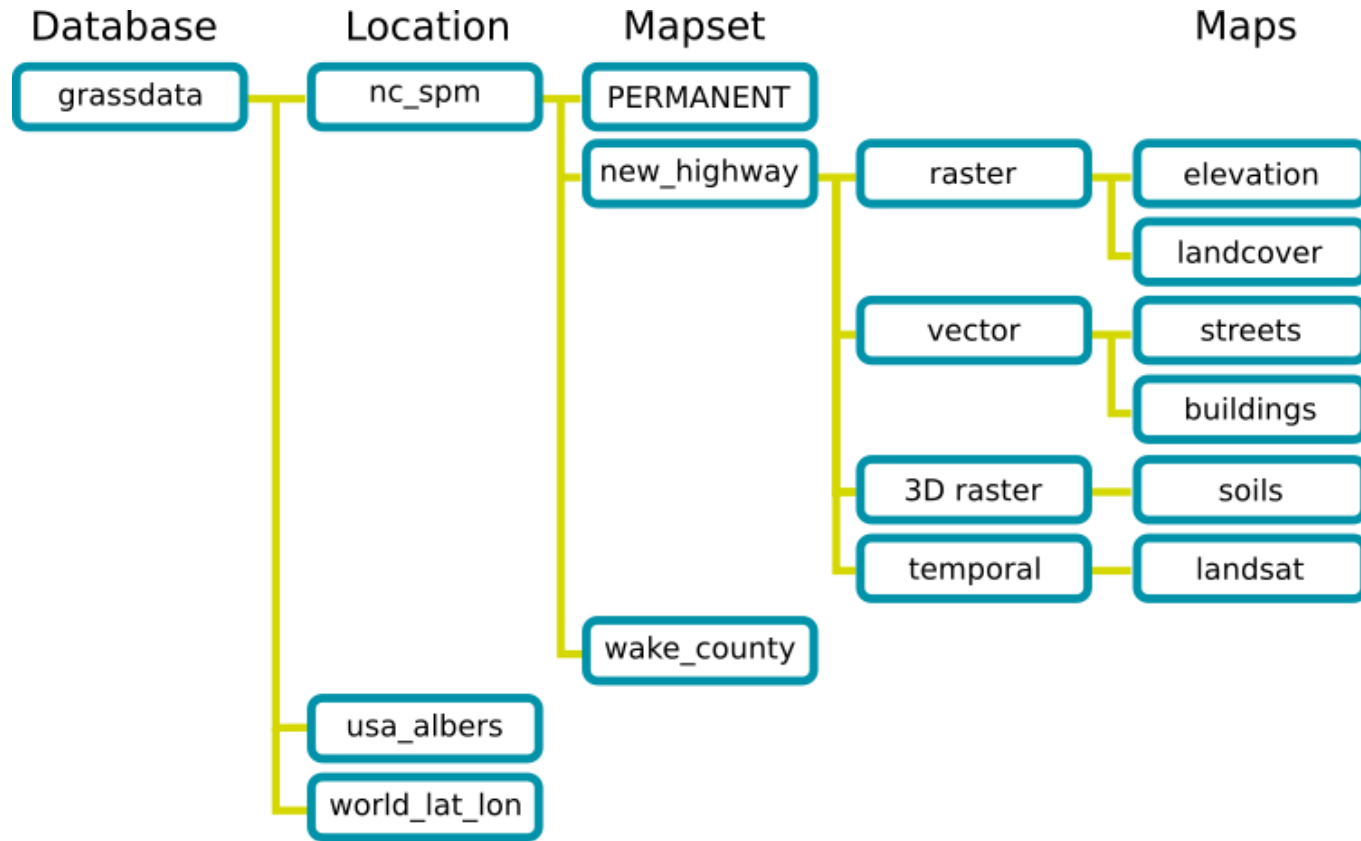


GRASS GIS “database” structure

In GRASS GIS, all datasets are stored in a **single directory** called the "**GRASS GIS Database**" and they are further divided into LOCATION(s) and MAPSET(s).

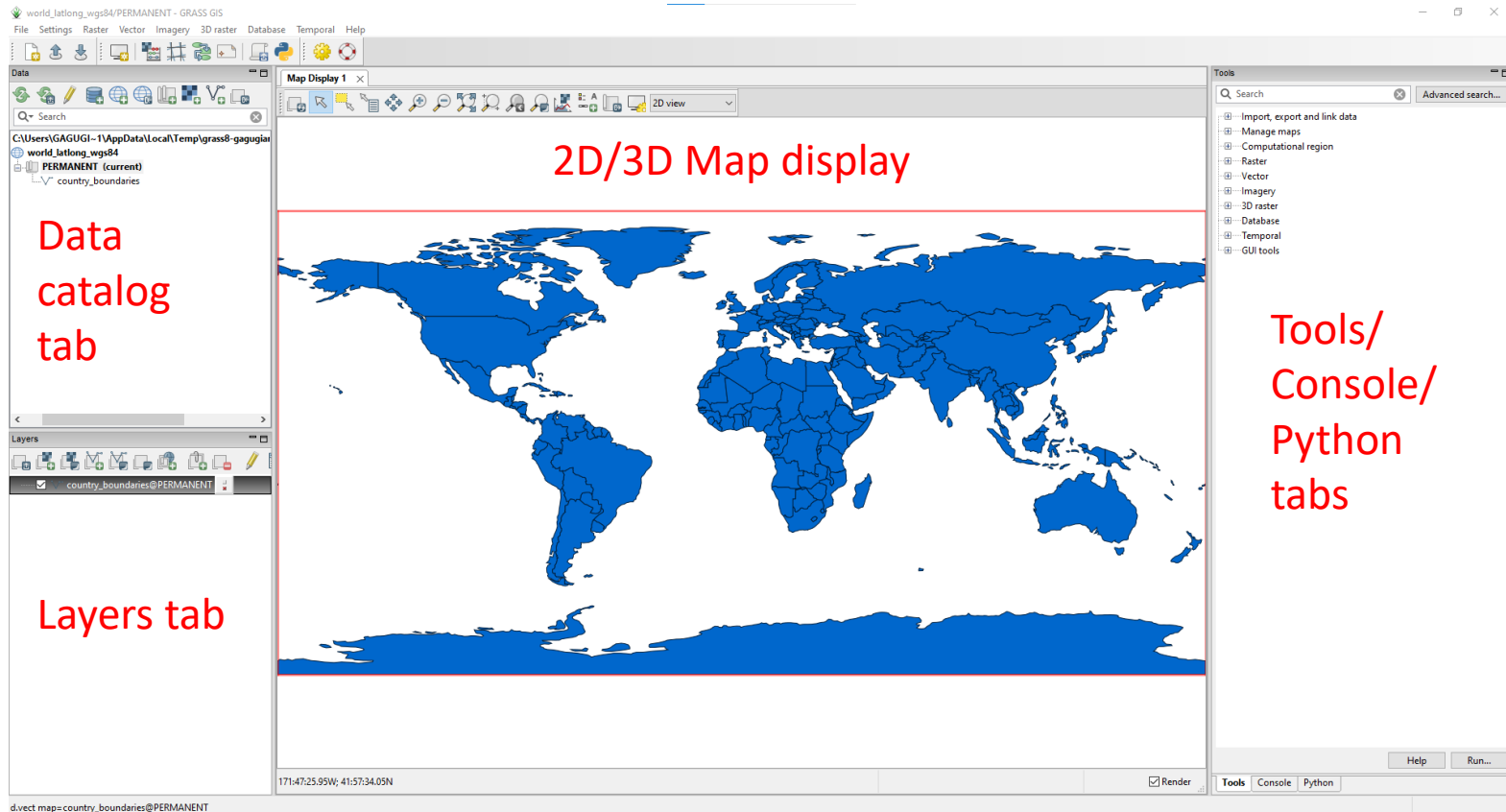
- A **LOCATION** is a directory containing all data having the same projection and – possibly – region (see later)
- A **MAPSET** is a subdirectory of LOCATION containing thematically similar data. Mapset PERMANENT is always present and read-only!
 - One LOCATION can have multiple MAPSETS.
 - Each MAPSET contain files and directories of maps in vector or raster format (2D and/or 3D)
- The **REGION** defines the size and the resolution (cell size) of the work area
 - First defined upon creation of the LOCATION, but can be changed later
 - Each MAPSET can have its own region

GRASS GIS “database” structure



Running GRASS GIS - GUI

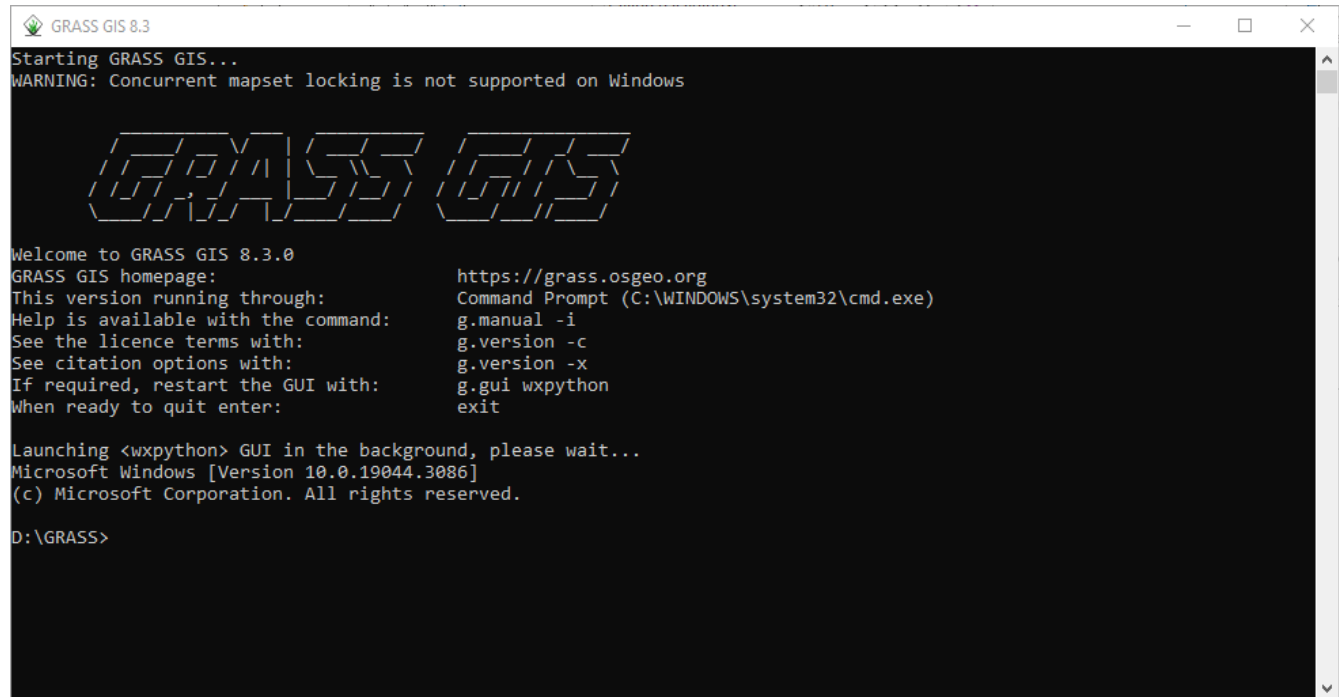
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The screenshot displays the GRASS GIS GUI interface. The central window, titled "Map Display 1", shows a world map with country boundaries highlighted in blue. The text "2D/3D Map display" is overlaid in red on the map. To the left, the "Data" panel shows a search bar and a list of data sources, including "world_latlong_wgs84" and "country_boundaries". The text "Data catalog tab" is overlaid in red on this panel. Below the "Data" panel is the "Layers" panel, which shows the loaded layer "country_boundaries@PERMANENT". The text "Layers tab" is overlaid in red on this panel. To the right, the "Tools" panel is visible, containing a search bar and a list of tool categories such as "Import, export and link data", "Manage maps", "Computational region", "Raster", "Vector", "Imagery", "3D raster", "Database", "Temporal", and "GUI tools". The text "Tools/ Console/ Python tabs" is overlaid in red on this panel. At the bottom of the map display, the coordinates "171:47:25.95W; 41:57:34.05N" are shown, along with a "Render" checkbox and "Tools Console Python" buttons.

Running GRASS GIS – Command prompt

- In the background, minimized, there is always a window with the command prompt.
- It can be used to type GRASS commands directly, too



```
GRASS GIS 8.3
Starting GRASS GIS...
WARNING: Concurrent mapset locking is not supported on Windows

GRASS GIS

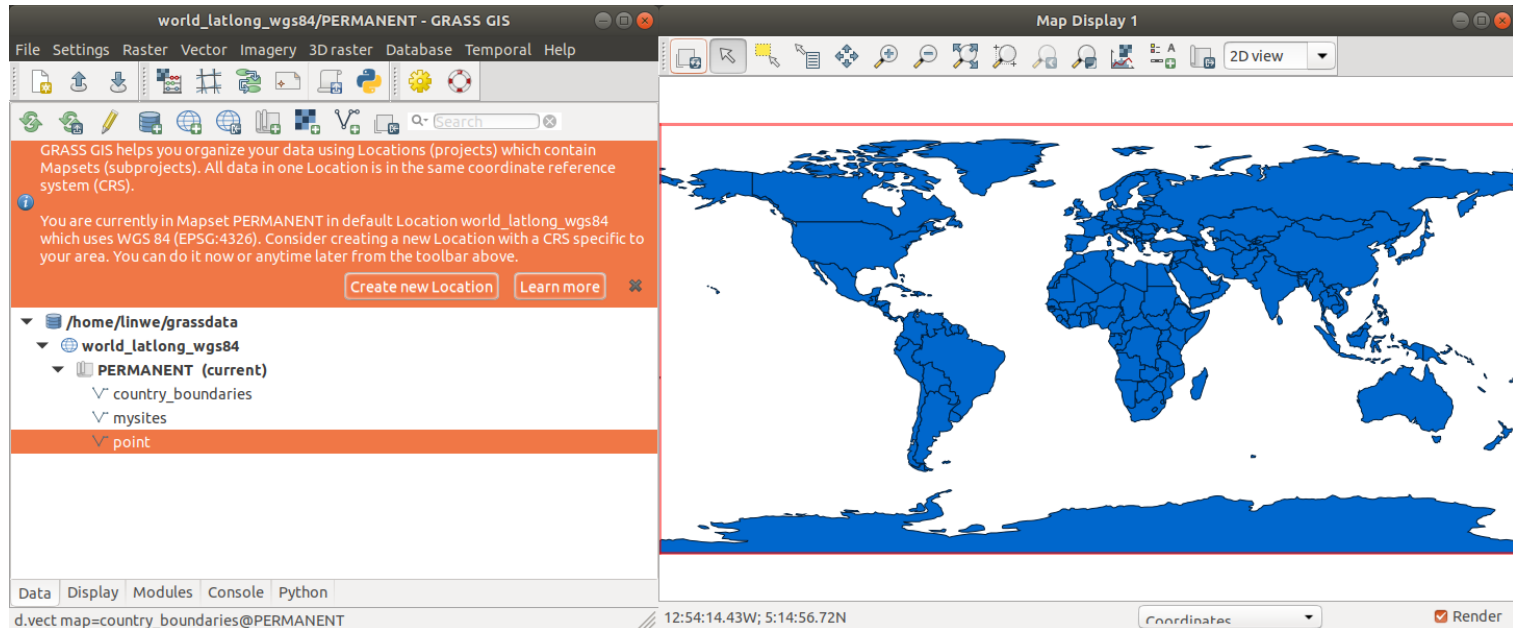
Welcome to GRASS GIS 8.3.0
GRASS GIS homepage:          https://grass.osgeo.org
This version running through: Command Prompt (C:\WINDOWS\system32\cmd.exe)
Help is available with the command: g.manual -i
See the licence terms with:      g.version -c
See citation options with:       g.version -x
If required, restart the GUI with: g.gui wxpython
When ready to quit enter:        exit

Launching <wxpython> GUI in the background, please wait...
Microsoft Windows [Version 10.0.19044.3086]
(c) Microsoft Corporation. All rights reserved.

D:\GRASS>
```

GRASS GIS

- When launching GRASS GIS for the first time, it will load the default Location "world_latlong_wgs84" where you can find a map layer called "country_boundaries" showing a world map in the WGS84 coordinate system
- If you know the CRS of your data or study area, you can fill **EPSG code** or description, and Location Wizard finds appropriate CRS from a predefined list of projections.

