

```
882 #' # the three output rasters are returned in a list of length 3
883 #' terrain
884 #' }
885
886 run_qgis <- function(alg = NULL, ..., params = NULL, load_output = FALSE,
887                     show_output_paths = TRUE, qgis_env = set_env()) {
888
889   # check if the QGIS application has already been started
890   tmp <- try(expr = open_app(qgis_env = qgis_env), silent = TRUE)
```

Integrating R with GIS for Statistical Geocomputing

Jannes Muenchow

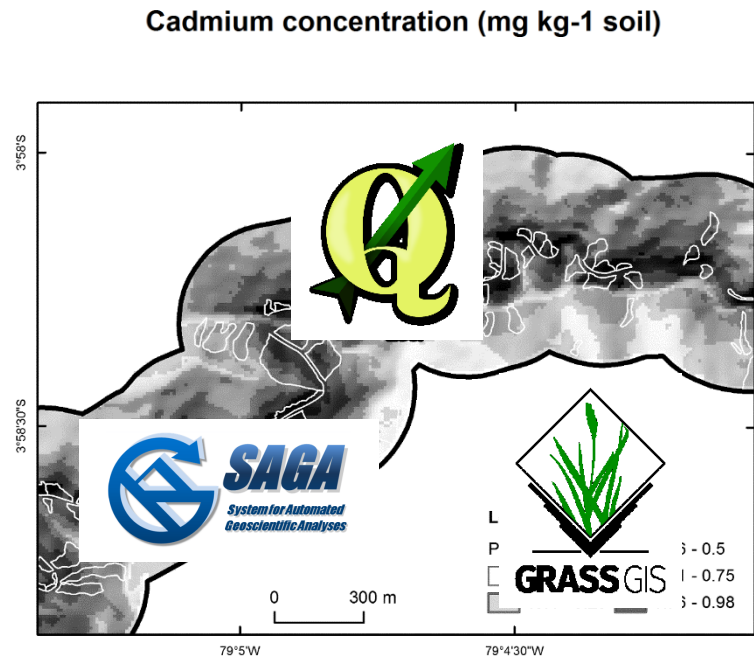


Contents



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1. R as a GIS
2. R-GIS bridges
3. R/GIS use cases
4. RQGIS, RSAGA, rgrass7



Brenning et al. (2015): landslide susceptibility near highways.

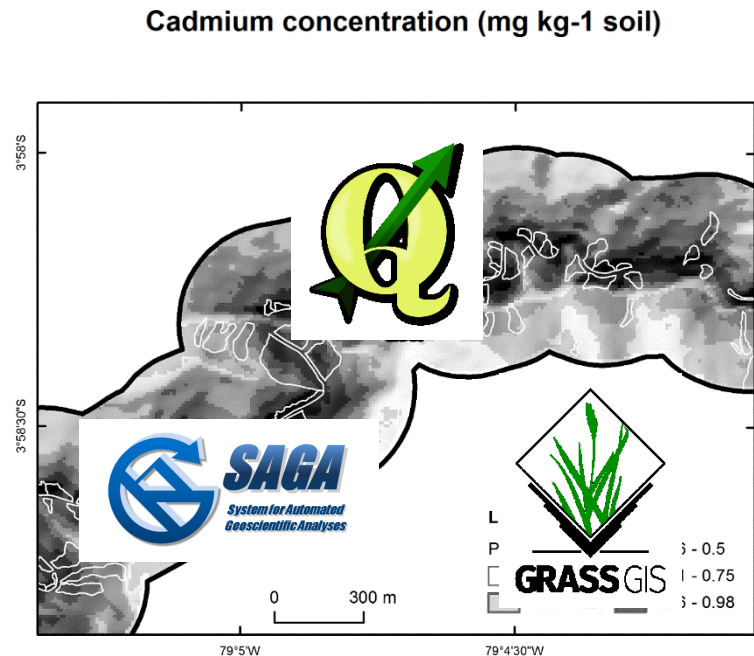
Data: Rikken, M.G.J & Van Rijn, R.P.G. (1993).

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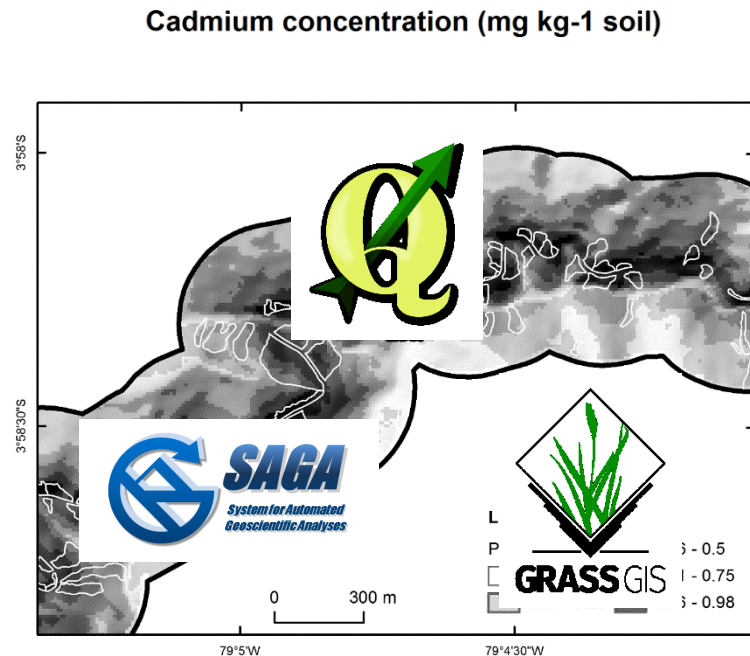
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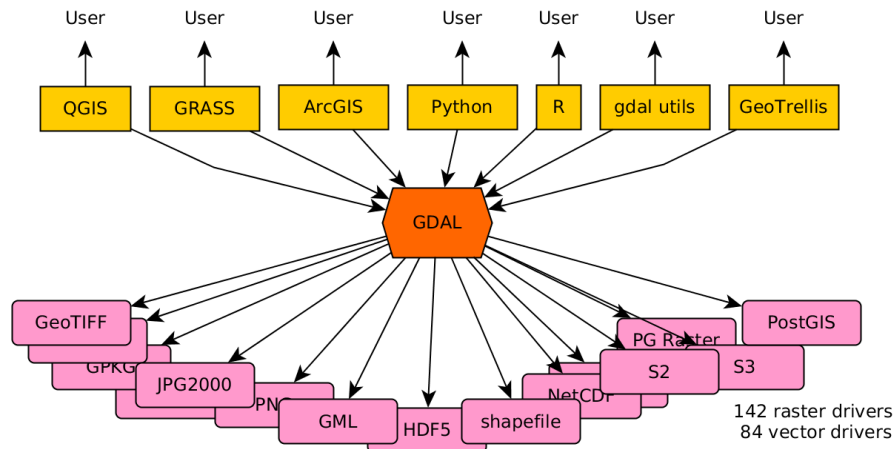
R AS A GIS



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R as a GIS

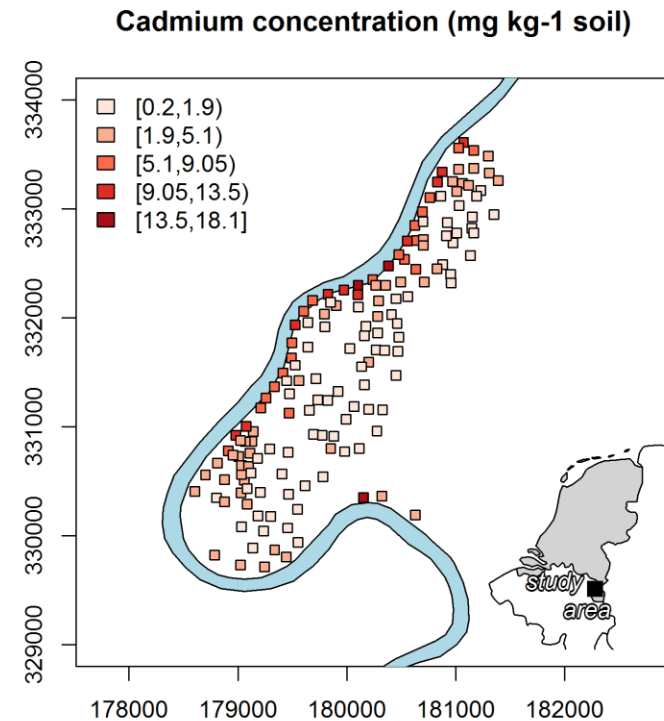
- More than 100 geo-related R packages (<https://cran.r-project.org/web/views/Spatial.html>)
- Package **rgdal** for importing and exporting geodata



