

Tutorial for using Lunaserv in QGIS

Lunaserv is a so-called Web Map Service (WMS) that makes it possible to visualize and process data obtained by NASA's Lunar Reconnaissance Orbiter (LRO) satellite and other satellites orbiting the Moon in a simplified manner on the Internet or, as in this case, in the QGIS geographical information system. The LRO satellite has been in orbit around the Moon since its launch in 2009 and collects data from the lunar surface using various instruments. The attached instruments can be used to analyze parameters such as the general condition of the lunar surface, the temperature, possible ice and water deposits, the relief, elevation models and much more from the lunar surface.

The following instructions are intended to help with the implementation of the Lunaserv WMS in QGIS and the associated possibility of using the data from the instruments mentioned.

The following illustrations show the numbers assigned to the steps so that you can find your way through the program more easily.

1. The first step begins with the installation or start of QGIS, the selected geographical information system for processing data with a spatial reference. In general, QGIS is used in particular for analyzing data with an earth reference. However, QGIS can also be used to analyze data related to the Moon. Under this link you will find the current version of QGIS as a download (<https://www.qgis.org/de/site/forusers/download.html>).

After installation, you can start QGIS via the desktop and open a new project, which will be suggested to you immediately after starting the program.

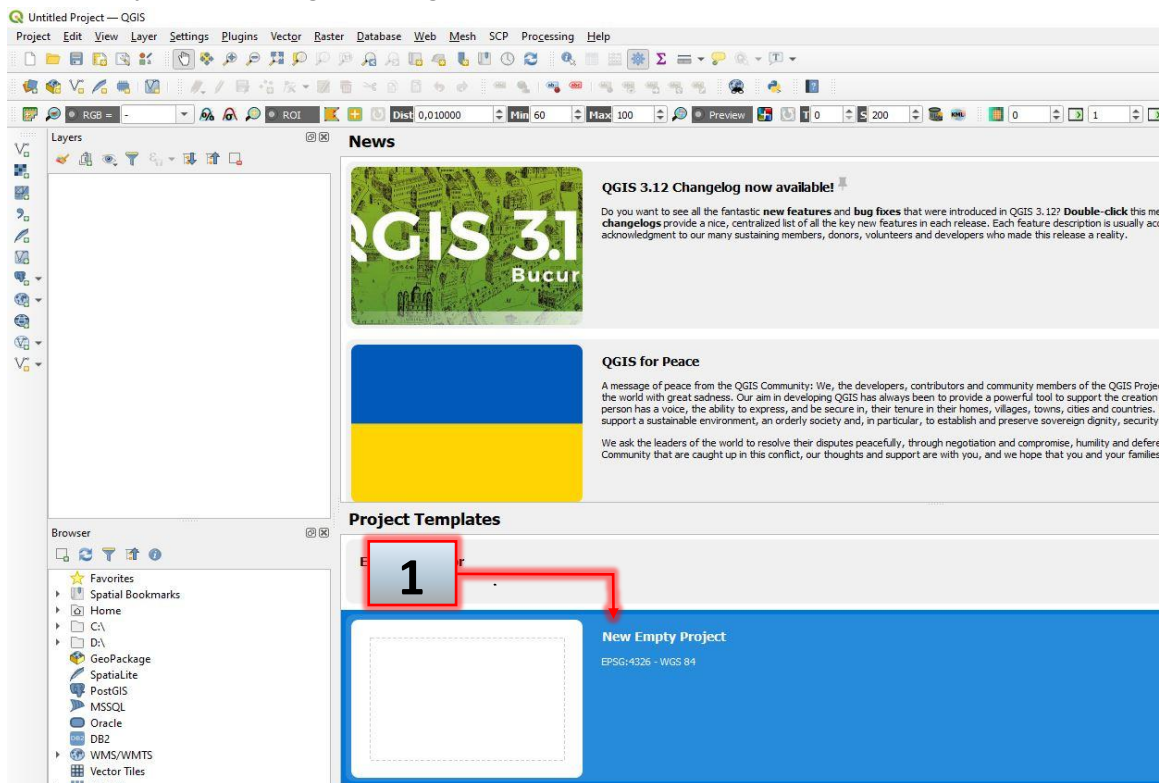


Fig. 1: First steps - QGIS

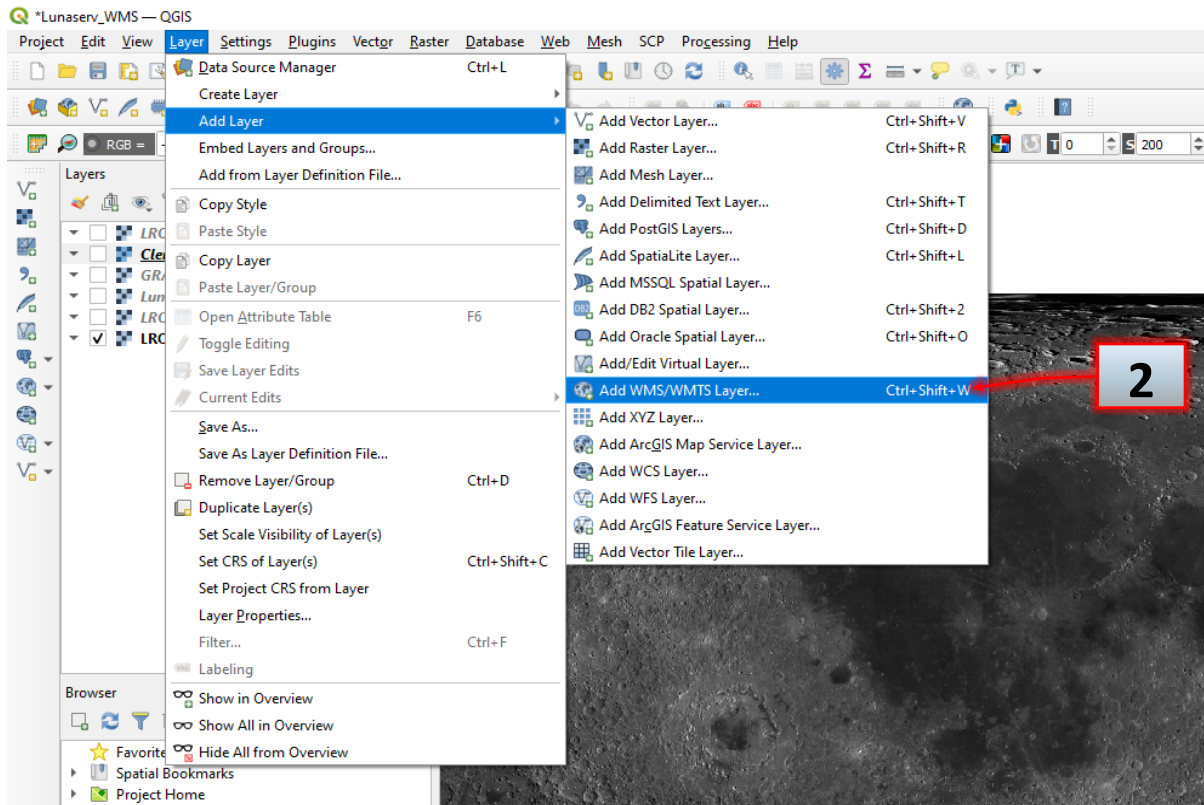


Fig. 2: QGIS overlay and layer integration

2. Once the new project has been started by *double-clicking*, a menu can be selected via the tab "Layer → Add Layer → Add WMS/WMTS Layer" to select a menu that enables the integration of the WMS.