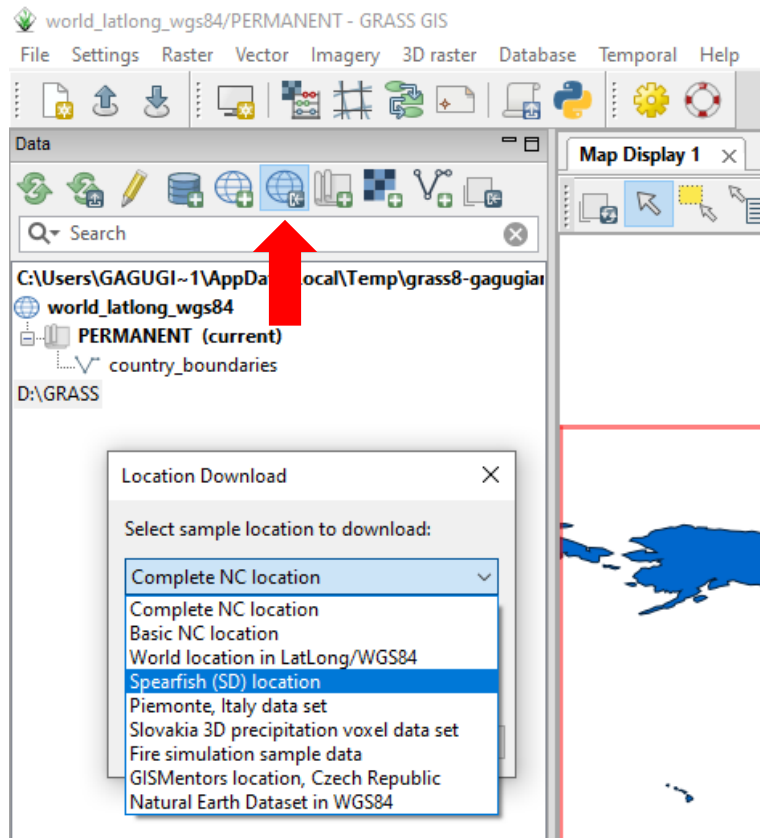


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Adding sample datasets

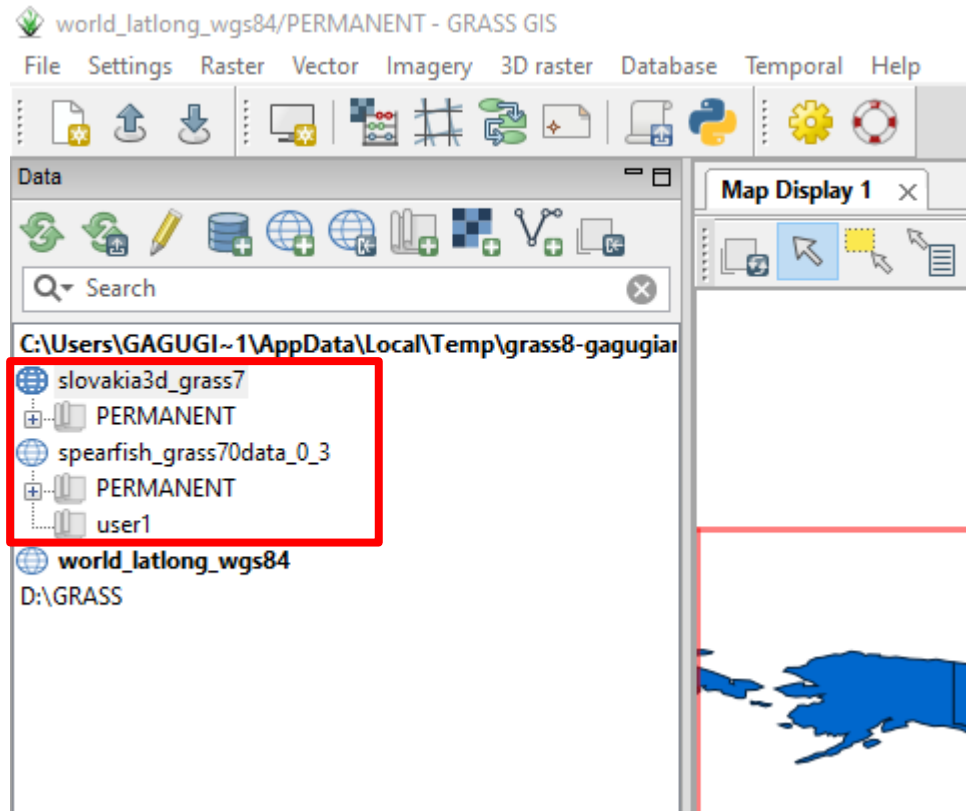
- You can easily install sample datasets
- Click on the "Download sample location to current GRASS database" button and select the desired sample datasets. Here, for example, we choose Spearfish and Slovakia3D precipitation voxel data set

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Adding sample datasets

- You can easily install sample datasets
- Click on the "Download sample location to current GRASS database" button and select the desired sample datasets. Here, for example, we choose Spearfish and Slovakia3D precipitation voxel data set
- Once installed, you will see a new locations called **slovakia3d_grass7** and **spearsish_grass70data_0_3**



Defining a customized GRASS data folder

Intro

GRASS modules

GRASS GIS DB

Running GRASS

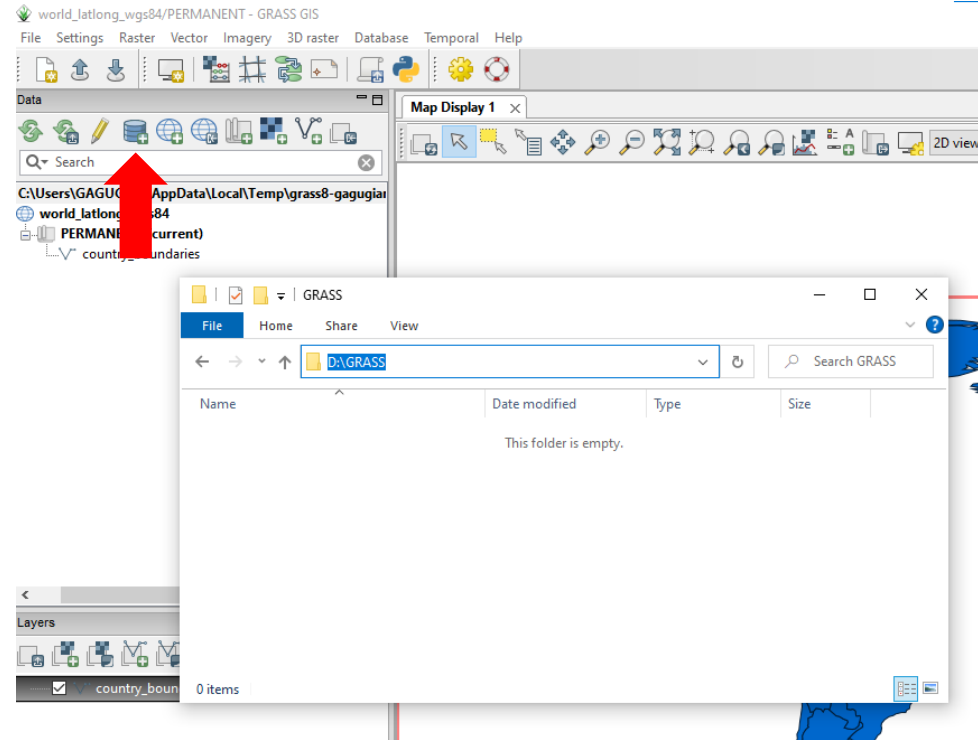
New setup

Running modules

Test data

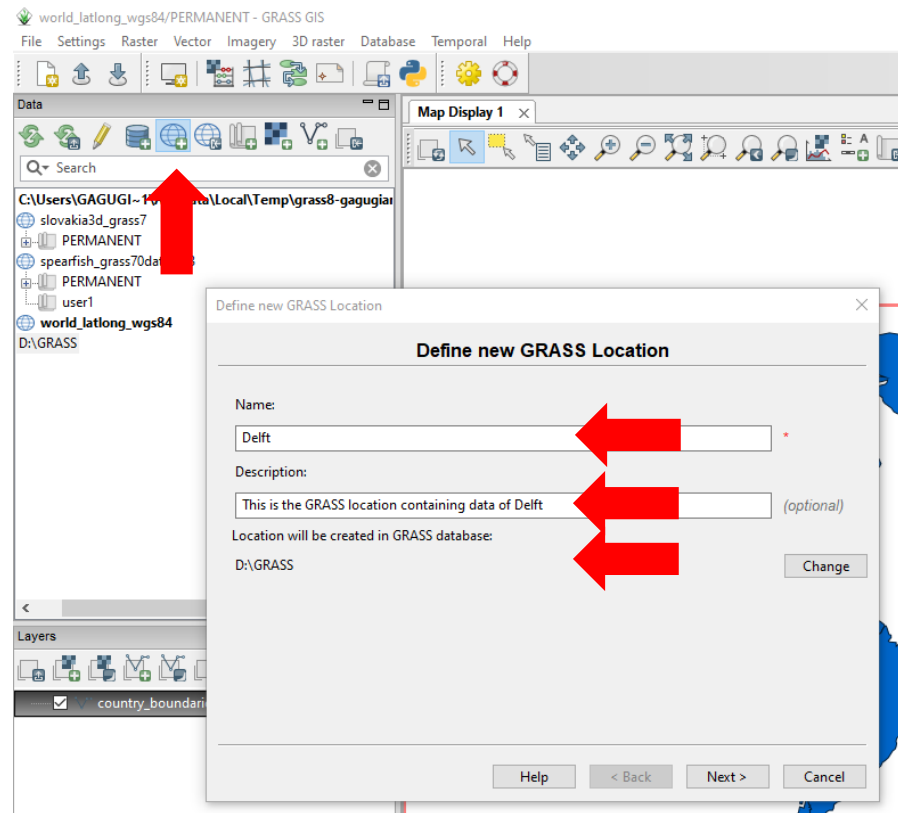
Help

- It is a good idea to set up your own folder where to store your GRASS data.
- Click on the "Add existing or create new database" and choose a directory (here, for example, D:\GRASS)
- You will be immediately requested if you want to add a location
- If you have the necessary information, you can proceed
- Alternatively, you can also copy/paste an already existing location



Adding a new GRASS location

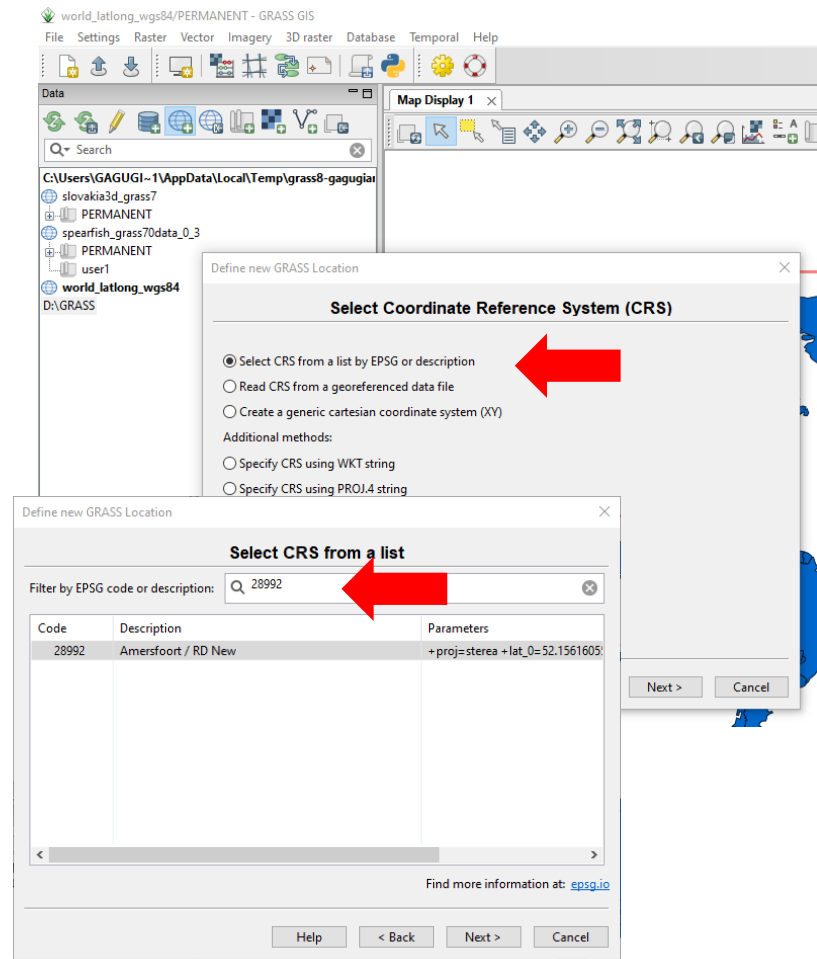
- Click on the "Create new location in current GRASS database
- Choose a name (e.g. Delft)
- Optionally add a description
- Optionally select which GRASS database to use (e.g. The previously set D:\GRASS)



Adding a new GRASS location

- You will be asked to provide the needed parameters
- The easiest way is to choose the first optio and to select the CRS from a list of EPSG codes
- You can type the code or a string and you can then pick the desired CRS. Here, for example 28992 for the NL
- Accepts the standard settings and...