<http://r-spatial.org/2016/11/29/openeo.html>

R as a GIS

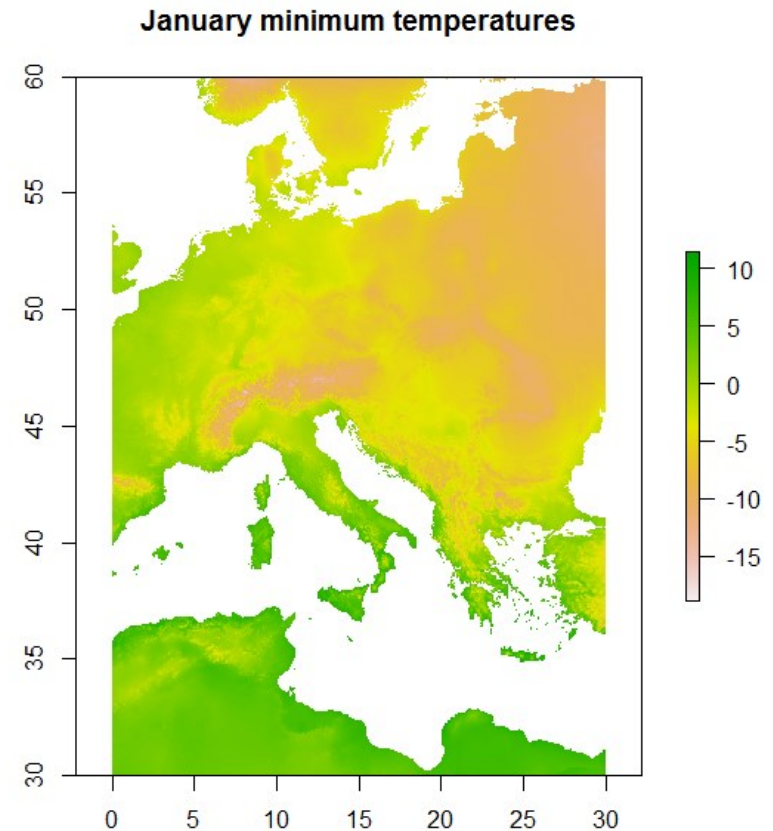
- More than 100 geo-related R packages (<https://cran.r-project.org/web/views/Spatial.html>)
- Package **rgdal** for importing and exporting geodata
- Packages **sp** and **sf** for vector geodata



Data: Rikken, M.G.J & Van Rijn, R.P.G. (1993).

R as a GIS

- More than 100 geo-related R packages (<https://cran.r-project.org/web/views/Spatial.html>)
- Package **rgdal** for importing and exporting geodata
- Packages **sp** and **sf** for vector geodata
- Package **raster** for raster geodata



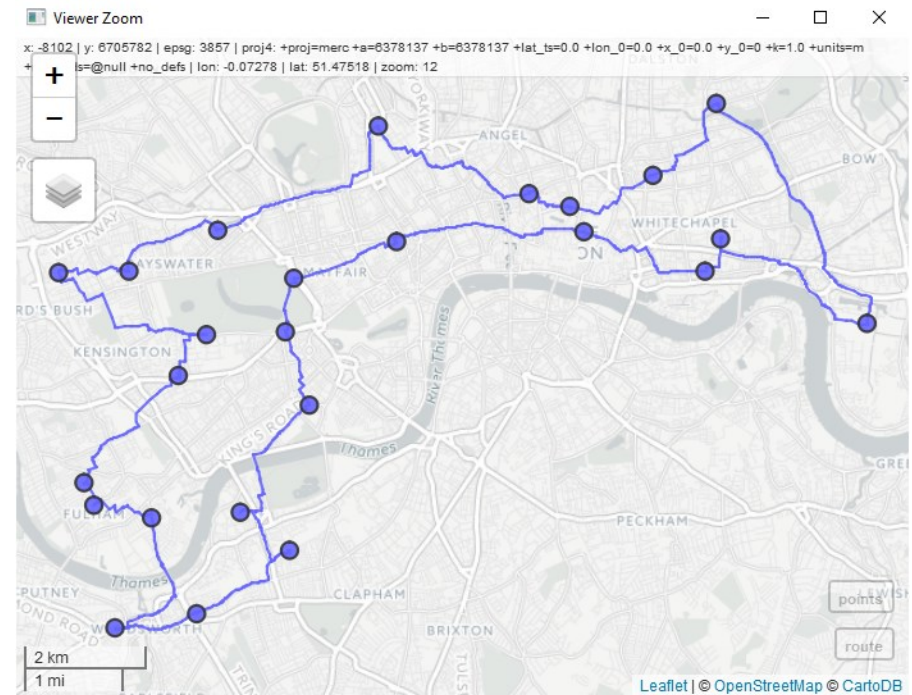
Data: <http://www.worldclim.org/>.

Interactive map handling



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- Interactive visualization through **mapview** (based on **leaflet**)



R as a GIS



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Defining a GIS as a system for the analysis, manipulation and visualization of geographical data (Longley, Goodchild, Maguire, and Rhind 2011), one could argue that R has become a GIS

But what about...



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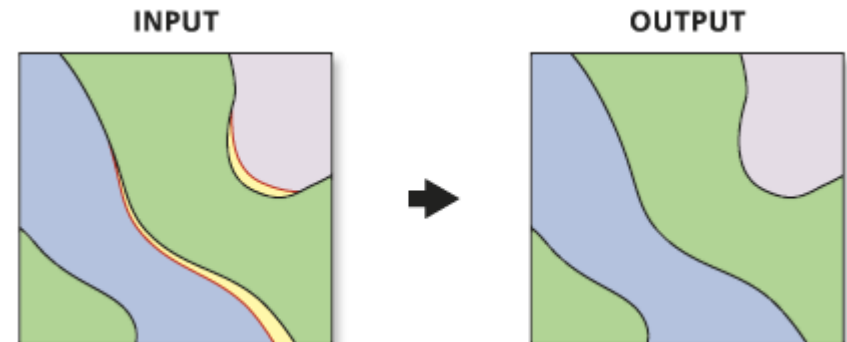


(digitizing)



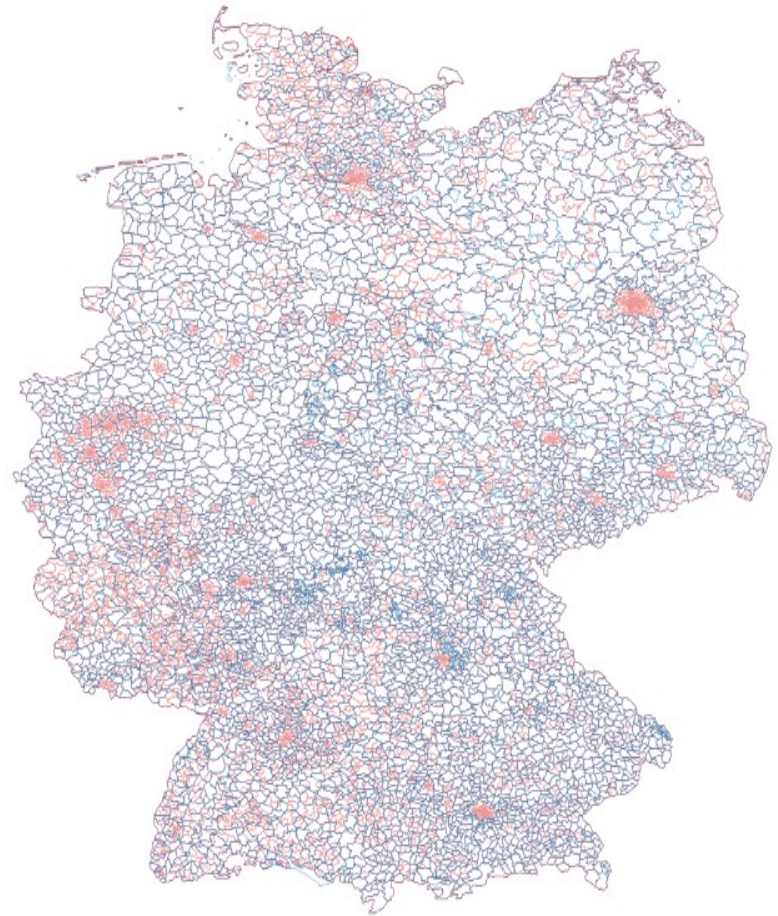
(Geodatabase-functionality
and topology rules)