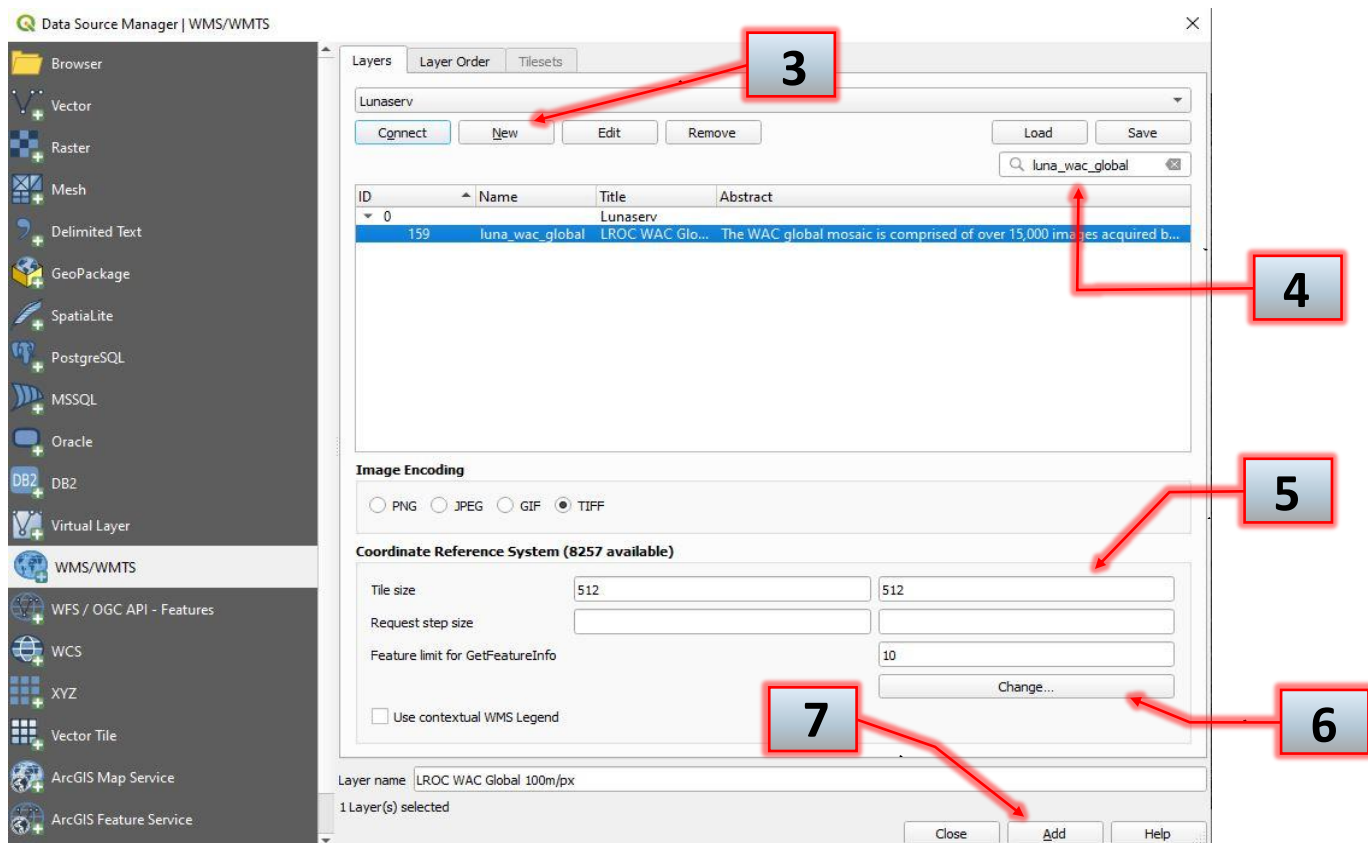


Fig. 3: WMS layer integration

3. In this window, first click on "New" (a new window opens) and enter a name such as "Lunaserv" in the "Name" field and the following address in the URL field: <http://webmap.lroc.asu.edu/>.
You can then confirm with "Ok".
You can then connect the WMS with "Connect".
4. Lunaserv has a large library of layers that visualize the various parameters of the lunar surface. You can select these layers as required using the search field. To begin with, it is recommended that you first select the standard layer of the Moon (true color representation of the lunar surface). This can be found via "luna_wac_global". After the search entry, this can be clicked once in the list below and is then selected.
5. In the "tile size" fields, "512" should be entered in both fields (left and right).
6. Before adding the layer, you should ensure that the correct reference system is selected. This ensures that each point on the Moon is assigned to a correct coordinate. This can be changed at the bottom right via "Change". If it is not already set, "WGS 84 (EPSG 4326)" should be selected for the first loading of each layer. However, this must be adjusted later (mentioned later).
7. The layer can then be added via "Add" and the pop-up window closes via "Close".
8. The layer should now be displayed in the *Layers box* in QGIS on the left. It is available as a flat map and represents the entire surface of the Moon.
9. As already mentioned, Lunaserv has numerous different layers that can be selected according to your own interests via the pop-up window mentioned above. This should be done individually for each layer. Further examples are
 - "LROC WAC Color Shaded Relief" - shows relief structures of the Moon using a color scale (white/red = steep relief; blue = flat relief).
 - "Lunar Nomenclature" - shows the different lunar area designations.
 - "GRAIL Crustal Thickness" - visualizes the different thicknesses of the lunar crust (see Fig. 5).
 - "Clementine Elevation Map" - shows the global differences in elevation of the lunar surface (red = high mountains; blue = lowlands or craters).
 - "LROC WAC TiO₂ Abundance Color" - shows the different occurrences of titanium dioxide / rutile on the Moon in color.