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world_latlong_wgs84/PERMANENT - GRASS GIS

File Settings Raster Vector Imagery 3D raster Database Temporal Help

Data

Map Display 1

C:\Users\GAGUGI-1\AppData\Local\Temp\grass8-gagugia

slovakia3d_grass7

PERMANENT

spearfish_grass70data_0_3

PERMANENT

user1

world_latlong_wgs84

D:\GRASS

Define new GRASS Location

Select Coordinate Reference System (CRS)

Select CRS from a list by EPSG or description

Read CRS from a georeferenced data file

Create a generic cartesian coordinate system (XY)

Additional methods:

Specify CRS using WKT string

Specify CRS using PROJ.4 string

Define new GRASS Location

Select CRS from a list

Filter by EPSG code or description: 28992

Code	Description	Parameters
28992	Amersfoort / RD New	+proj=sterea +lat_0=52.1561605

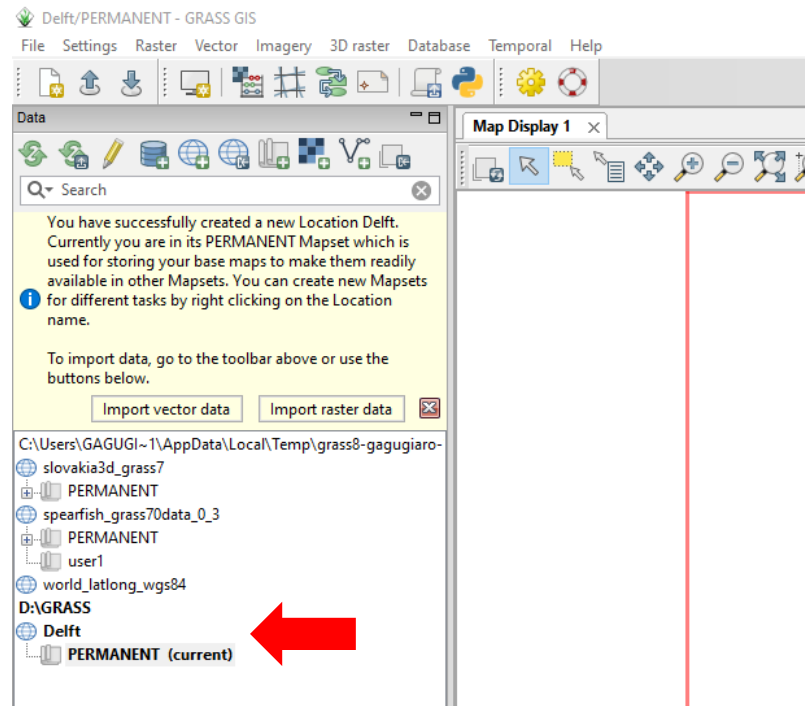
Find more information at: epsg.io

Next > Cancel

Help < Back Next > Cancel

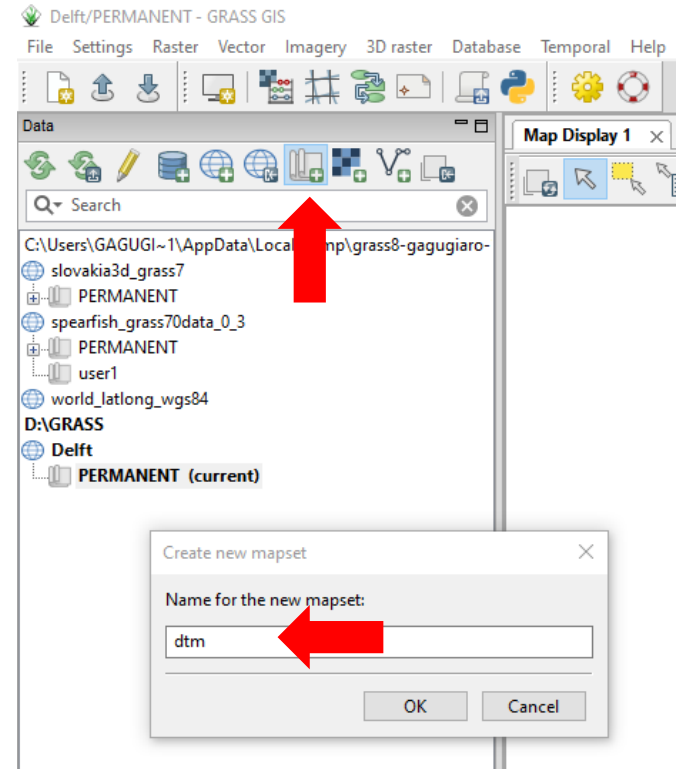
Adding a new GRASS location

- You will be asked to provide the needed parameters
- The easiest way is to choose the first option and to select the CRS from a list of EPSG codes
- You can type the code or a string and you can then pick the desired CRS. Here, for example 28992 for the NL
- Accepts the standard settings and...
- ...the new location, with the default PERMANENT mapset will be created
- You are now offered the option to directly import new data (to the PERMANENT mapset), or you can alternatively create a your own mapset



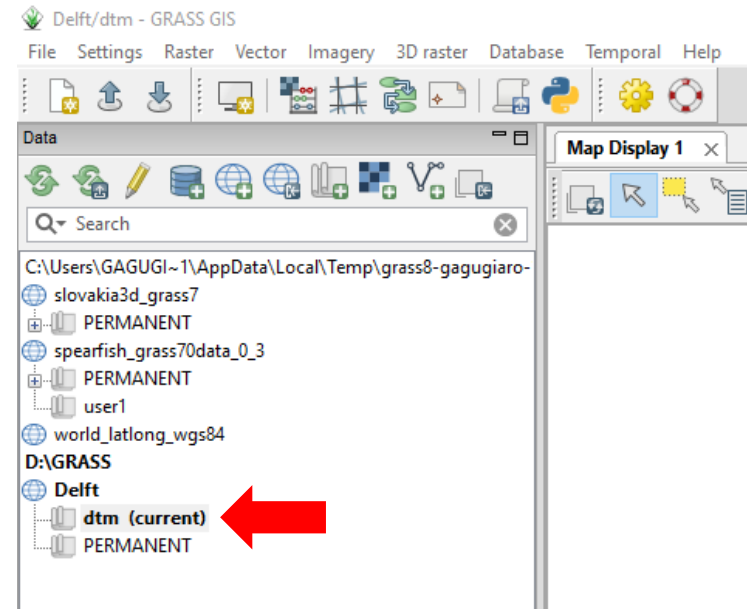
Adding a new GRASS mapset

- Click on the "Create new mapset in current location" button and set the name of the new mapset. Here, for example, "dtm"



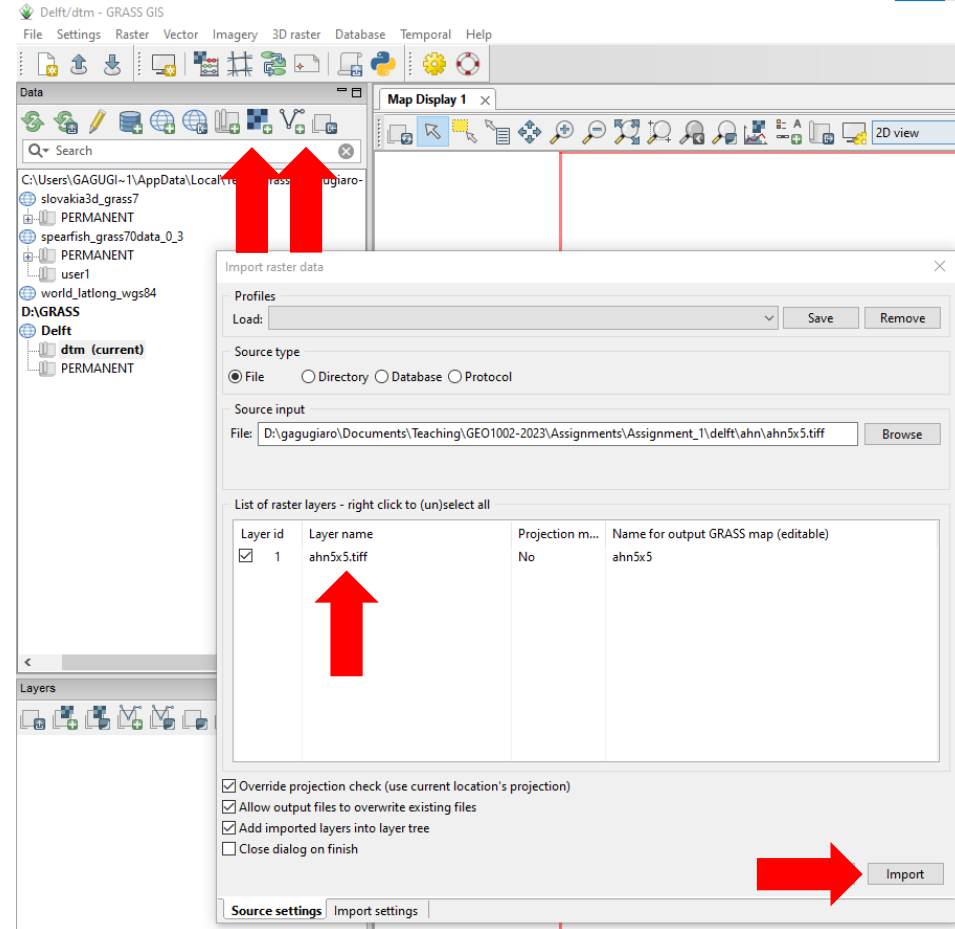
Adding a new GRASS mapset

- A new mapset is then added.
- Please note the **"current" suffix**. It reminds you of the mapset you are currently working in, i.e. All maps you will create will be written in the current mapset!



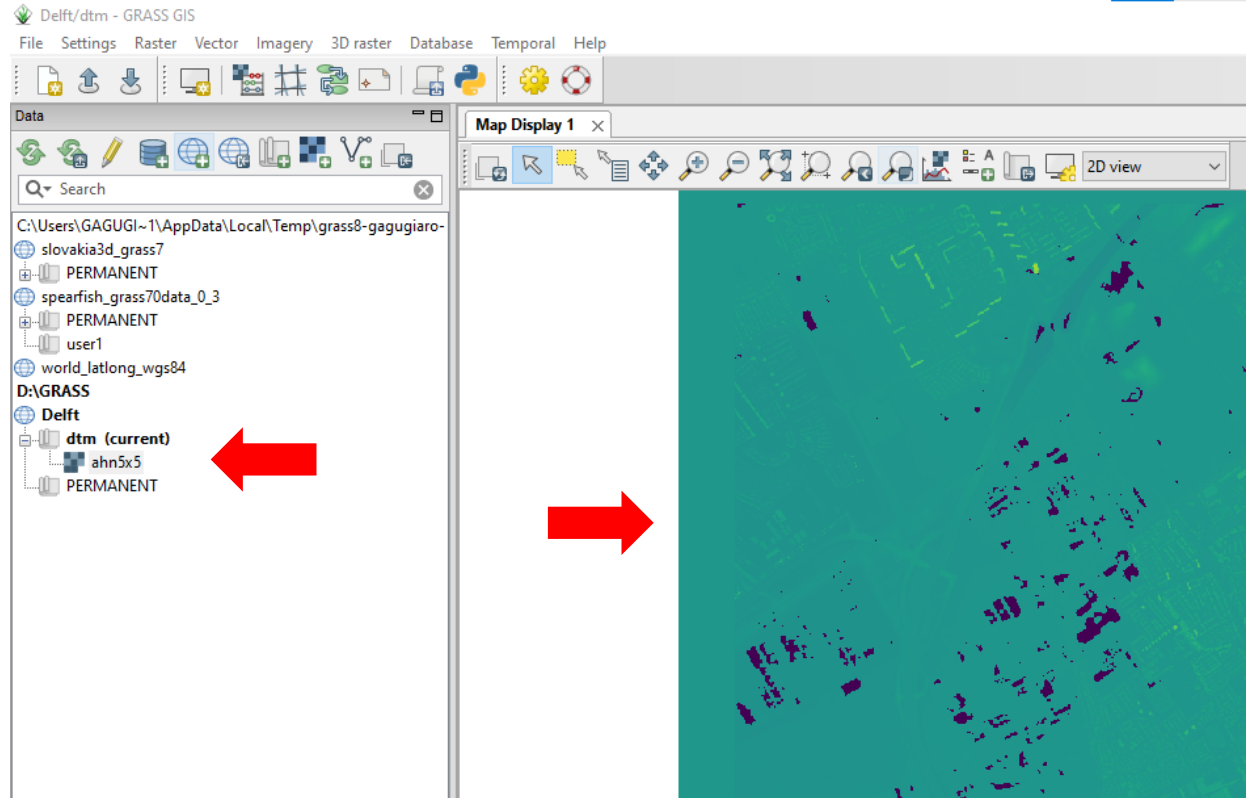
Importing data into the current mapset

- Once you have selected which mapset to work on, you can import data (vector or raster) by clicking on the proper "Import raster data" or "Import vector data" buttons
- Here, for example, we decide to import raster data. A window will open asking for the details. Here we import a till file containing the DTM of a portion of Delft
- Set the options and then click on "Import"



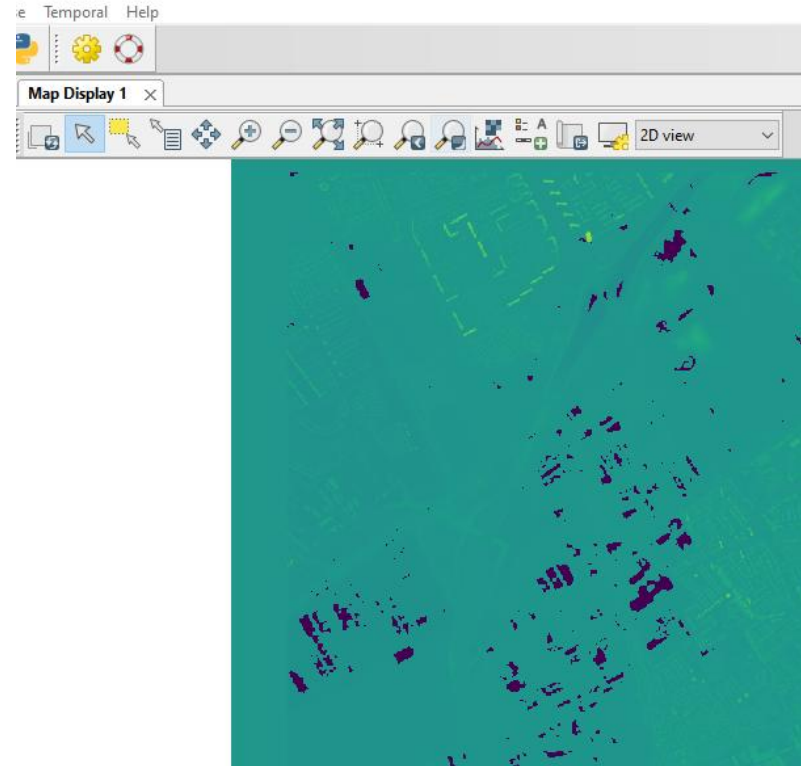
Importing data into the current mapset

- The file will be converted into a GRASS raster layer, added to the current mapset, and visualised in the Map Display



Setting the GRASS computational region

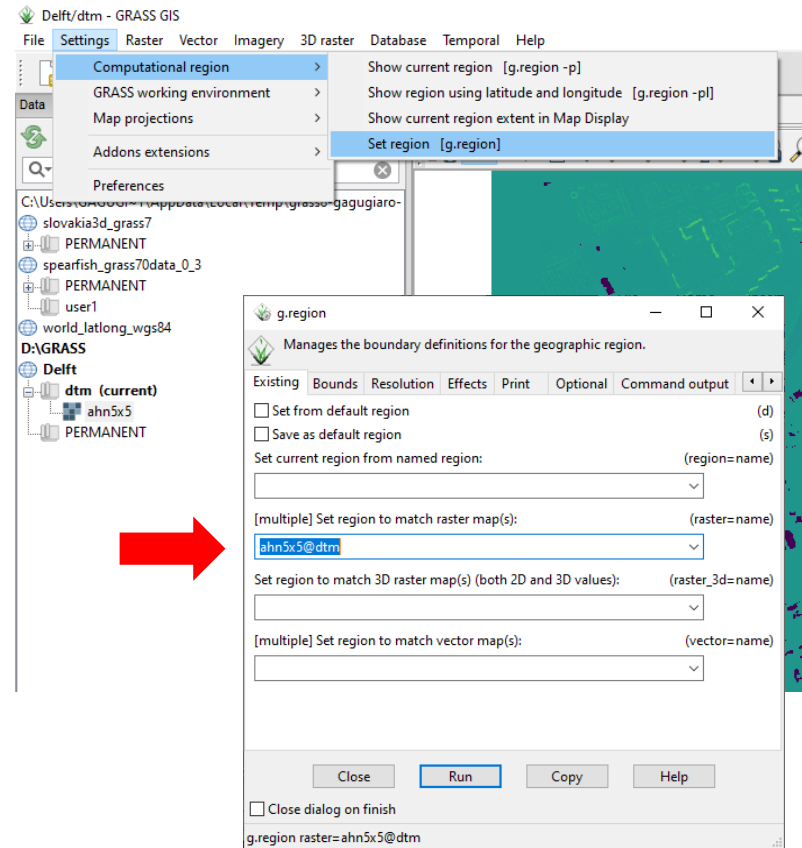
- When working in GRASS, it is **FUNDAMENTAL** to set the **computational region** correctly. Whatever operation you will carry out, it will be done **only within** the boundaries of such region.
- The region is displayed by means of a **red boundary in the map display**.
- It can be set and adapted according to your needs



No red boundary visible, the region is not set correctly!