<http://www.unioneag.org>



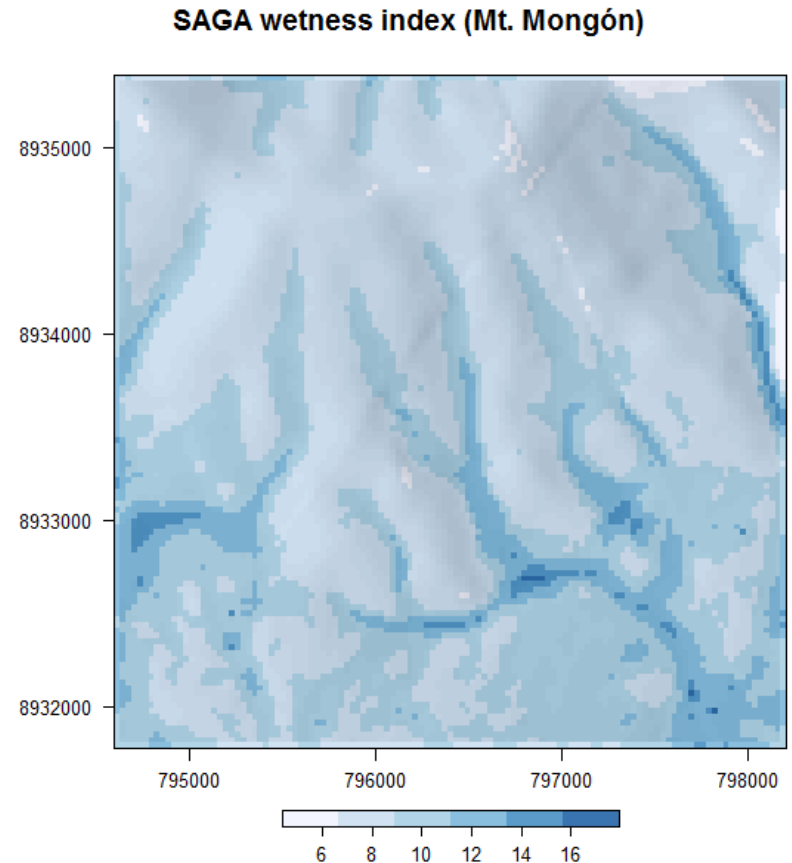
Computationally demanding operations

- Computationally demanding operations



Missing geoalgorithms

- Catchment area
- Catchment slope
- Saga Wetness Index
- Lidar processing
- ...



Interface



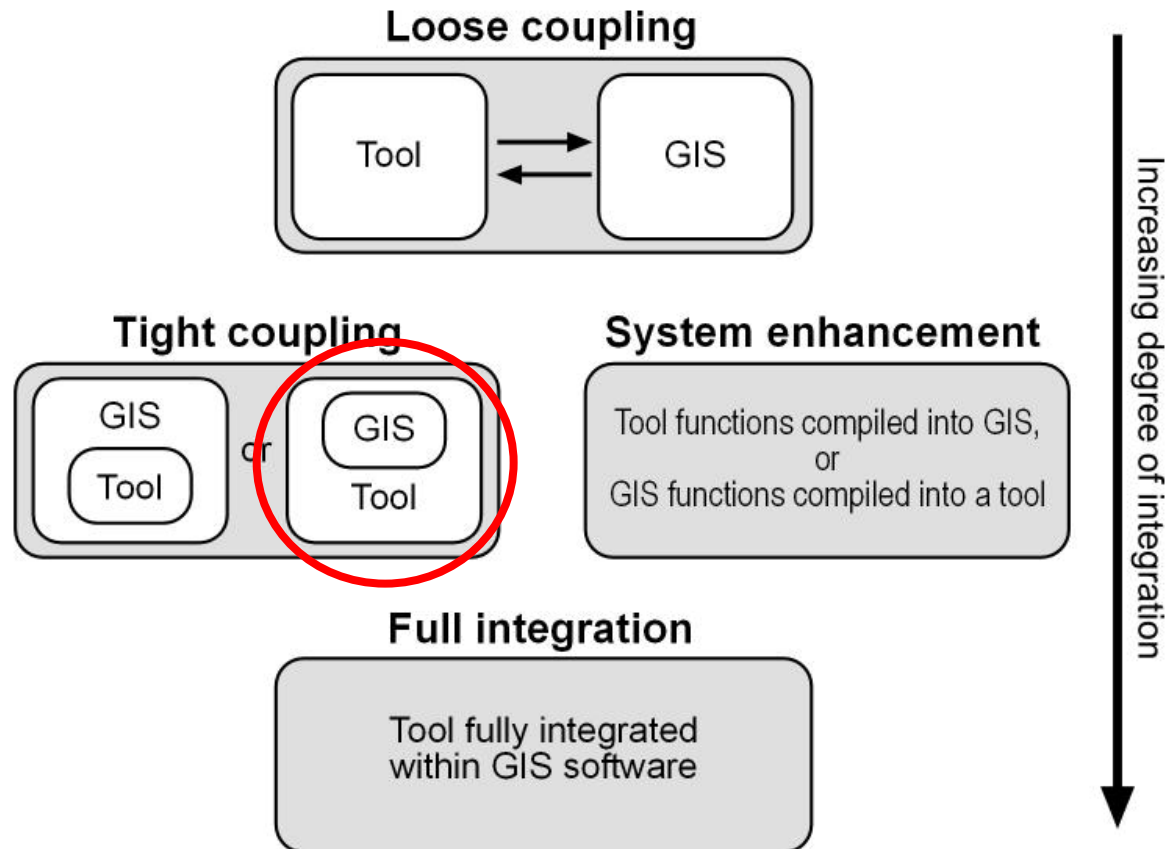
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R has been designed from the beginning as an interactive interface to other software packages (Chambers, 2016).

GIS interfaces



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<http://www.geocomputation.org/2000/GC009/Gc009.htm>

R-GIS bridges



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RSAGA



RQGIS



GRASS GIS

rgrass7



RPyGeo

GIS-R bridges



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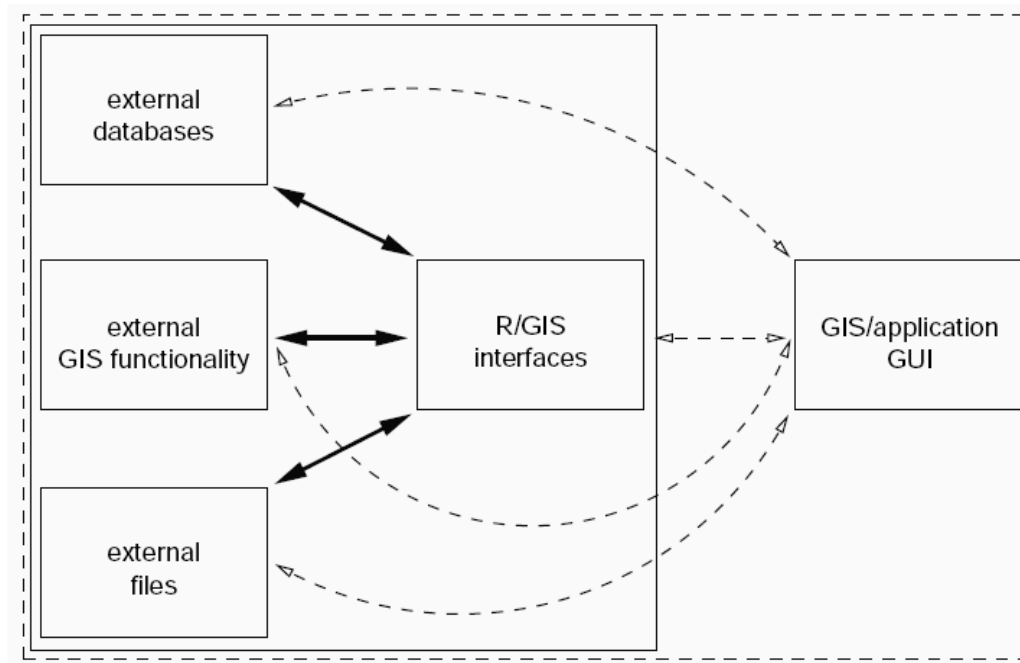