The different layers can be easily selected using the search field:

https://wms.lroc.asu.edu/lroc/rdr_product_select | <http://webmap.lroc.asu.edu/lunaserv.html>

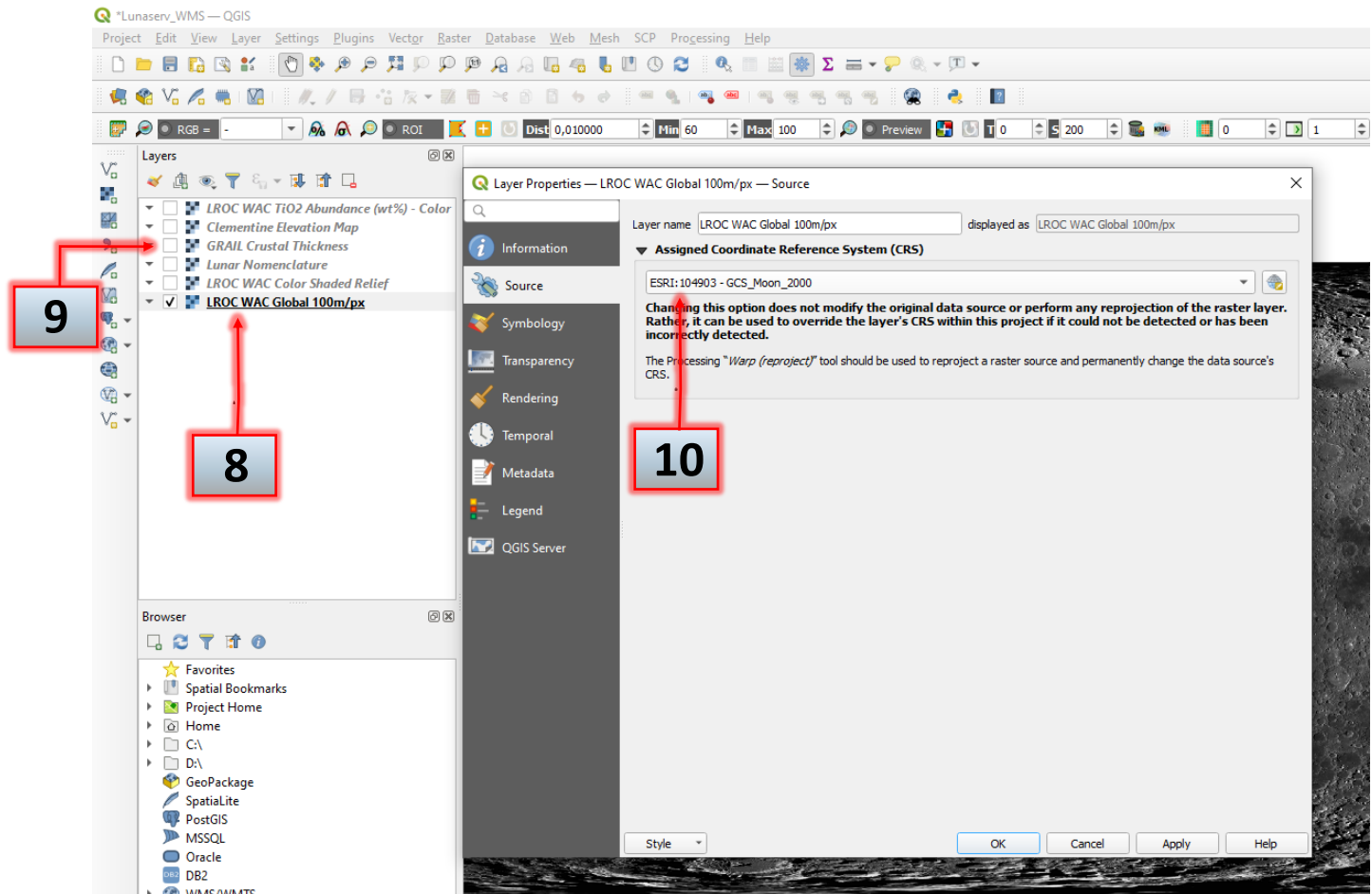


Fig. 4: Reference system "Moon 2000"