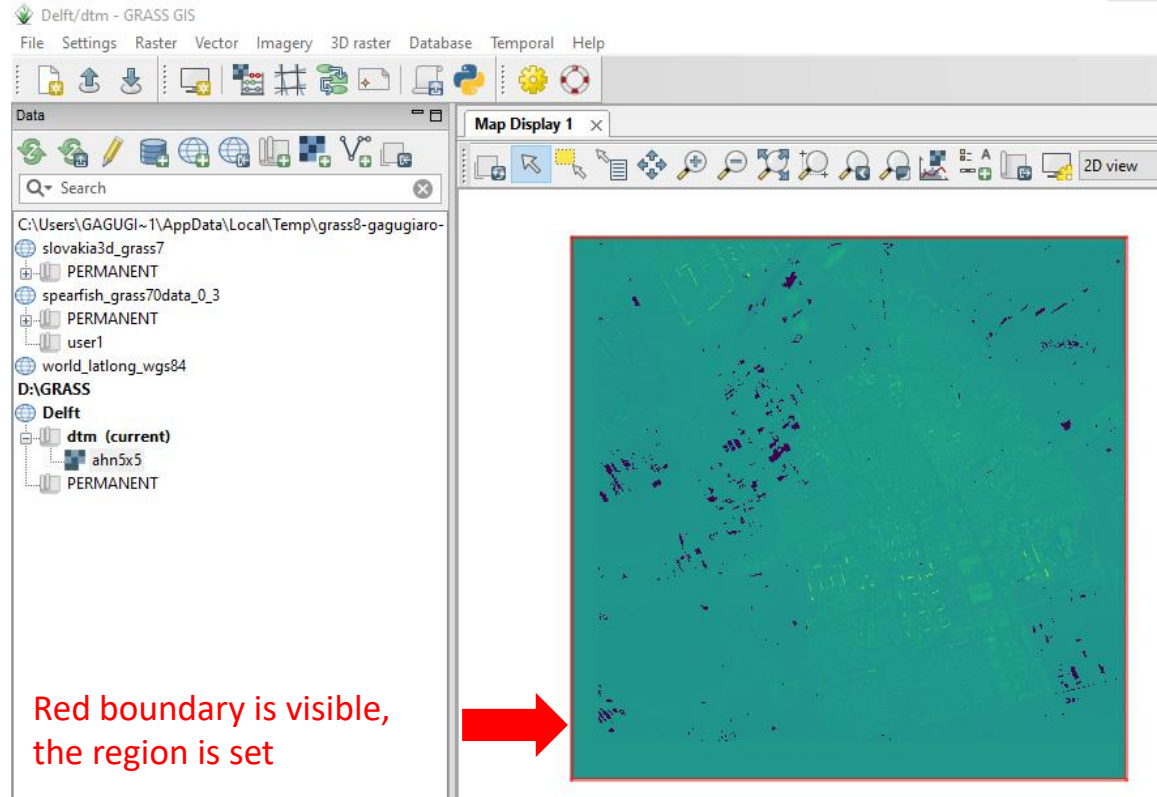
Setting the GRASS computational region

- You can set the region from the GUI via Settings\Computational region\Set region
- A command GUI will open. For example, you can set it to the extents of the previously imported DTM map (it is just an example!)



Setting the GRASS computational region

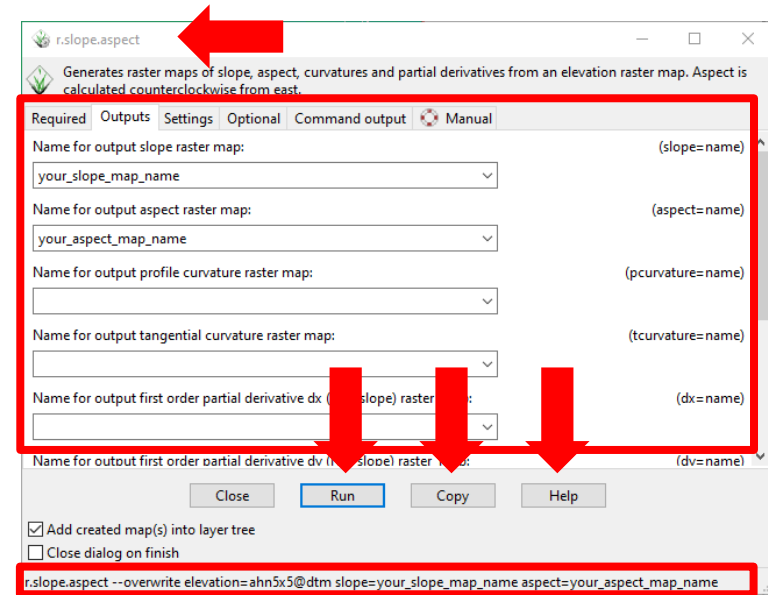
- Now you can see the current region as a red boundary around the selected raster layer.



Red boundary is visible,
the region is set

Working with GRASS GIS: Module windows

- In general, nearly every GRASS module has an associated window GUI. The name of the module is written on the top of the window
- All user-defined parameters and flags can be set manually
- Once you are done, you simply press the "Run" button
- You can see (and copy) the full command with parameters and flags in the bottom part of the window. This is useful for learning how parameters are set, and to use the command in scripts to automate the process
- For help, simply press the "Help" button



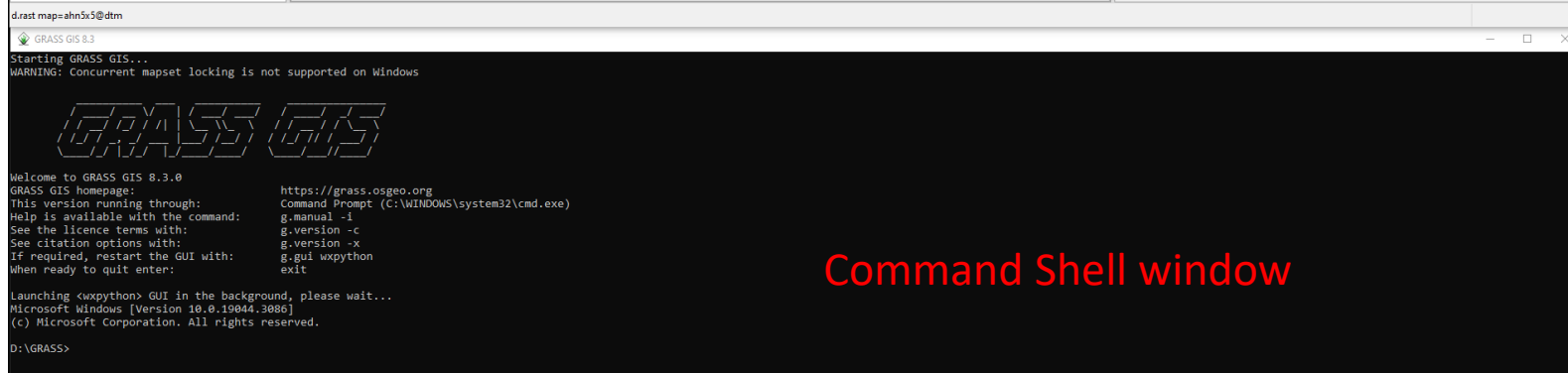
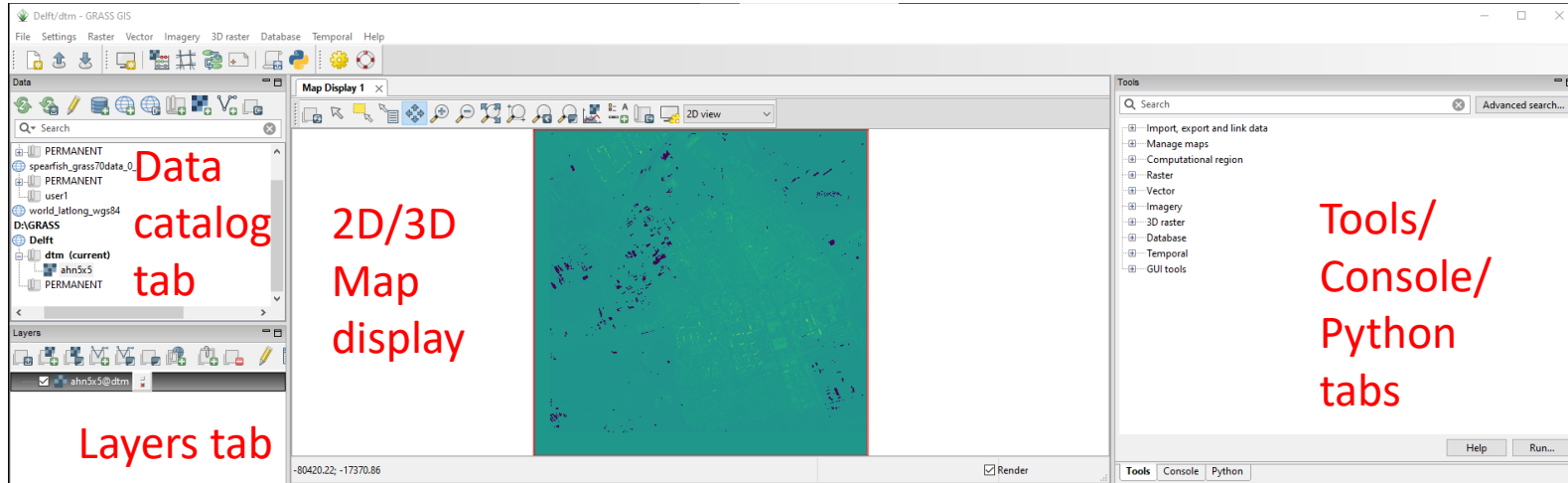
Working with GRASS GIS

There are **different, alternative ways** to launch and run the GRASS modules:

- a) Using the **GUI drop-down menus** (the names of the modules are also suggested) with mouse and/or keyboard
- b) Double clicking on the module name in the **Tools tab**
- c) Writing the module name (with, optionally, parameters) in the **Console tab**
- d) Writing the module name (with, optionally, parameters) in the **Command shell**
- e) Writing Python code in the **Python tab**
- f) Writing Python code in the **Python code editor**
- g) From within **QGIS + GRASS Plugin** (not recommended)
- h) A combination thereof

Working with GRASS GIS

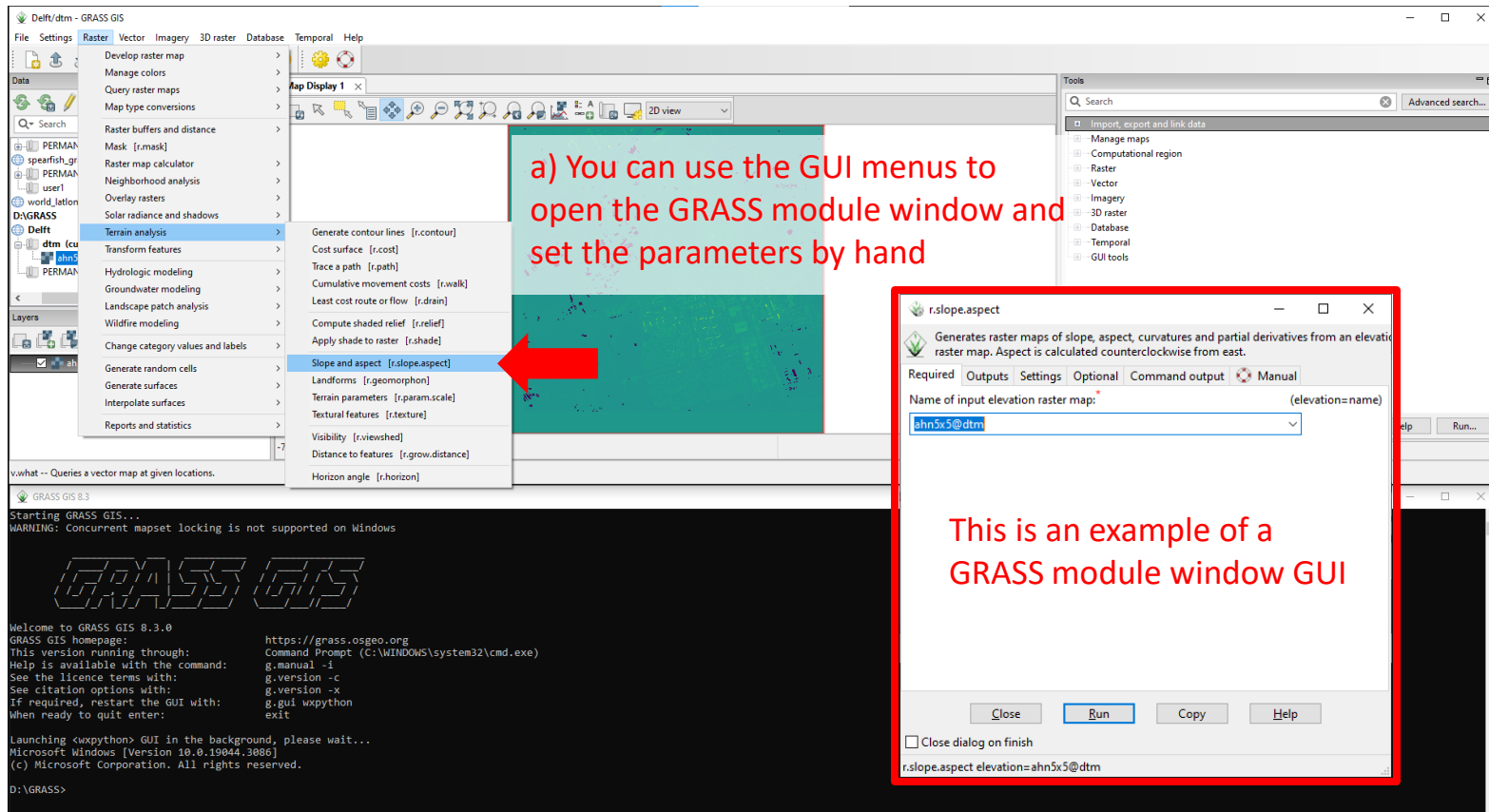
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Command Shell window