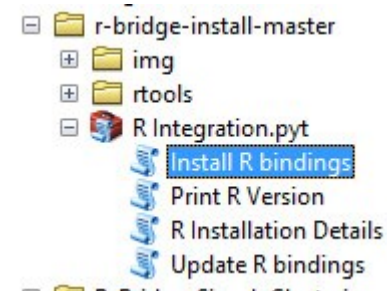
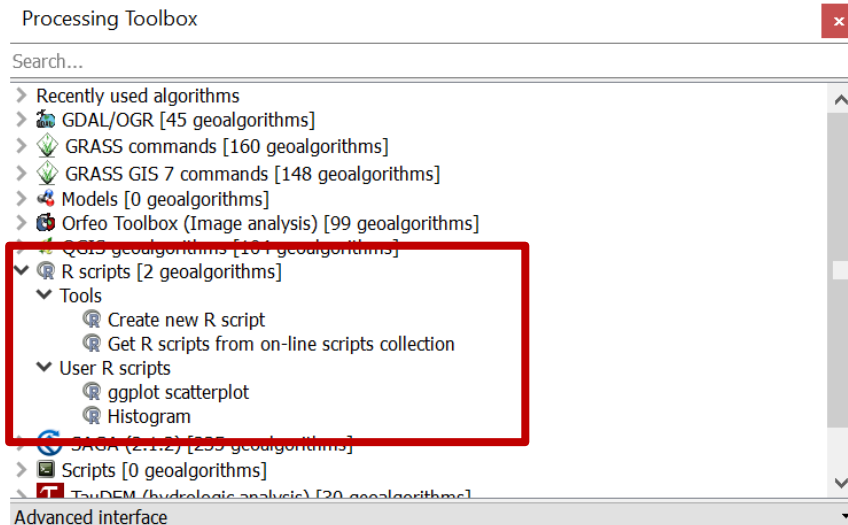
Figure taken from Roger Bivand's GeoStats 2016 presentation:

http://spatial.nhh.no/misc/geostat_talk16.zip

GIS-R bridges – QGIS & ArcGIS



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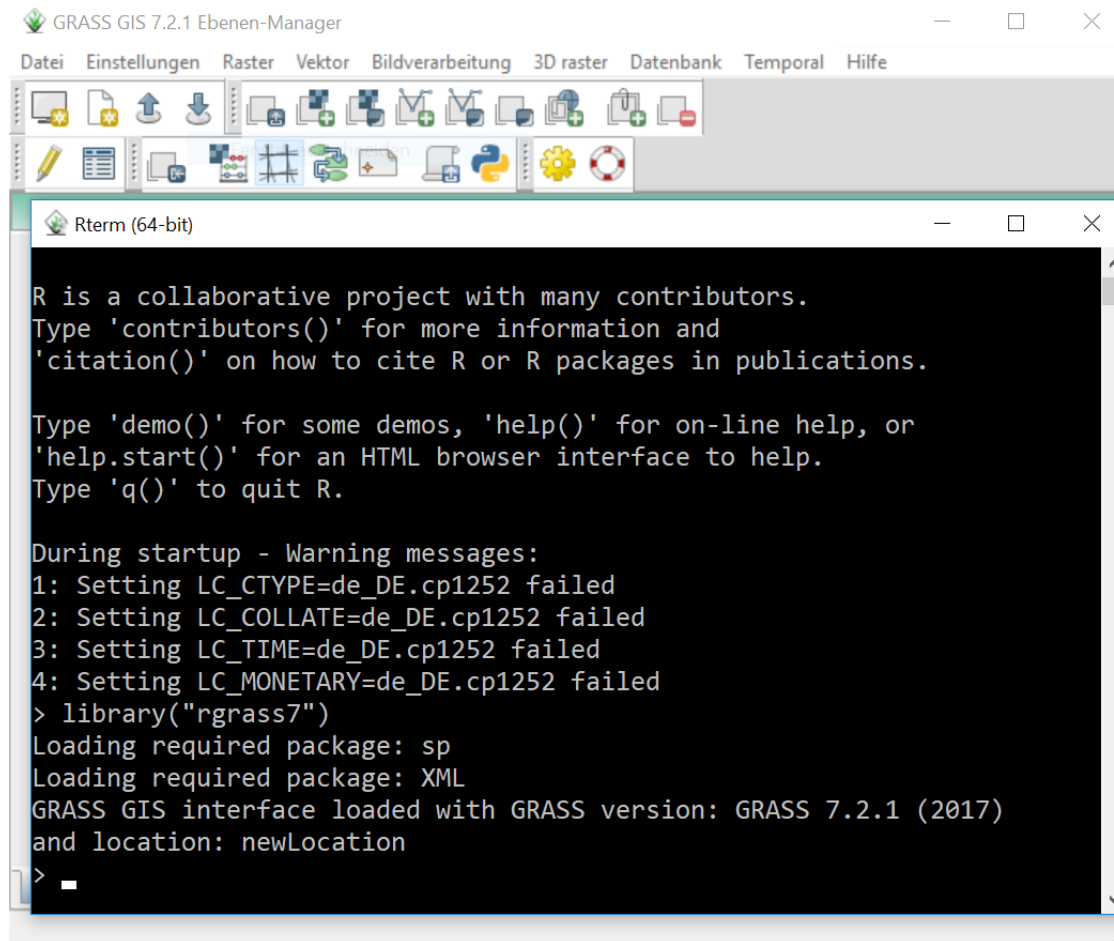


<https://www.r-bloggers.com/combining-arcgis-and-r-clustering-toolbox/>

GIS-R bridges - GRASS



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A screenshot of the GRASS GIS 7.2.1 Ebenen-Manager window. The window has a menu bar with 'Datei', 'Einstellungen', 'Raster', 'Vektor', 'Bildverarbeitung', '3D raster', 'Datenbank', 'Temporal', and 'Hilfe'. Below the menu bar is a toolbar with various icons. The main area of the window is a black terminal window titled 'Rterm (64-bit)'. The terminal displays the following text:

```
R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.  
  
Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.  
  
During startup - Warning messages:  
1: Setting LC_CTYPE=de_DE.cp1252 failed  
2: Setting LC_COLLATE=de_DE.cp1252 failed  
3: Setting LC_TIME=de_DE.cp1252 failed  
4: Setting LC_MONETARY=de_DE.cp1252 failed  
> library("rgrass7")  
Loading required package: sp  
Loading required package: XML  
GRASS GIS interface loaded with GRASS version: GRASS 7.2.1 (2017)  
and location: newLocation  
> █
```



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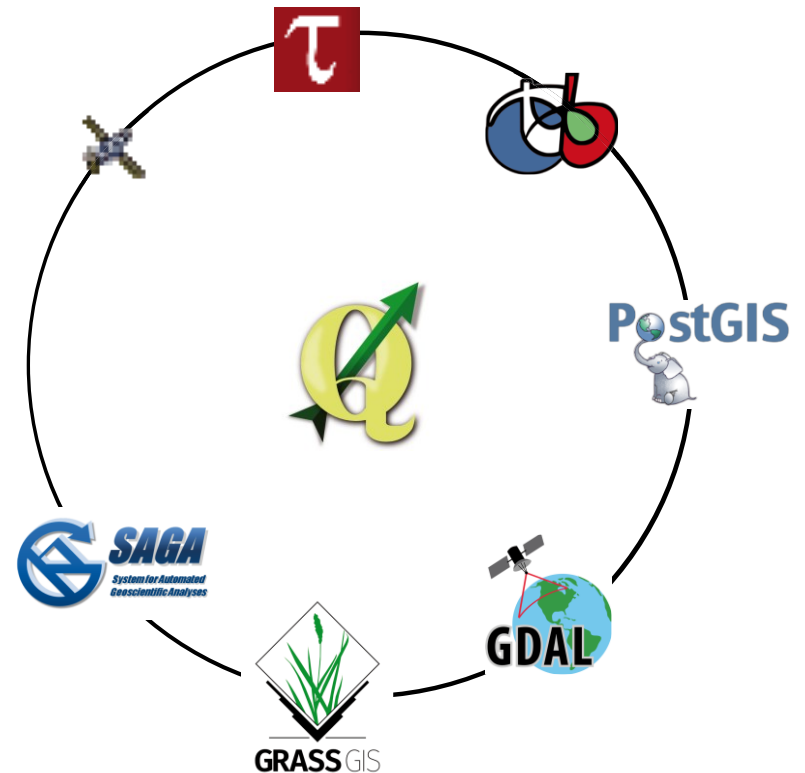
R-GIS BRIDGES

Why (R)QGIS?