10. It is now important to check that all layers are displayed in the correct reference system. Two things should be checked for this. First, the reference system defined for the project can be selected in the bottom right-hand corner of the QGIS overlay. "Moon 2000" (ESRI: 104903) should be used here. In addition, the specified reference system should also be set for each layer by *double-clicking* in the Layers box, then "Source" to set up the mentioned reference system which should be applied with "Apply". You can also obtain further information on the selected layer via "Information" by scrolling down and clicking on "Selected Layer".

The following figure shows the "Crustal Thickness" layer which displays the thickness of the lunar crust from red (>60 km thickness) to blue (<10 km thickness) as an example for the selection of Lunaserv layers (see below).

You can show or hide the various layers that are now displayed in the list on the left (see Fig. 4 (9)) using the check mark. Also remember to save the project (diskette symbol top left).

Tasks are also provided for using the various layers.

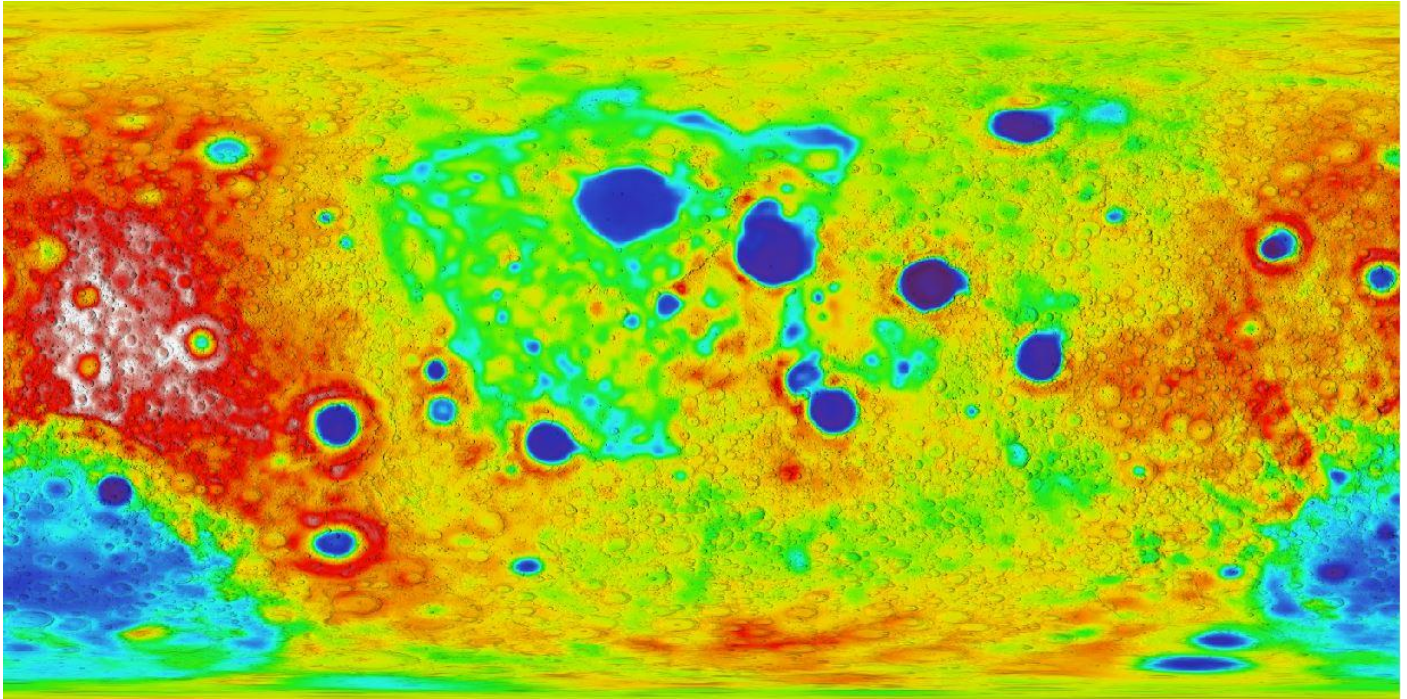


Fig. 5: „GRAIL Crustal Thickness“ Moon layer