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a) You can use the GUI menus to open the GRASS module window and set the parameters by hand

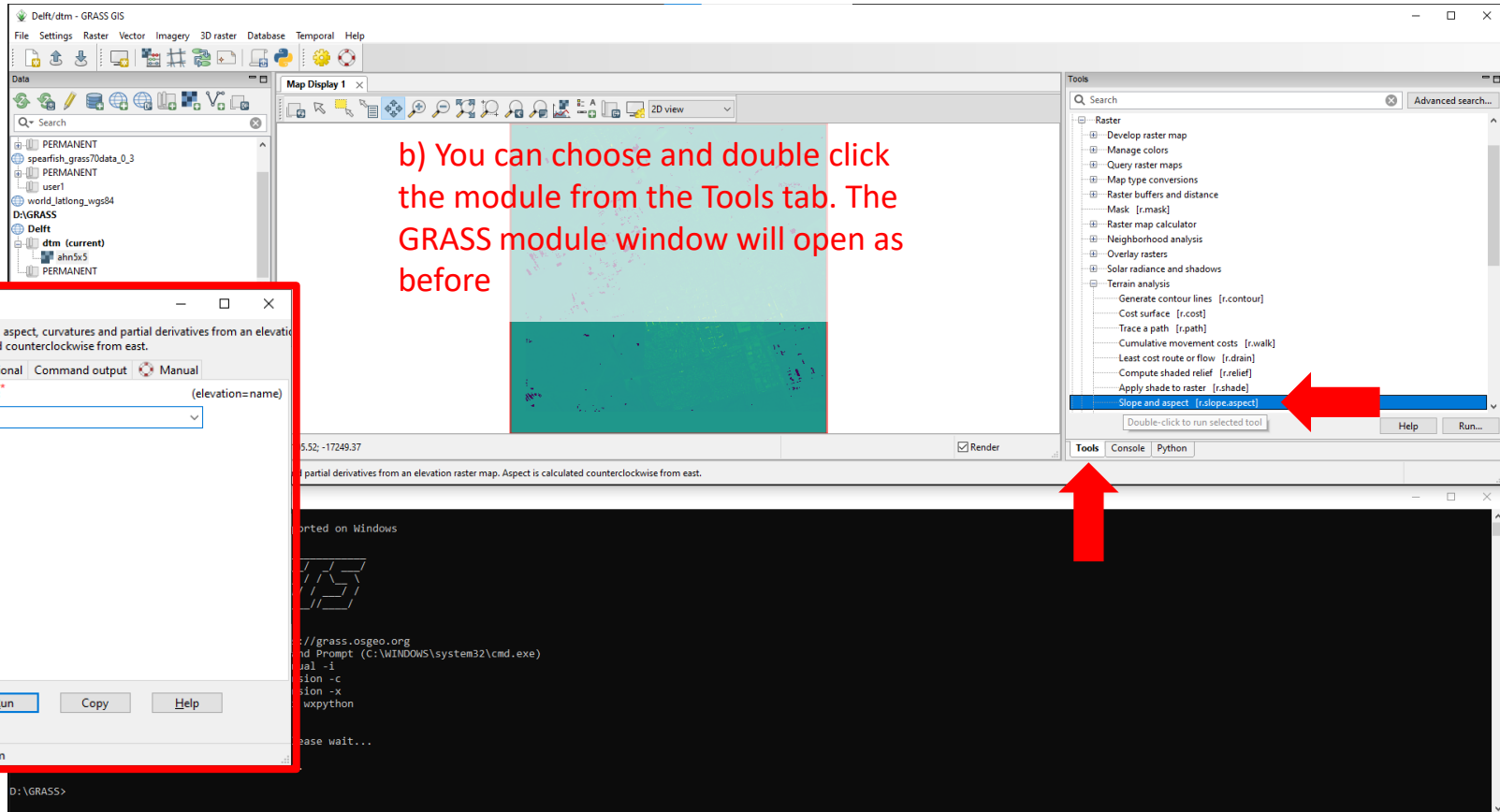
This is an example of a GRASS module window GUI

```

D:\dtm - GRASS GIS
File Settings Raster Vector Imagery 3D raster Database Temporal Help
Data
  Develop raster map
  Manage colors
  Query raster maps
  Map type conversions
  Raster buffers and distance
  Mask [r.mask]
  Raster map calculator
  Neighborhood analysis
  Overlay rasters
  Solar radiance and shadows
  Terrain analysis
  Transform features
  Hydrologic modeling
  Groundwater modeling
  Landscape patch analysis
  Wildfire modeling
  Change category values and labels
  Generate random cells
  Generate surfaces
  Interpolate surfaces
  Reports and statistics
  Generate contour lines [r.contour]
  Cost surface [r.cost]
  Trace a path [r.path]
  Cumulative movement costs [r.walk]
  Least cost route or flow [r.drain]
  Compute shaded relief [r.relief]
  Apply shade to raster [r.shade]
  Slope and aspect [r.slope.aspect]
  Landforms [r.geomorphon]
  Terrain parameters [r.param.scale]
  Textural features [r.texture]
  Visibility [r.viewshed]
  Distance to features [r.grow.distance]
  Horizon angle [r.horizon]
  v.what -- Queries a vector map at given locations.
  GRASS GIS 8.3
  Starting GRASS GIS...
  WARNING: Concurrent mapset locking is not supported on Windows
  GRASS GIS
  Welcome to GRASS GIS 8.3.0
  GRASS GIS homepages: https://grass.osgeo.org
  This version running through: Command Prompt (C:\WINDOWS\system32\cmd.exe)
  Help is available with the command: g.manual -i
  See the licence terms with: g.version -c
  See citation options with: g.version -x
  If required, restart the GUI with: g.gui wxpython
  When ready to quit enter: exit
  Launching <wxpython> GUI in the background, please wait...
  Microsoft Windows [Version 10.0.19044.3086]
  (c) Microsoft Corporation. All rights reserved.
  D:\GRASS>
  r.slope.aspect
  Generates raster maps of slope, aspect, curvatures and partial derivatives from an elevati
  raster map. Aspect is calculated counterclockwise from east.
  Required Outputs Settings Optional Command output Manual
  Name of input elevation raster map: (elevation=name)
  ahn5x5@dtm
  Close Run Copy Help
  r.slope.aspect elevation=ahn5x5@dtm
  
```

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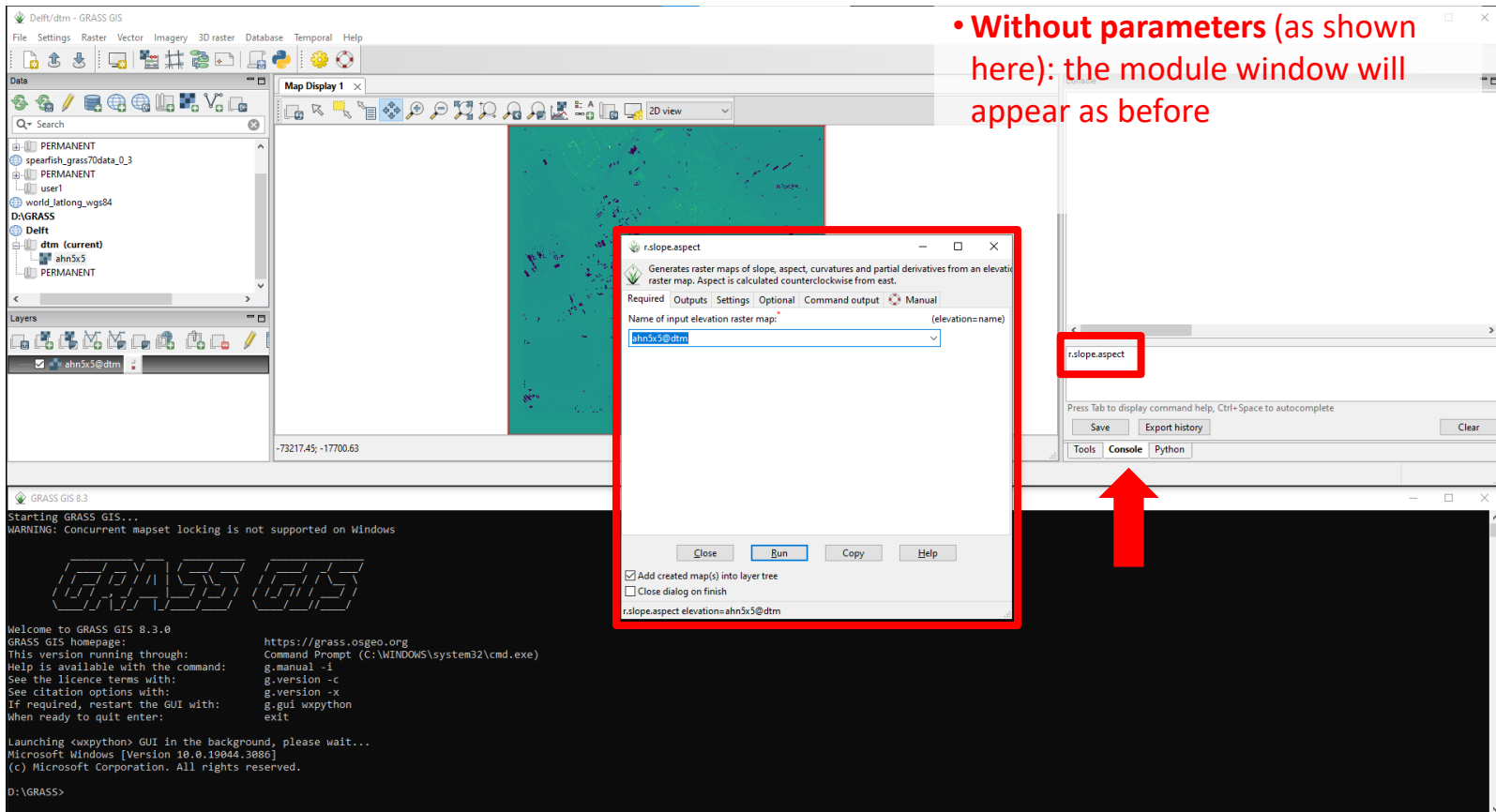
The screenshot shows the GRASS GIS desktop environment. The main window displays a map with a terrain visualization. On the right, the 'Tools' panel is open, showing a list of modules. The 'Slope and aspect' module is highlighted in blue. A red arrow points to this module. Below the Tools panel, a red arrow points to the 'Tools' tab in the interface. In the foreground, a dialog box for the 'r.slope.aspect' module is open, showing the 'Name of input elevation raster map' set to 'ahn5x5@dtm'. The dialog box has a red border and contains buttons for 'Close', 'Run', 'Copy', and 'Help'. The 'Run' button is highlighted in blue. The background window has a red text overlay that reads: 'b) You can choose and double click the module from the Tools tab. The GRASS module window will open as before'.

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c1) You can write the module name in the Console tab. Two options:

- **Without parameters** (as shown here): the module window will appear as before



The screenshot shows the GRASS GIS GUI with the 'r.slope.aspect' module dialog box open. The 'Name of input elevation raster map:' field is set to 'ahn5x5@dtm'. The 'Console' tab is selected in the bottom right, showing the command 'r.slope.aspect elevation=ahn5x5@dtm'. A red arrow points from the console to the dialog box, and another red arrow points from the dialog box to the console.

GRASS GIS 8.3

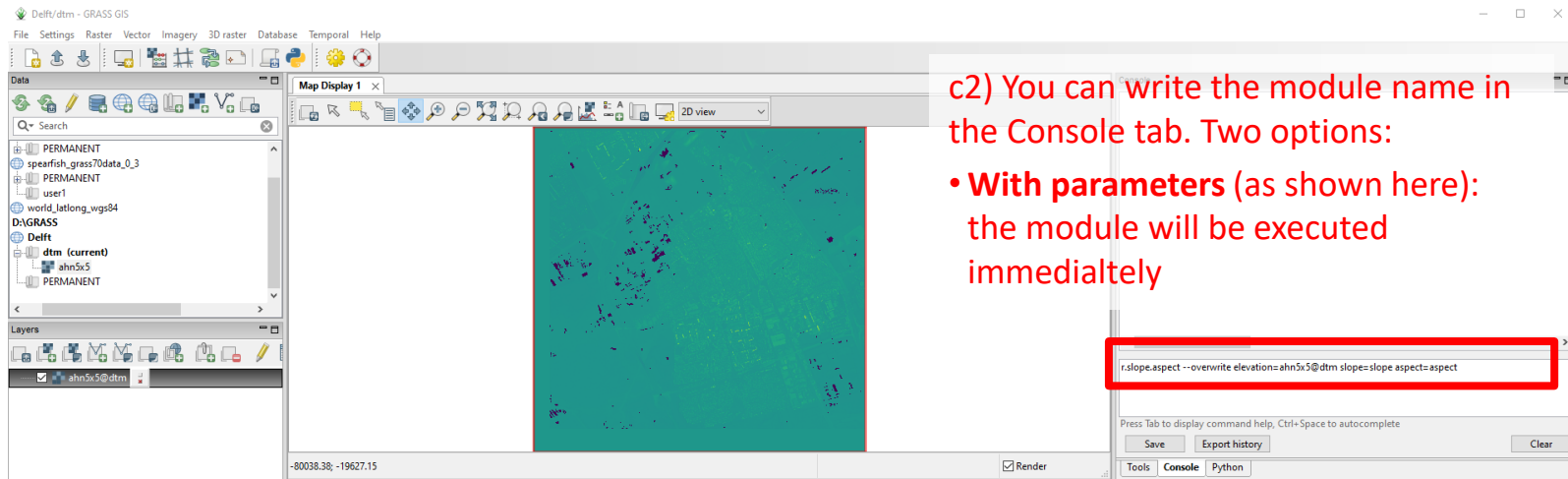
```
Starting GRASS GIS...
WARNING: Concurrent mapset locking is not supported on Windows

Welcome to GRASS GIS 8.3.0
GRASS GIS homepage: https://grass.osgeo.org
This version running through: Command Prompt (C:\WINDOWS\system32\cmd.exe)
Help is available with the command: g.manual -i
See the licence terms with: g.version -c
See citation options with: g.version -x
If required, restart the GUI with: g.gui wxpython
When ready to quit enter: exit

Launching <wxpython> GUI in the background, please wait...
Microsoft Windows [Version 10.0.19044.3086]
(c) Microsoft Corporation. All rights reserved.
D:\GRASS>
```