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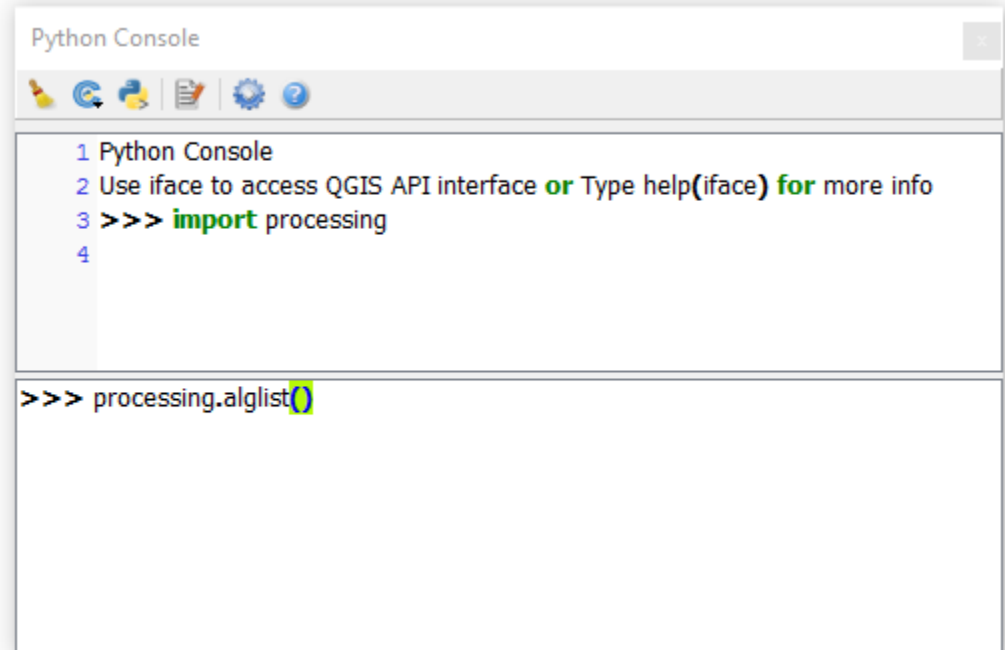
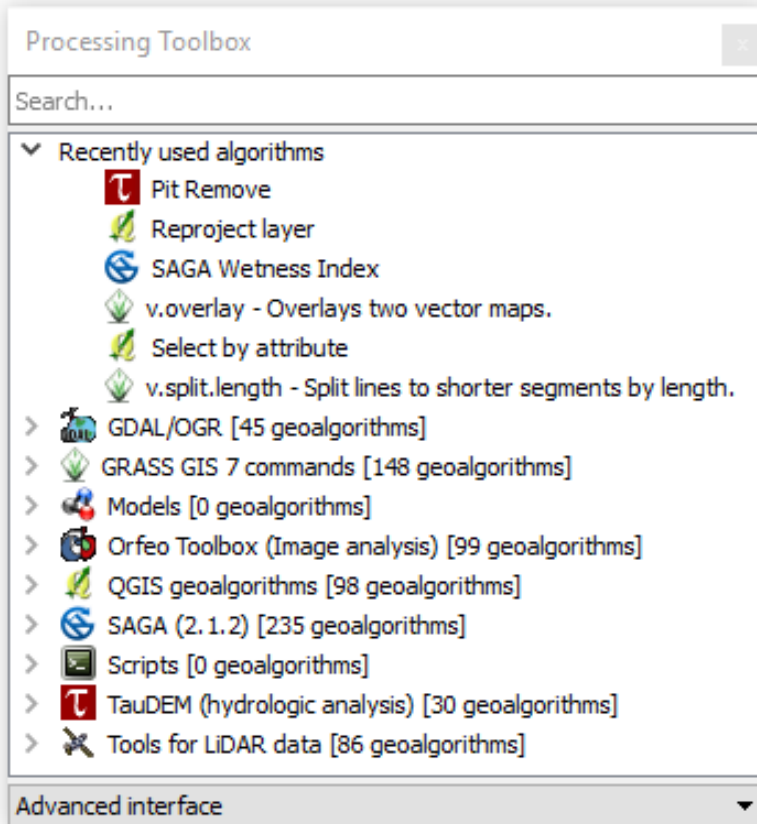
- One of the most-widely used Desktop GIS
- Unified interface
- Quite user-friendly



QGIS – Python API



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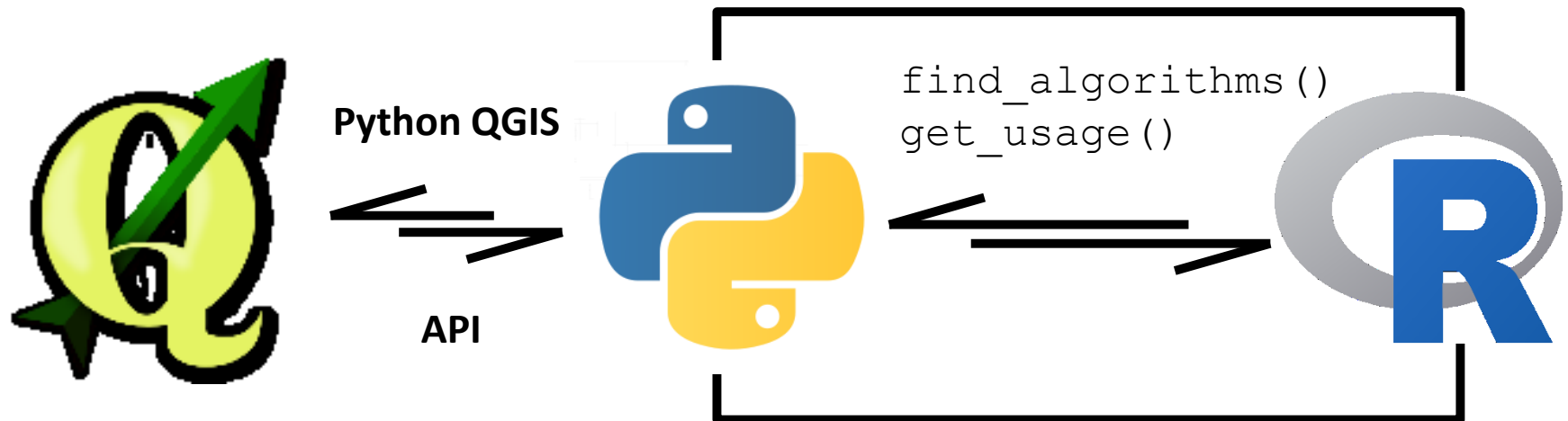


Python tunnel via reticulate



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Python tunnel via **reticulate** (`open_app()`)





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Example

```
library("RQGIS")  
get_usage("saga:sagawetnessindex")
```

```
ALGORITHM: Saga wetness index  
  DEM <ParameterRaster>  
  SUCTION <ParameterNumber>  
  AREA_TYPE <ParameterSelection>  
  SLOPE_TYPE <ParameterSelection>  
  SLOPE_MIN <ParameterNumber>  
  SLOPE_OFF <ParameterNumber>  
  SLOPE_WEIGHT <ParameterNumber>  
  AREA <OutputRaster>  
  SLOPE <OutputRaster>  
  AREA_MOD <OutputRaster>  
  TWI <OutputRaster>
```

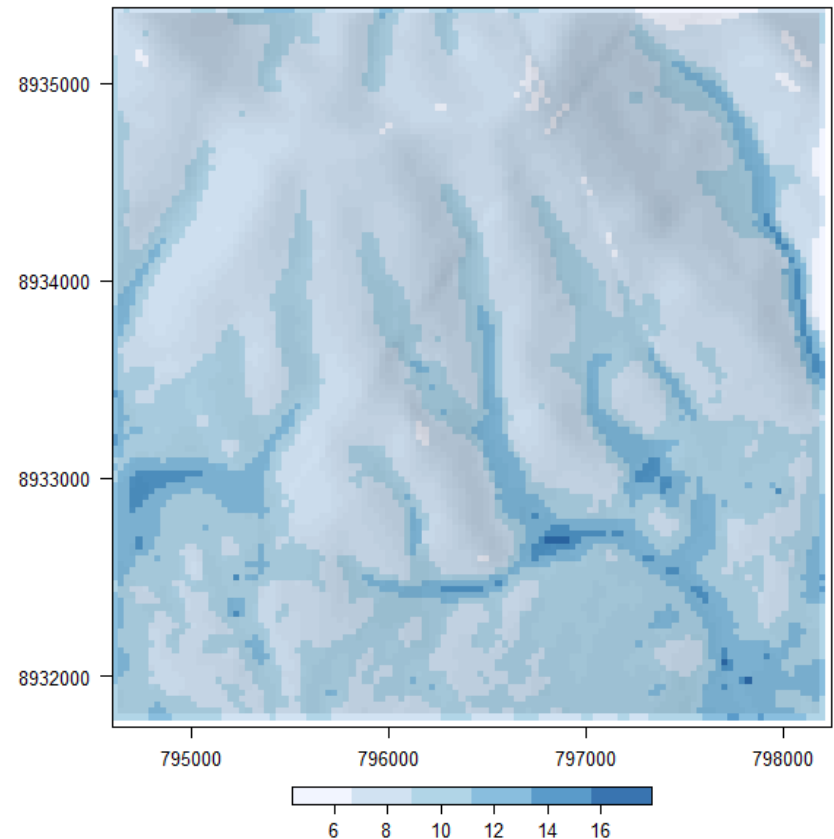
```
open_help("saga:sagawetnessindex")
```


Let's run_qgis



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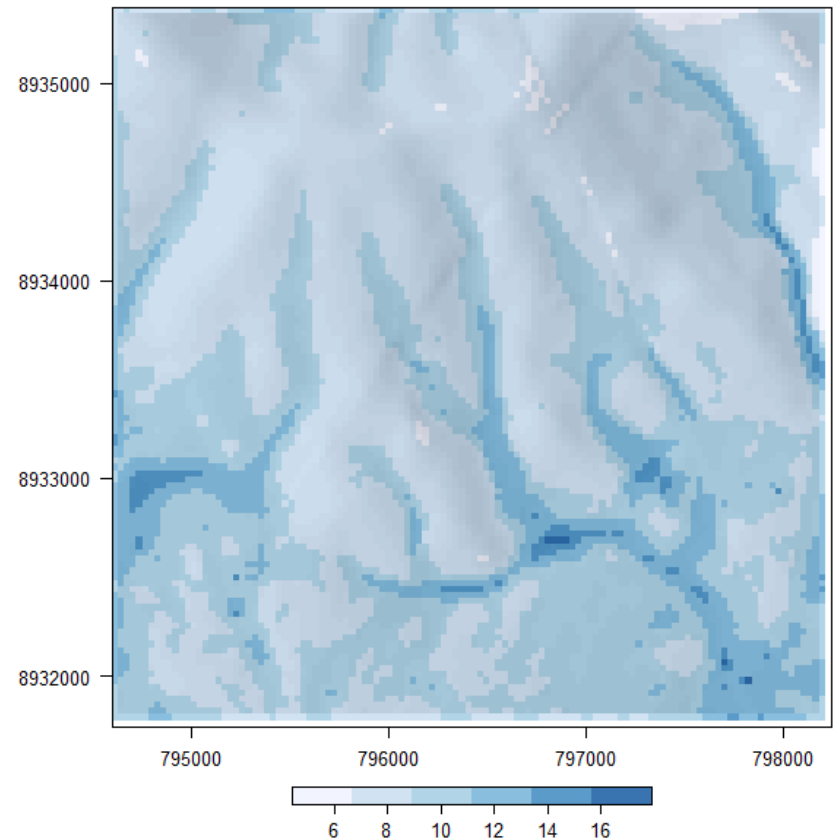
```
data("dem")
twi <- run_qgis(
  "saga:sagawetnessindex",
  DEM = dem,
  TWI = "twi.tif",
  load_output = TRUE)
```



Let's run_qgis

Spatial object residing
in R

```
data("dem")  
twi <- run_qgis(  
  "saga:sagawetnessindex",  
  DEM = dem,  
  TWI = "twi.tif",  
  load_output = TRUE)
```

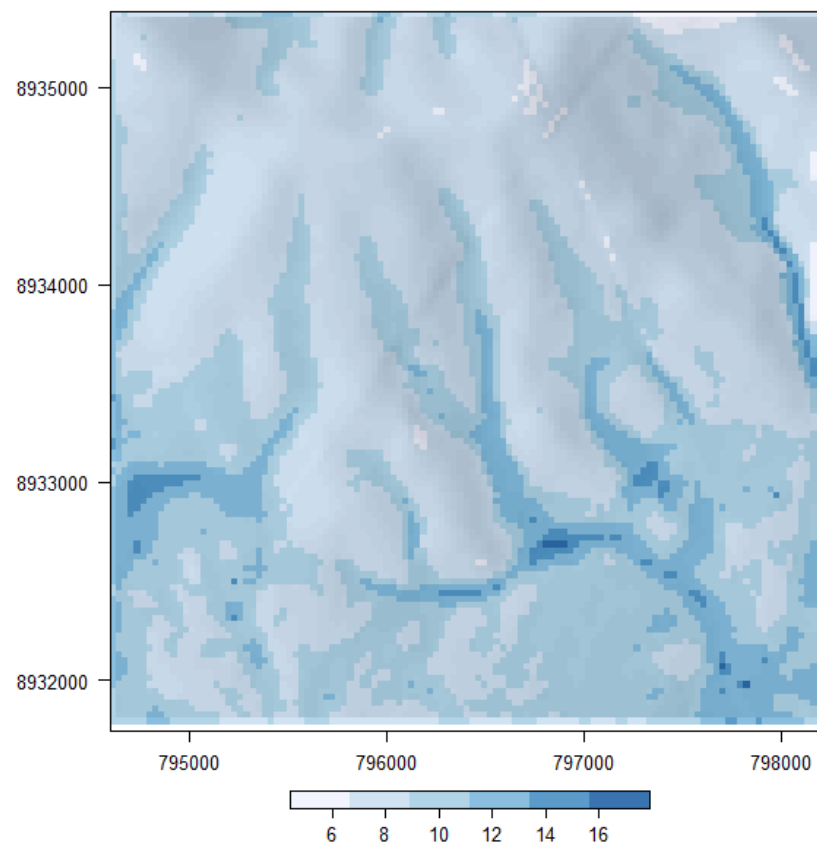


Let's run_qgis

Spatial object residing
in R

```
data("dem")  
twi <- run_qgis(  
  "saga:sagawetnessindex",  
  DEM = dem,  
  TWI = "twi.tif",  
  load_output = TRUE)
```

Loads automatically the QGIS output
back into R



(R)SAGA



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- First SAGA release in 2004
- Also open-source
- Started out with a focus on raster processing



RSAGA



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RSAGA interface

- The RSAGA package provides R geocomputing functions that make use of the command line interface of SAGA GIS, `saga_cmd.exe`, to execute SAGA GIS modules.

```
#####  ##  #####  ##  
###      ##  ##      ###  
###   #  ##  ##  #####  #  ##  
      ### #####  ##      # #####  
##### #    ##  ##### #    ##
```

SAGA Version: 2.1.2 (64 bit)

under GNU General Public License (GPL)

Usage:

`saga_cmd [-h, --help]`

`saga_cmd [-v, --version]`



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RSAGA structure

Geoprocessing environment

- List data structure with information on working directory, location of SAGA GIS binaries, etc.

Geoprocessor (using SAGA GIS)

- Workhorse that calls SAGA GIS and provides low-level access to all SAGA GIS modules

User-level interface functions (using SAGA GIS):

- e.g., `rsaga.local.morphometry`, `rsaga.hillshade`

Local and focal functions (written in R):

- e.g., `multi.focal.function`, `grid.predict`

Utility functions (written in R):

- e.g., `pick.from.ascii.grid`

The R-GRASS interface



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- First released in 1984
- In the beginning developed by the US Army (1982 – 1995), also with a focus on raster processing
- Since 1997 developed by scientists



rgrass7



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- Use ASDAR -> show .exe files

If you want to know more...

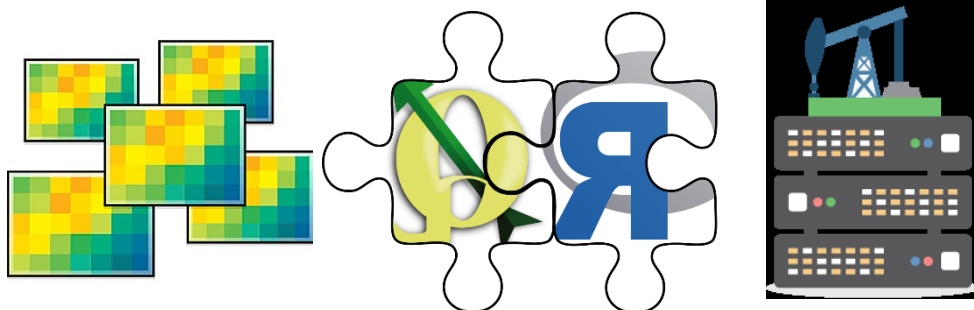


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- <http://robinlovelace.net/geocompr/>
- <https://github.com/jannes-m/geocompr/blob/master/13-gis.Rmd>