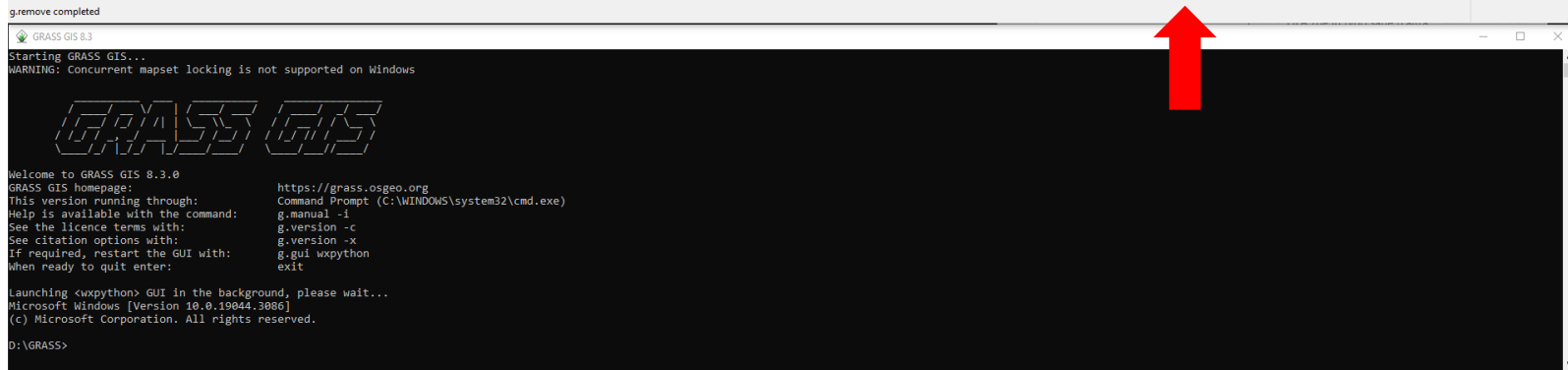
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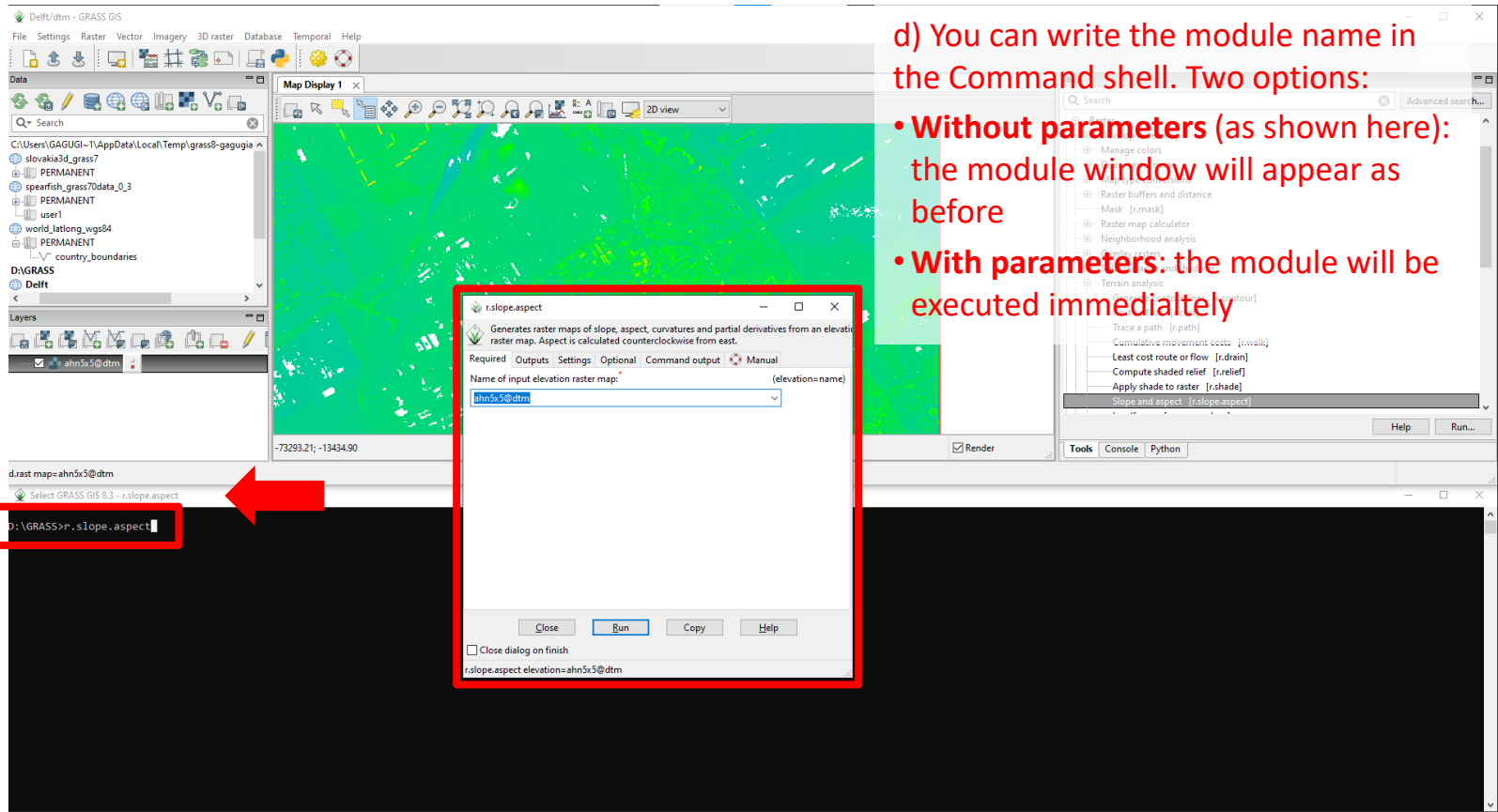
c2) You can write the module name in the Console tab. Two options:

- **With parameters** (as shown here): the module will be executed immediately



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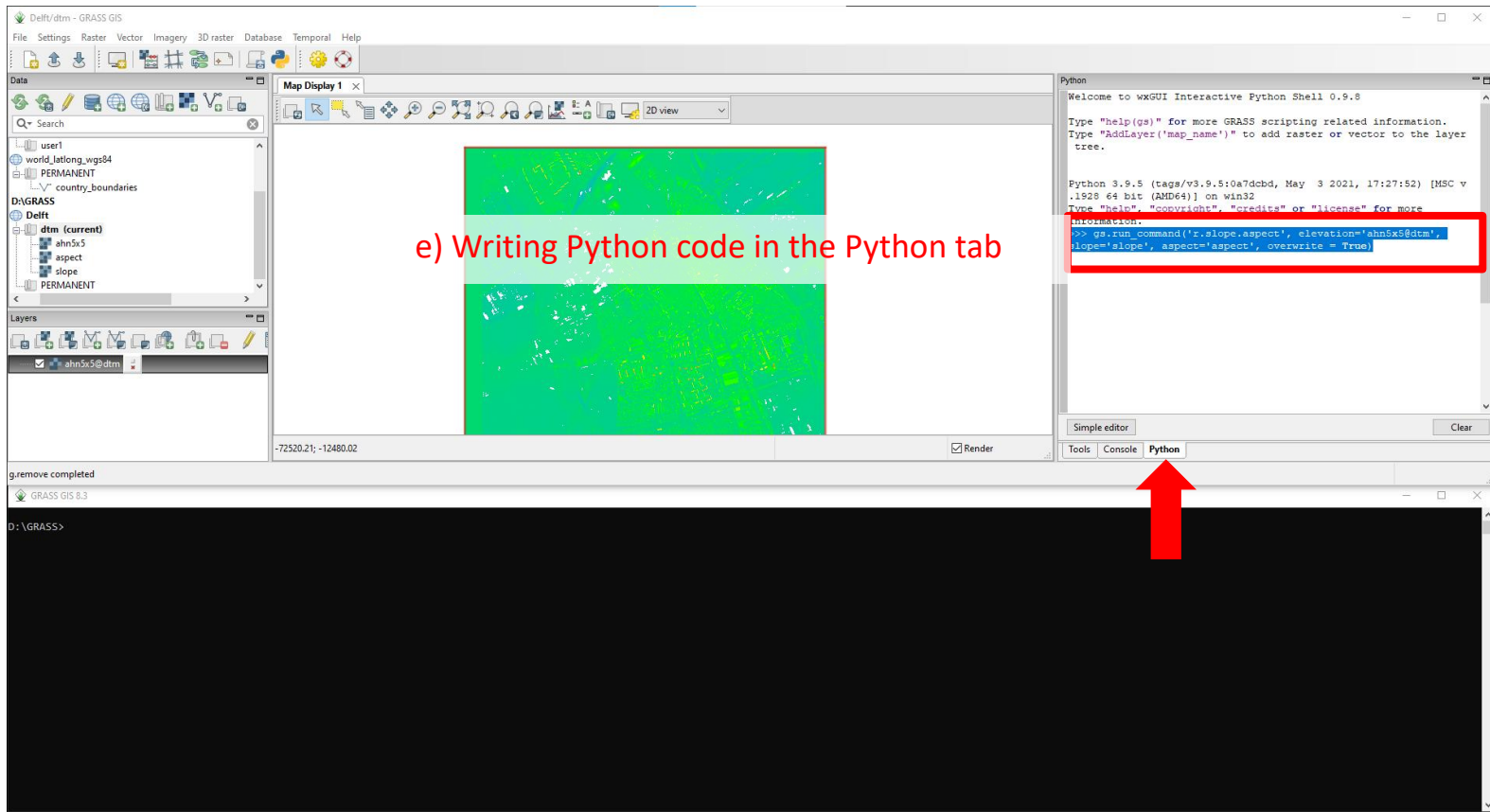


The screenshot shows the GRASS GIS desktop environment. A dialog box for the `r.slope.aspect` module is open, with the input elevation raster map set to `ahn5x5@dtm`. Below the dialog, a terminal window shows the command `D:\GRASS>r.slope.aspect` being entered, with a red arrow pointing to the prompt.

- d) You can write the module name in the Command shell. Two options:
- **Without parameters** (as shown here): the module window will appear as before
 - **With parameters**: the module will be executed immediately

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The screenshot shows the GRASS GIS desktop environment. The main window is titled "Delft/dtm - GRASS GIS" and contains a "Map Display 1" window showing a 2D view of a terrain map. The map is a color-coded elevation model with a red box overlaid on it. The text "e) Writing Python code in the Python tab" is written in red over the map. To the right of the map display is a "Python" window titled "Python" showing the wxGUI Interactive Python Shell 0.9.8. The shell contains the following text:

```
Welcome to wxGUI Interactive Python Shell 0.9.8

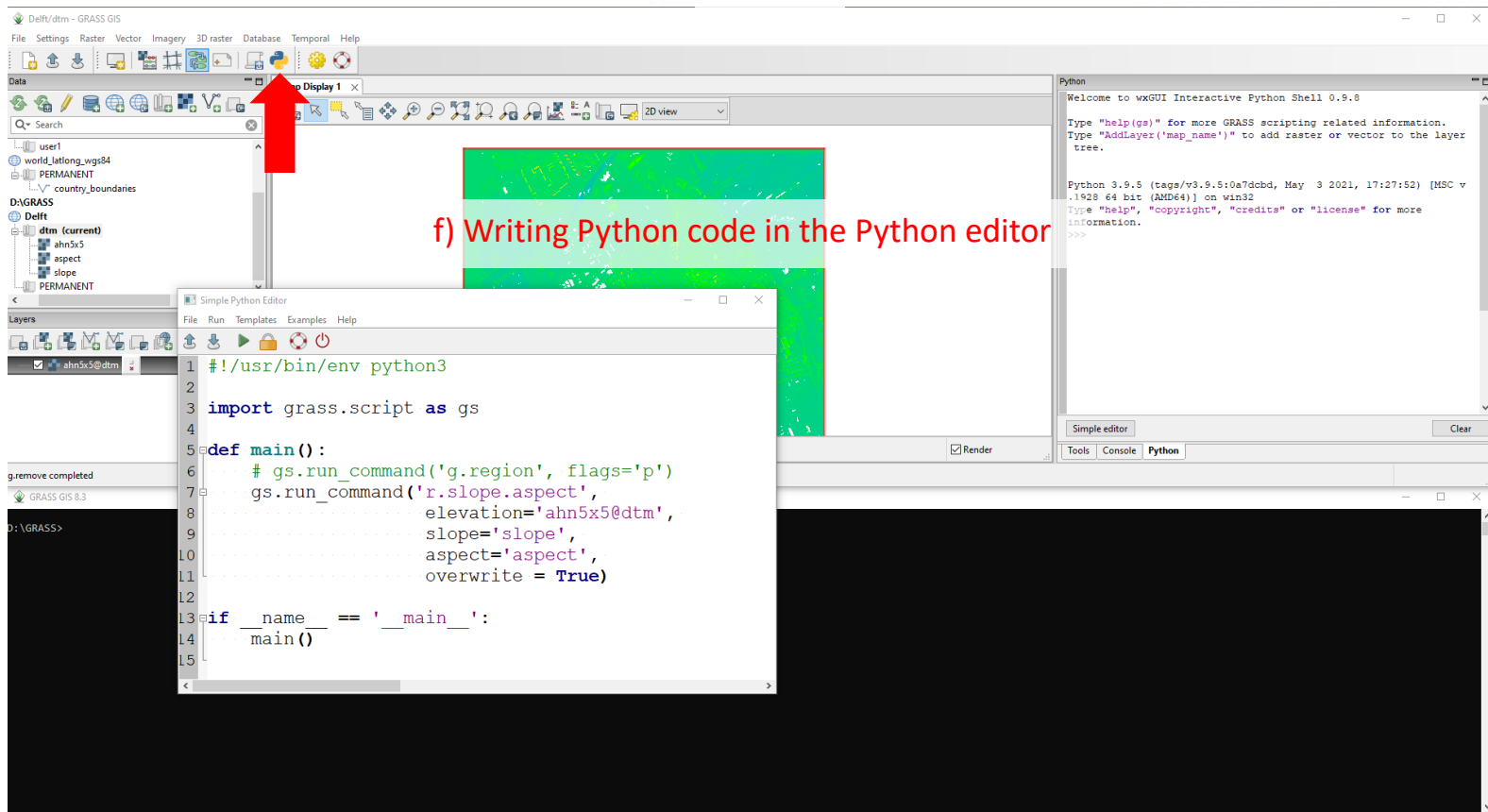
Type "help(gs)" for more GRASS scripting related information.
Type "AddLayer('map_name')" to add raster or vector to the layer
tree.

Python 3.9.5 (tags/v3.9.5:0a7dcbdb, May 3 2021, 17:27:52) [MSC v
.1928 64 bit (AMD64)] on win32
Type "help()" for more information.
Type "help('copyright', 'credits' or 'license') for more
information.
>>> gs.run_command('r.slope.aspect', elevation='ahn5xs@dtm',
slope='slope', aspect='aspect', overwrite = True)
```

A red arrow points to the "Python" tab in the bottom right corner of the interface. The bottom of the screenshot shows a terminal window titled "GRASS GIS 8.3" with the prompt "D:\GRASS>".