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R-GIS EXAMPLES



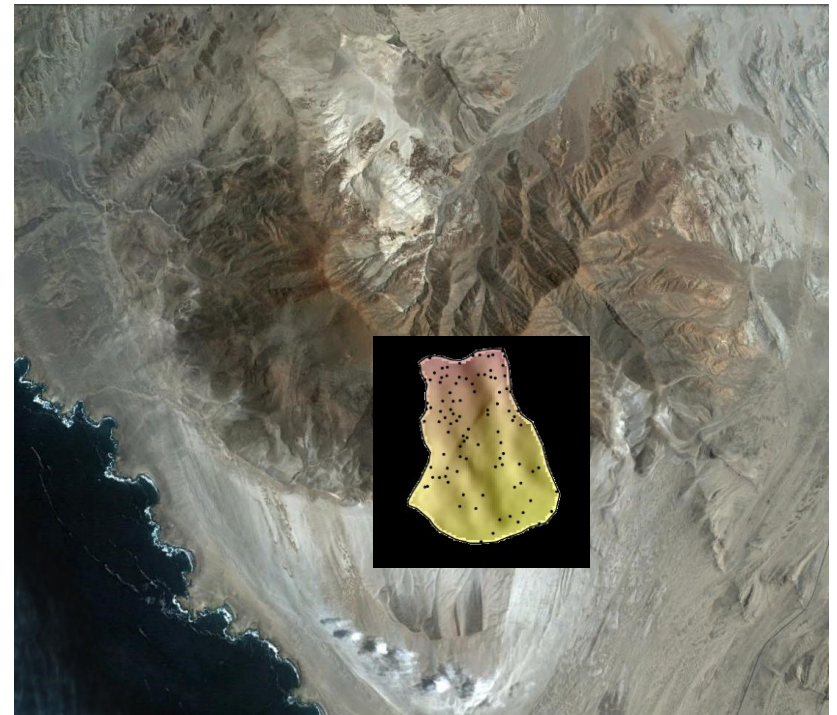
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- Add 2-3 more lomas slides
- Importance of lomas
- Fog oasis

Study area – Mount Mongón



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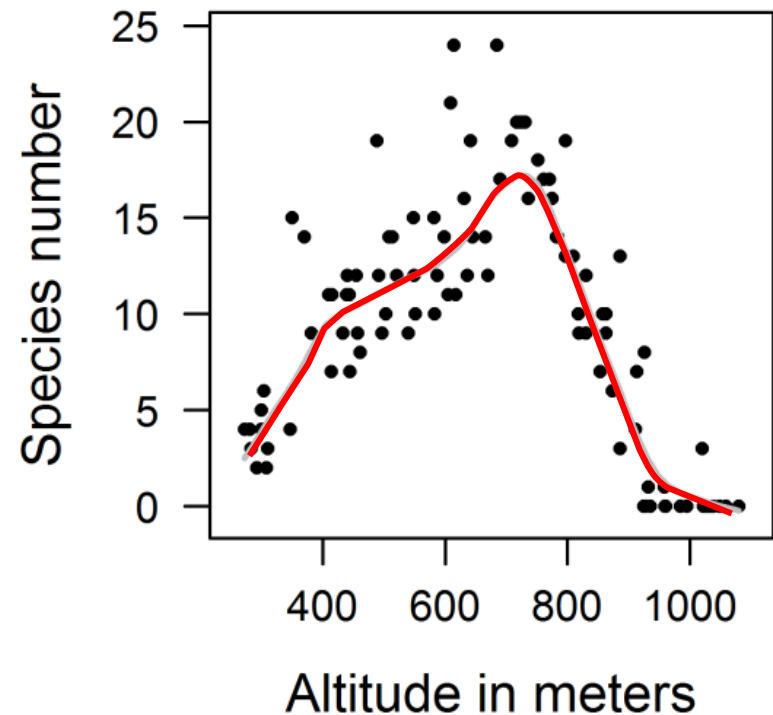


Source: Google Earth.

Non-linear Poisson model

Predictors:

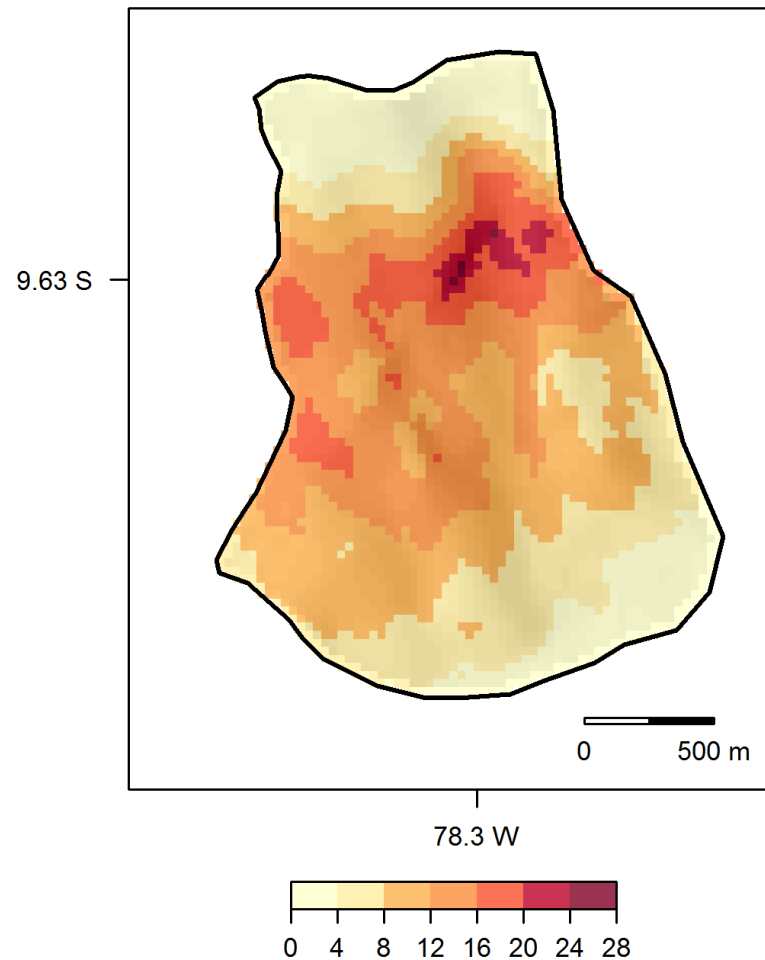
- Altitude
- catchment slope
- catchment area
- SAGA wetness index
- Curvatures
- solar radiation
- etc.



Spatial prediction of plant species diversity



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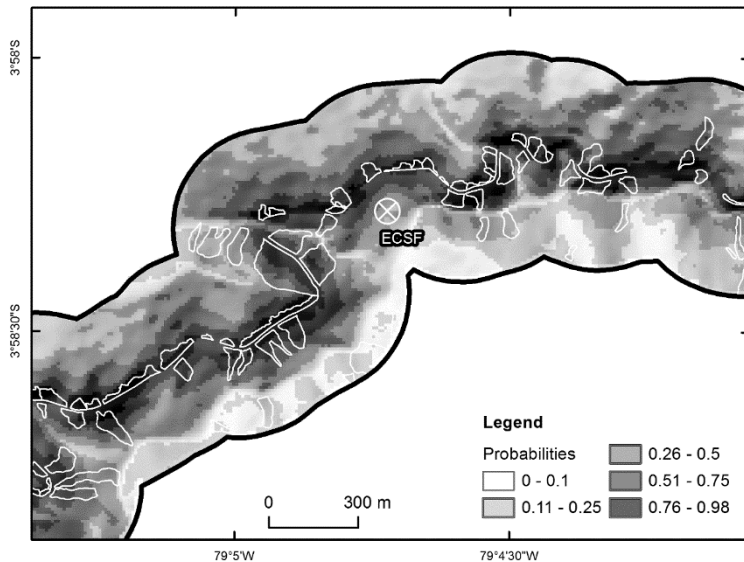


Muenchow et al. (2013): Predictive mapping of species richness and plant species' distributions.