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The screenshot shows the GRASS GIS desktop environment. A red arrow points to the 'Python' icon in the top toolbar. A central map display shows a green and blue terrain visualization. A 'Simple Python Editor' window is open in the foreground, containing the following code:

```

1 #!/usr/bin/env python3
2
3 import grass.script as gs
4
5 def main():
6     # gs.run_command('g.region', flags='p')
7     gs.run_command('r.slope.aspect',
8                   elevation='ahh5x5@dtm',
9                   slope='slope',
10                  aspect='aspect',
11                  overwrite = True)
12
13 if __name__ == '__main__':
14     main()
15

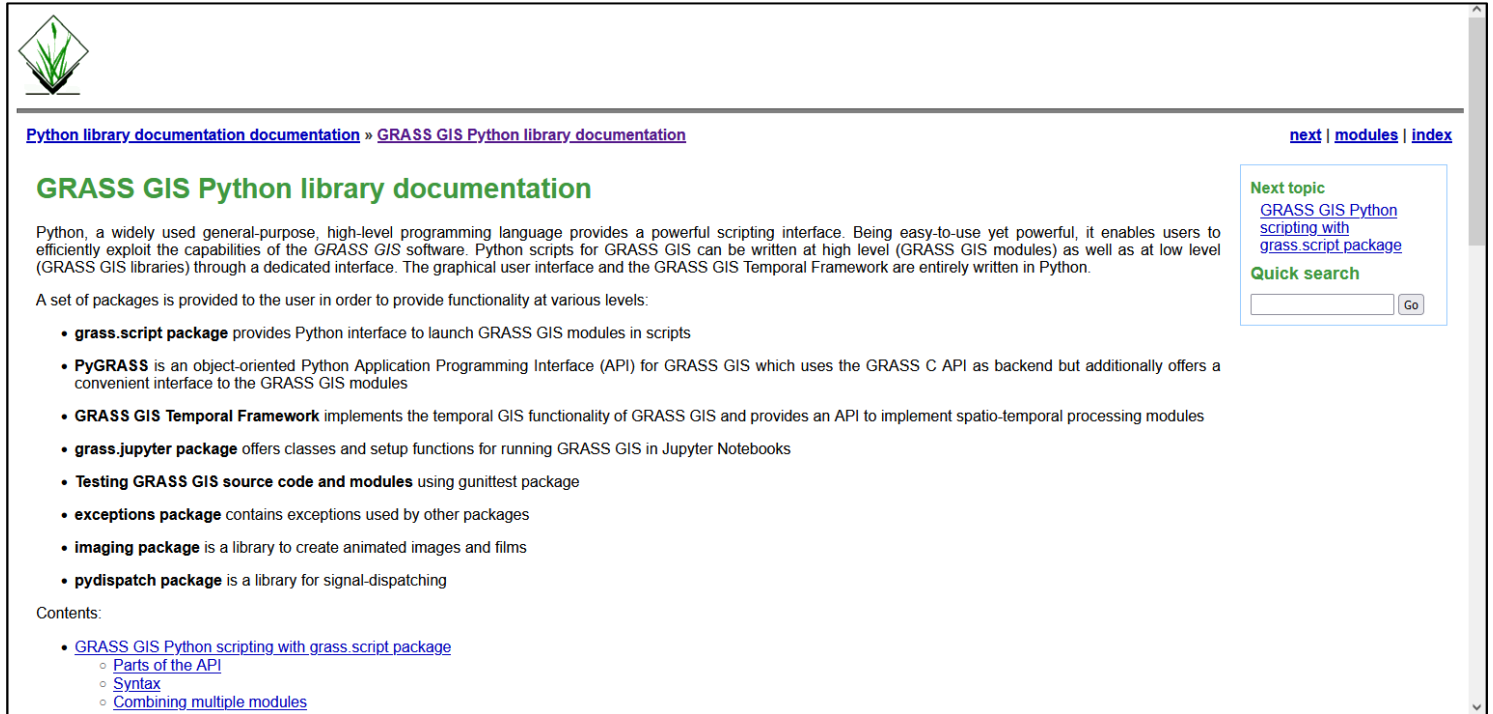
```

To the right, a 'Python' window shows the 'wxGUI Interactive Python Shell 0.9.0' with a welcome message and instructions on how to use the shell.

f) Writing Python code in the Python editor

GRASS and Python

- There is a useful manual providing all information on scripting GRASS with Python available at: <https://grass.osgeo.org/grass84/manuals/libpython/index.html>

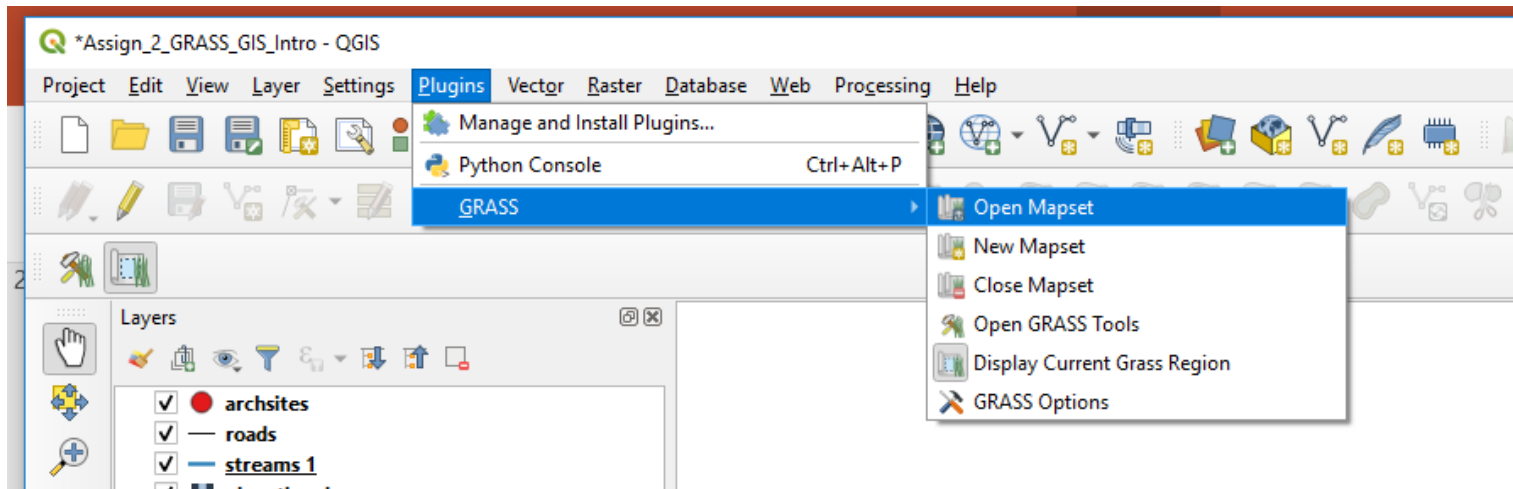


The screenshot shows the web page for GRASS GIS Python library documentation. At the top left is the GRASS logo. Below it is a breadcrumb trail: [Python library documentation documentation](#) » [GRASS GIS Python library documentation](#). To the right are links for [next](#), [modules](#), and [index](#). The main heading is **GRASS GIS Python library documentation**. The text explains that Python provides a powerful scripting interface for GRASS GIS, allowing users to write scripts at high or low levels. A list of packages is provided, including **grass.script package**, **PyGRASS**, **GRASS GIS Temporal Framework**, **grass.jupyter package**, **Testing GRASS GIS source code and modules**, **exceptions package**, **imaging package**, and **pydispatch package**. A 'Contents' section lists sub-topics like [Parts of the API](#), [Syntax](#), and [Combining multiple modules](#). On the right side, there is a 'Next topic' section with links to [GRASS GIS Python scripting with grass.script package](#) and a 'Quick search' box with a search input field and a 'Go' button.

Working with GRASS GIS: From QGIS

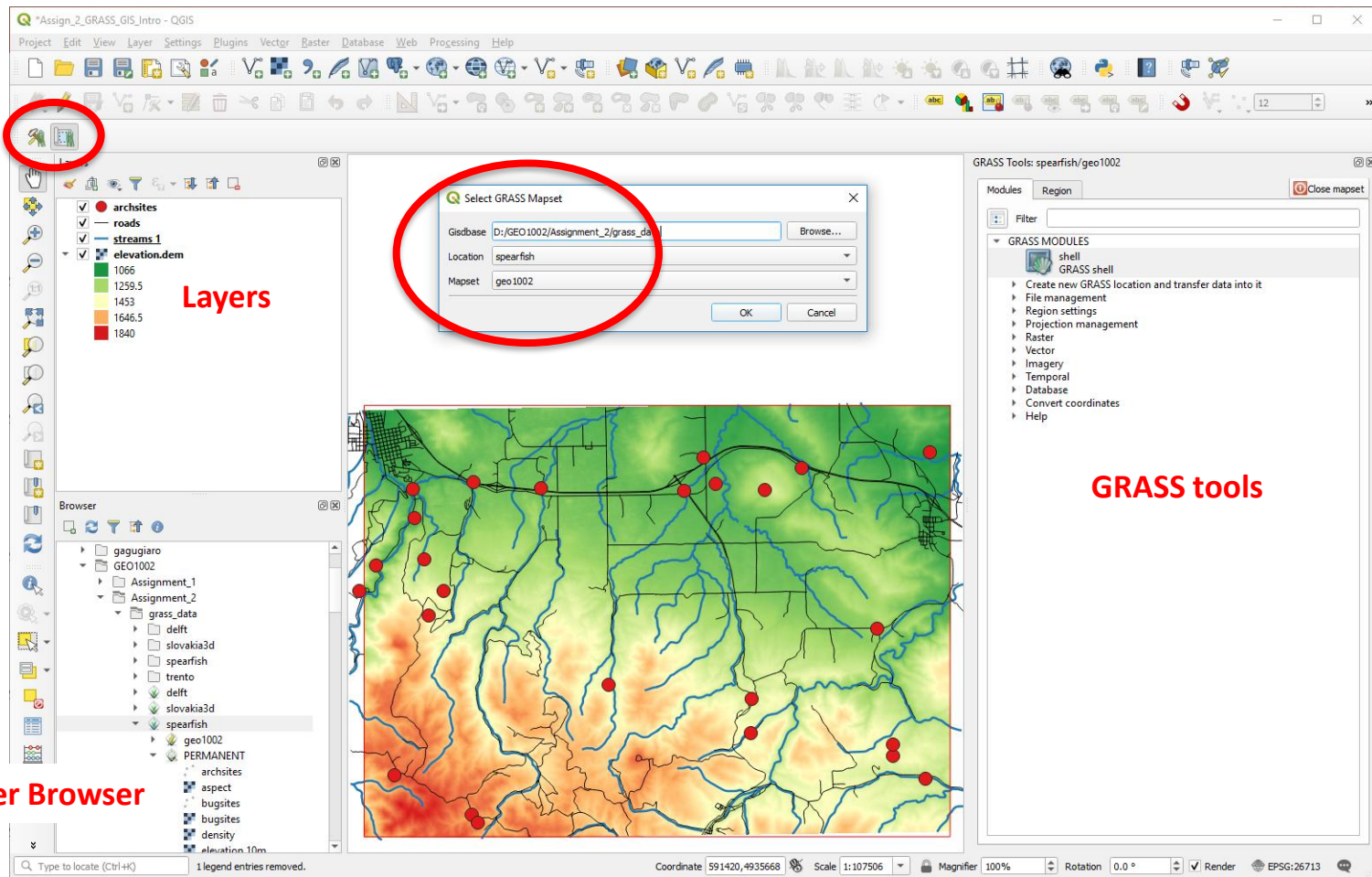
- Check that the GRASS plugin is installed and running!
- Select Plugins\GRASS\Open Mapset to configure GRASS in QGIS

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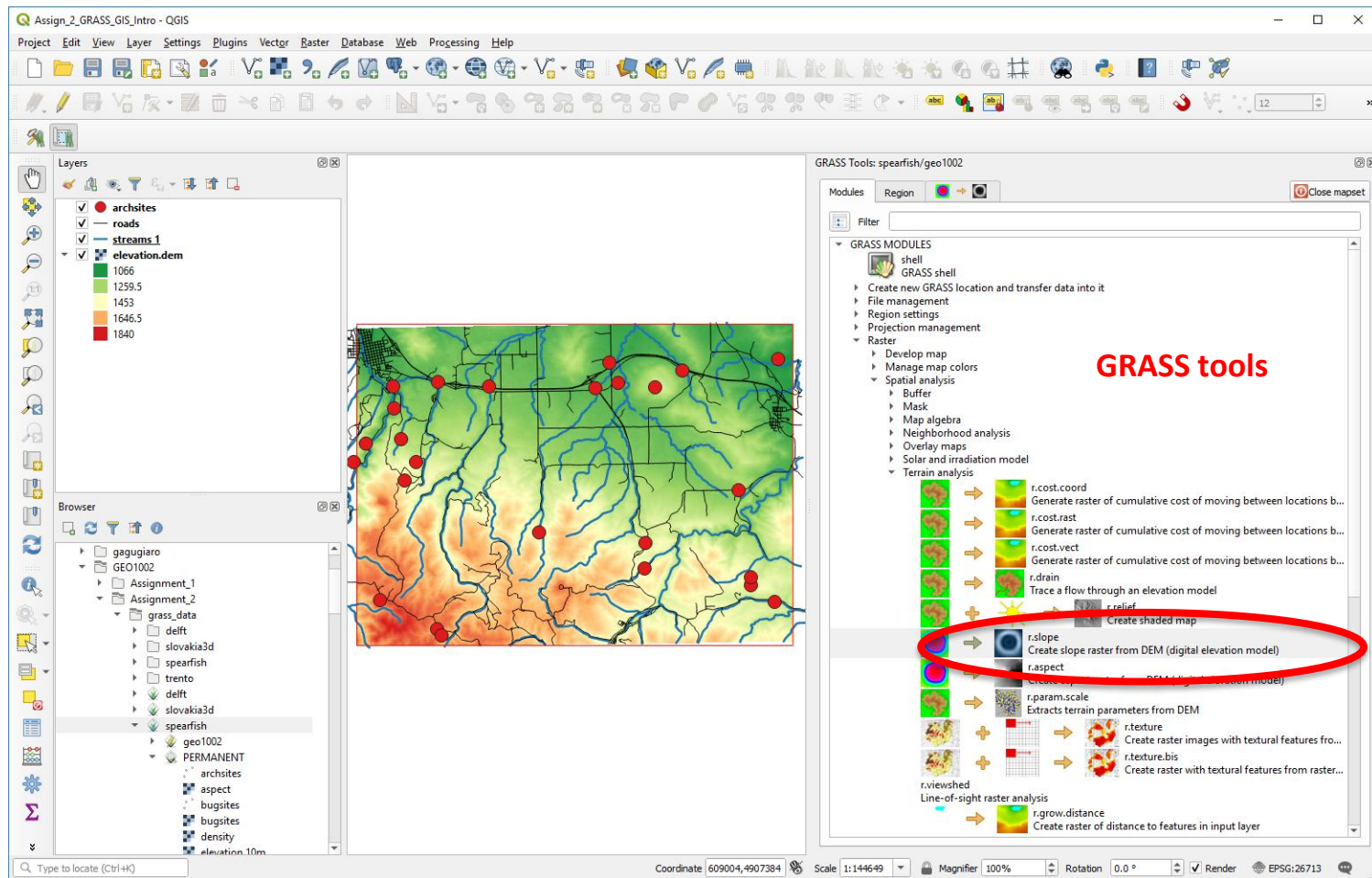


The screenshot shows the QGIS interface with the following components:

- Layers Panel:** Labeled "Layers", it lists several layers: archsites (red circle), roads (black line), streams_1 (blue line), and elevation_dem (green and brown terrain map). The elevation_dem layer is expanded to show values: 1066, 1259.5, 1453, 1646.5, and 1840.
- Select GRASS Mapset Dialog:** A dialog box is open, circled in red. It contains the following fields:
 - Grdbase: D:/GEO1002/Assignment_2/grass_data
 - Location: spearfish
 - Mapset: geo1002
- GRASS Tools Panel:** Labeled "GRASS tools", it shows a list of modules under the "Region" tab. The "shell" module is selected, and its sub-modules are listed:
 - GRASS shell
 - Create new GRASS location and transfer data into it
 - File management
 - Region settings
 - Projection management
 - Raster
 - Vector
 - Imagery
 - Temporal
 - Database
 - Convert coordinates
 - Help
- Layer Browser:** Labeled "Layer Browser", it shows a tree view of the project structure:
 - gagugiaro
 - GEO1002
 - Assignment_1
 - Assignment_2
 - grass_data
 - delft
 - slovakia3d
 - spearfish
 - trento
 - delft
 - slovakia3d
 - spearfish
 - geo1002
 - PERMANENT
 - archsites
 - aspect
 - bugsites
 - bugsites
 - density
 - elevation_10m

Working with GRASS GIS: From QGIS

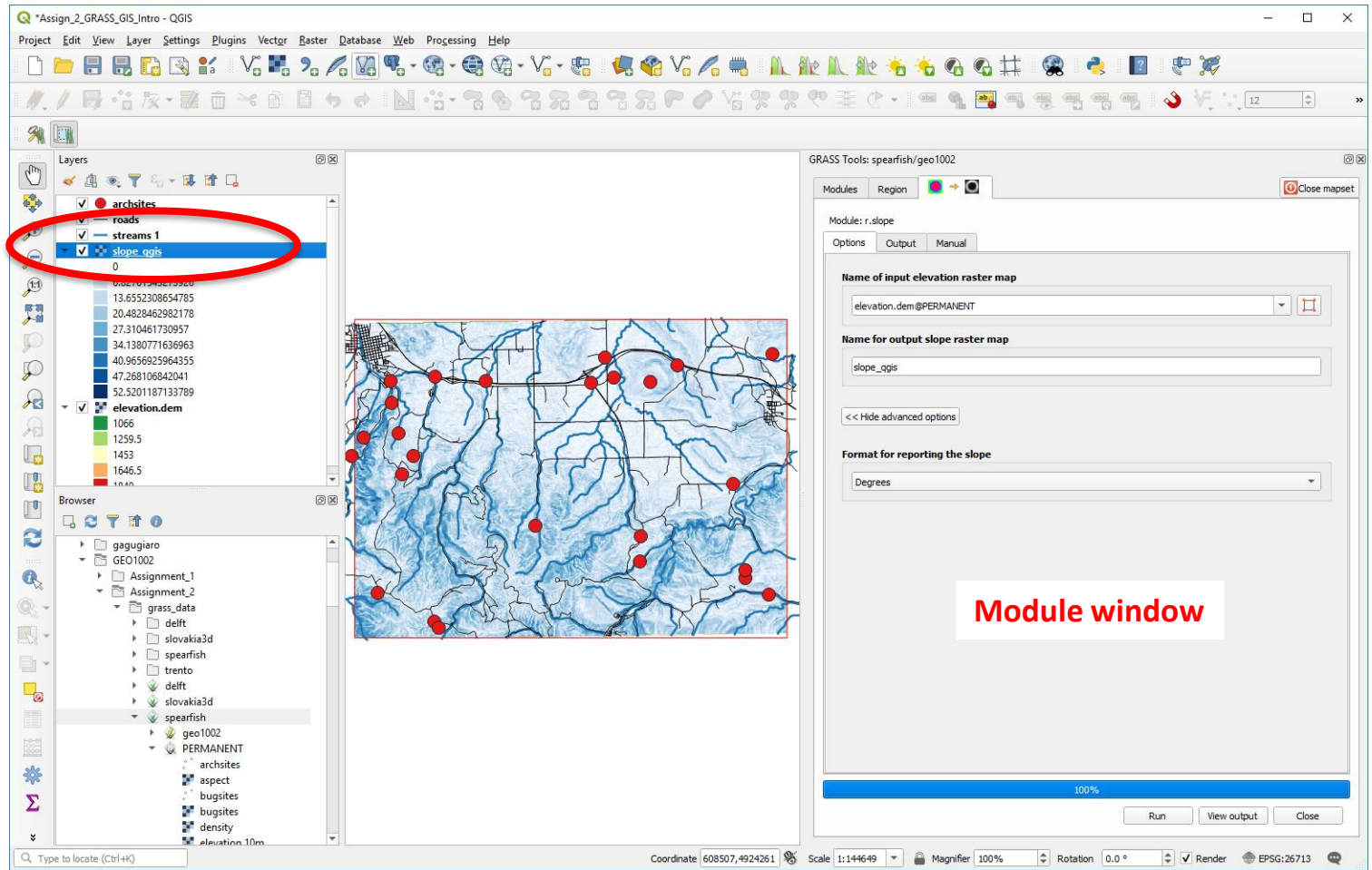
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The screenshot shows the QGIS interface with the GRASS GIS environment. The main map view displays a terrain elevation model with a network of roads and streams. The 'Layers' panel on the left shows the loaded data layers: archsites, roads, streams_1, and elevation.dem. The 'Browser' panel on the bottom left shows the project structure, including the 'PERMANENT' workspace and various data layers. The 'GRASS Tools' panel on the right lists available modules, with 'r.slope' highlighted by a red circle. The status bar at the bottom indicates the coordinate system (EPSG:26713) and scale (1:144649).

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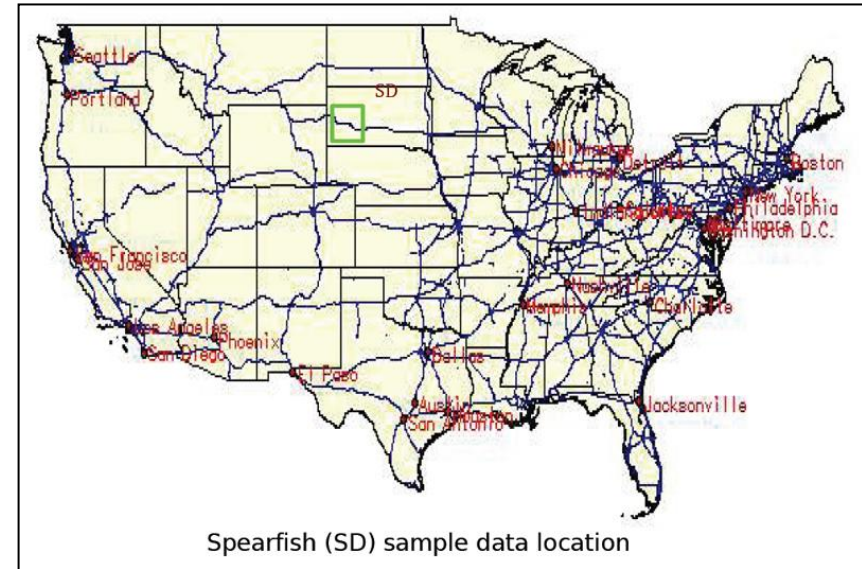


The screenshot displays the QGIS interface with the GRASS Tools window open for the 'r.slope' module. The 'Layers' panel on the left shows a list of layers, with 'slope_qgis' highlighted by a red circle. The 'GRASS Tools' window on the right shows the configuration for the 'r.slope' module, including the input elevation raster map ('elevation_dem@PERMANENT'), the output slope raster map ('slope_qgis'), and the format for reporting the slope ('Degrees'). A red text box labeled 'Module window' is overlaid on the right side of the interface.

GRASS GIS test data

There are many sample datasets to learn GRASS GIS, to “play around” and get used to how the program works. For example:

- **North Carolina**
 - LOTS of data in all formats
- **Spearfish (South Dakota)**
 - Contains raster e vector data
- **Spearfish imagery**
 - contains satellite imagery
- **Slovakia3d**
 - contains grid3d data (voxels)

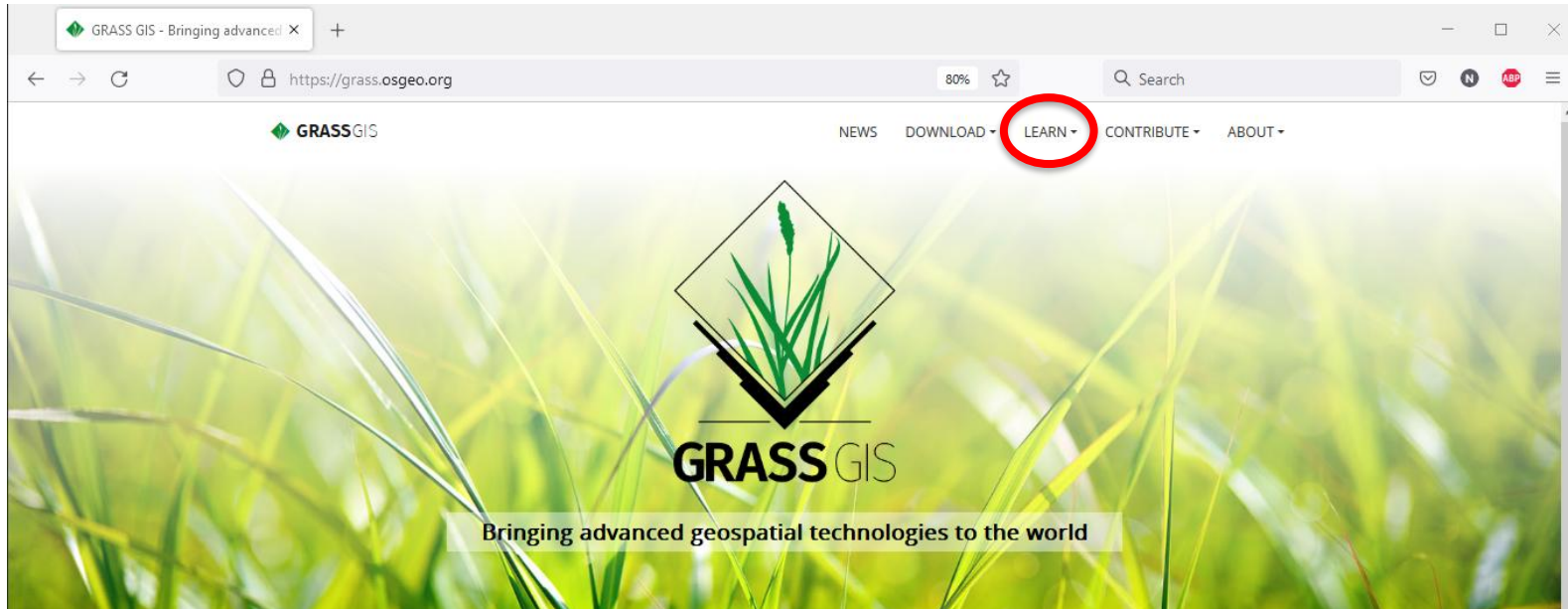


Download from <https://grass.osgeo.org/download/data/>

Help with GRASS GIS

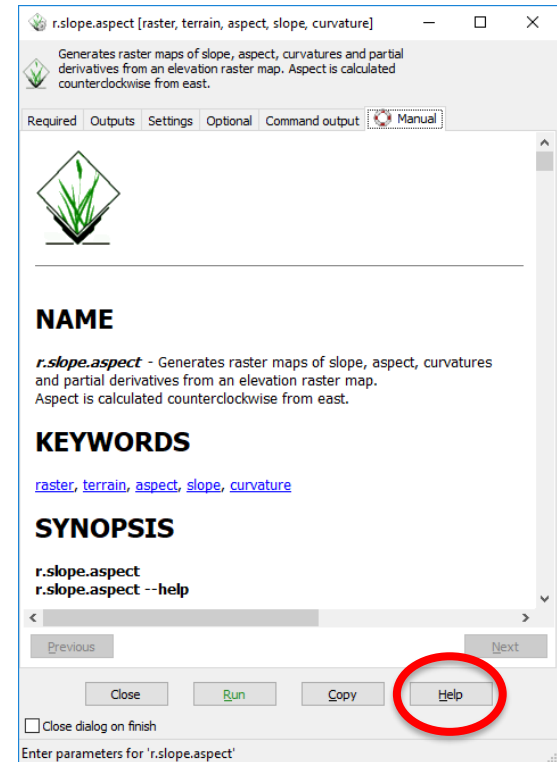
- GRASS GIS **manual**: <https://grass.osgeo.org/learn/manuals/>
- GRASS GIS **wiki**: <https://grasswiki.osgeo.org/wiki/GRASS-Wiki>
- GRASS GIS **tutorials**: <https://grass.osgeo.org/learn/tutorials/>

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Help with GRASS modules

- Run the module name with "--help" or "--h" in the Console window or in the Command shell
 - Example: `r.slope.aspect --help`
- From the module window, click on help button
- Refer to the GRASS online manual, where you find help for each module (see next slide)



Help with GRASS modules

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Quick Introduction

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- [Intro: projections and spatial transformations](#)
- [FAQ - Frequently Asked Questions \(Wiki\)](#)
- [Graphical index of functionality](#)

Graphical User Interface

- [wxGUI](#)
- [wxGUI components](#)
- [wxGUI toolboxes](#)
- [GUI commands](#)

Display

- [Display commands manual](#)
- [Display drivers](#)

General

- [GRASS GIS startup manual](#)
- [General commands manual](#)

Addons

- [Addons manual pages](#)

Programmer's Manual

- [Programmer's Manual](#)

Raster processing

- [Intro: 2D raster map processing](#)
- [Raster commands manual](#)

3D raster processing

- [Intro: 3D raster map \(voxel\) processing](#)
- [3D raster \(voxel\) commands manual](#)

Image processing

- [Intro: image processing](#)
- [Imagery commands manual](#)

Vector processing

- [Intro: vector map processing and network analysis](#)
- [Vector commands manual](#)
- [GRASS ASCII vector format specification](#)

Database

- [Intro: database management](#)
- [SQL support in GRASS GIS](#)
- [Database commands manual](#)

Temporal processing

- [Intro: temporal data processing](#)
- [Temporal commands manual](#)

Cartography

- [PostScript commands manual](#)
- [wxGUI Cartographic Composer](#)

Miscellaneous & Variables

- [Miscellaneous commands manual](#)
- [GRASS variables and environment variables](#)

Python

- [GRASS GIS Python library documentation](#)
- [PyGRASS documentation](#)
- [GRASS GIS in Jupyter Notebooks](#)



Dr. Giorgio Agugiaro

g.agugiaro@tudelft.nl

3D Geoinformation Group

TU Delft

The Netherlands

<https://3d.bk.tudelft.nl/gagugiaro>