Landslide susceptibility



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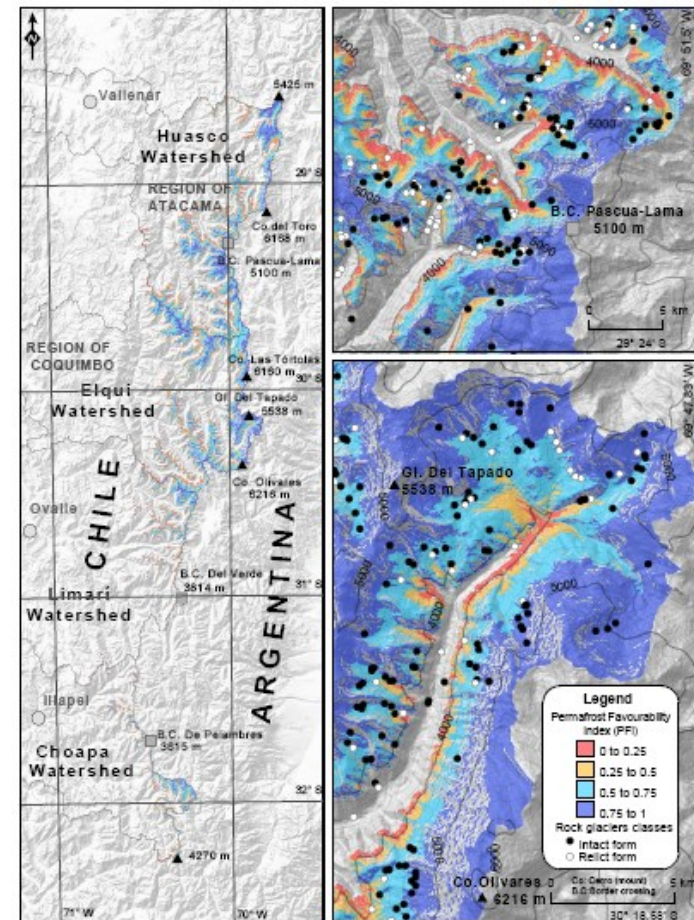
Brenning et al. (2015): Landslide susceptibility near highways.

Rock glaciers/permafrost



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- Computation of direct and diffuse incoming solar radiation



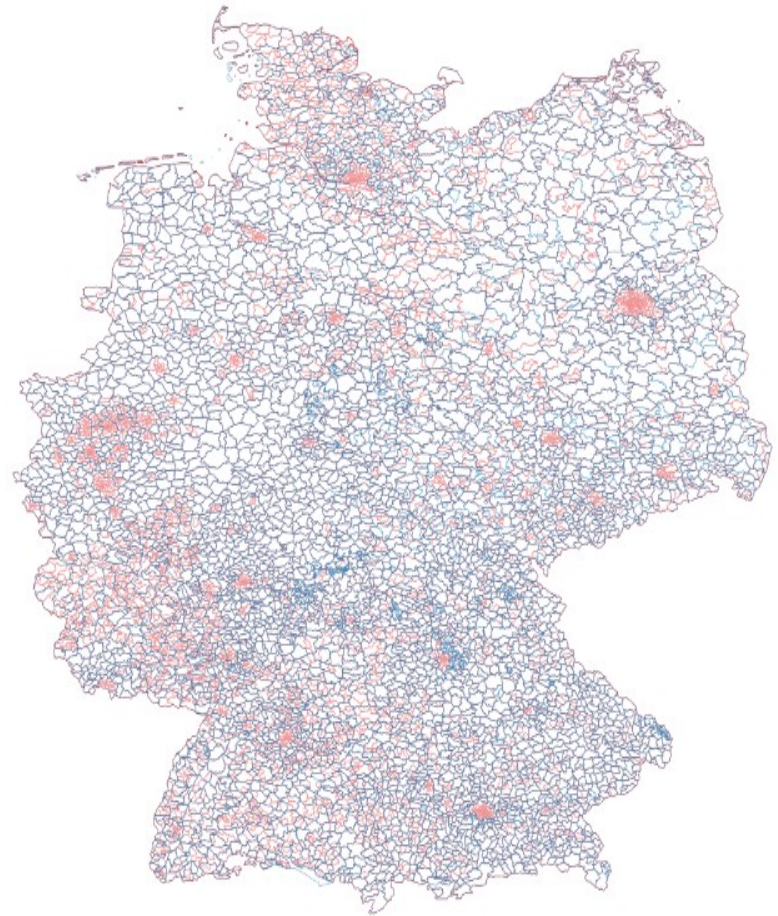
Azócar et al. (2017): Permafrost distribution modeling.

Geomarketing



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- Unioning postal code with municipality layers





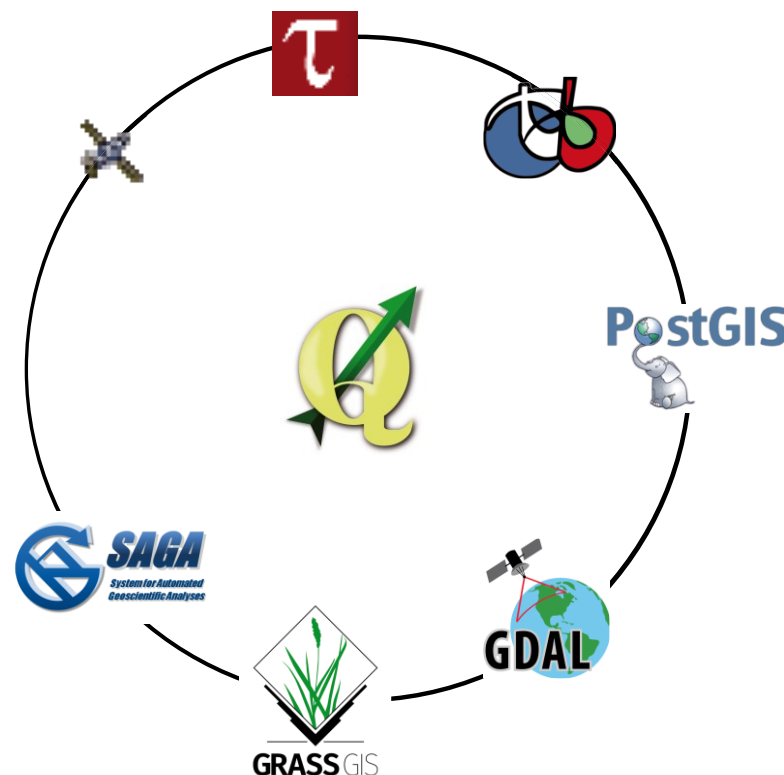
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COMPARING R/GIS BRIDGES

RQGIS vs. RSAGA/rgrass7

- Unified interface to SAGA, GRASS and further 3rd-party providers
- User-friendly
 - `open_help()`
 - R named arguments
 - Automatic retrieval of default values
 - On-the-fly import/export of spatial objects (`run_qgis`)
 - Automatic data conversions (e.g., asc, tif, etc.)



But:



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- QGIS does not provide access to all SAGA and GRASS functionalities
- RSAGA has special geocomputing functions (written in R)
- QGIS establishes a new GRASS session for each call and barely supports the GRASS geodatabase

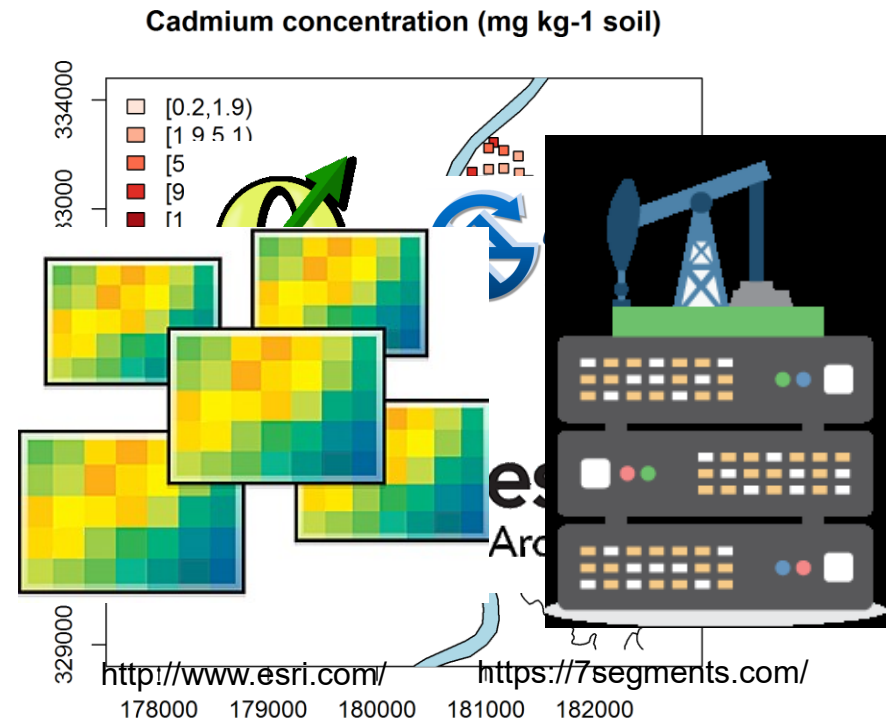


Wrap-up



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- We can use R as a GIS
- Geoprocessing is (often) better done with the help of a GIS
- R-GIS integration combines the best of two worlds
- RQGIS, RSAGA, rgrass7 are all great



Data: Rikken, M.G.J & Van Rijn, R.P.G. (1993).