```
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)
```

R-GIS bridges for Statistical Geocomputing

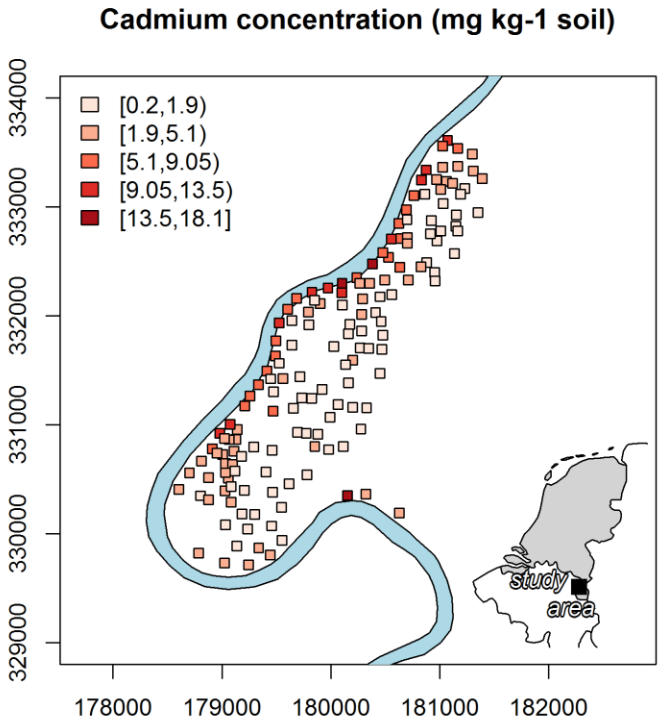
Jannes Muenchow

Where to find the material

https://github.com/jannes-m/geostats_rqgis

Contents

1. R as a GIS



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

Contents

1. R as a GIS
2. R-GIS bridges

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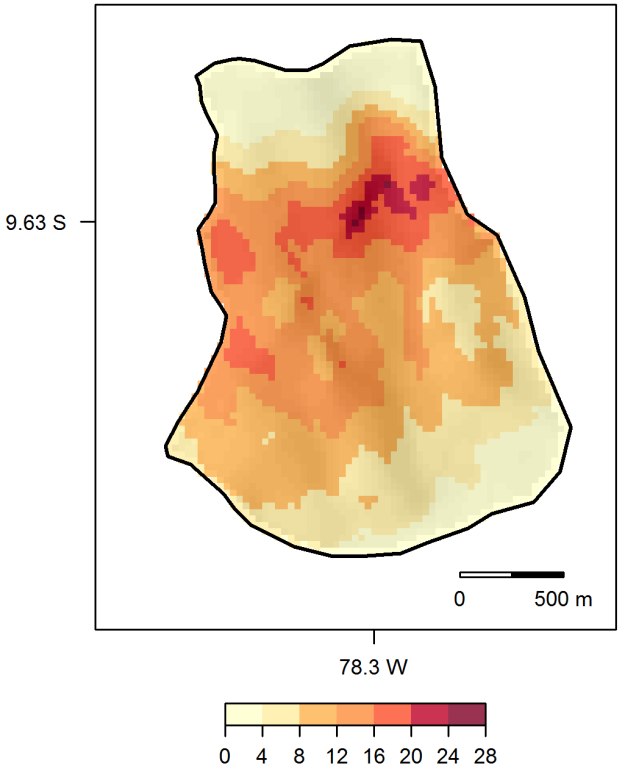
1. R as a GIS
2. R-GIS bridges
3. R/GIS examples



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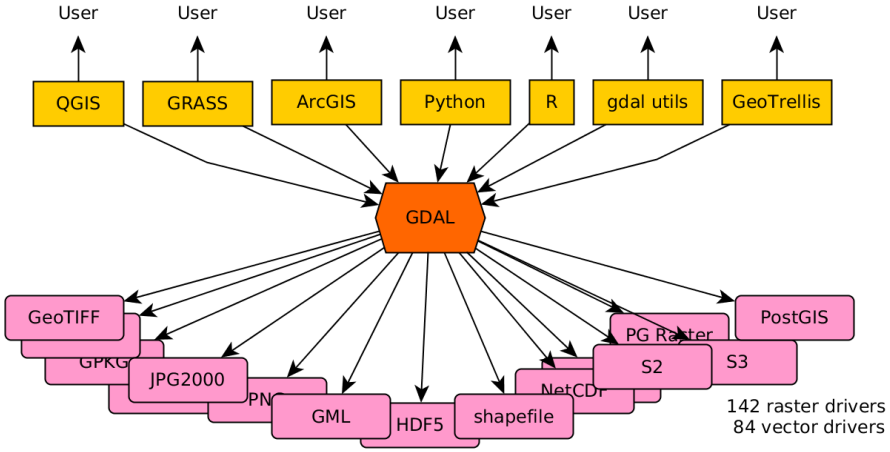
1. R as a GIS
2. R-GIS bridges
3. R/GIS examples
4. RQGIS, RSAGA, rgrass7

R AS A GIS

R as a GIS

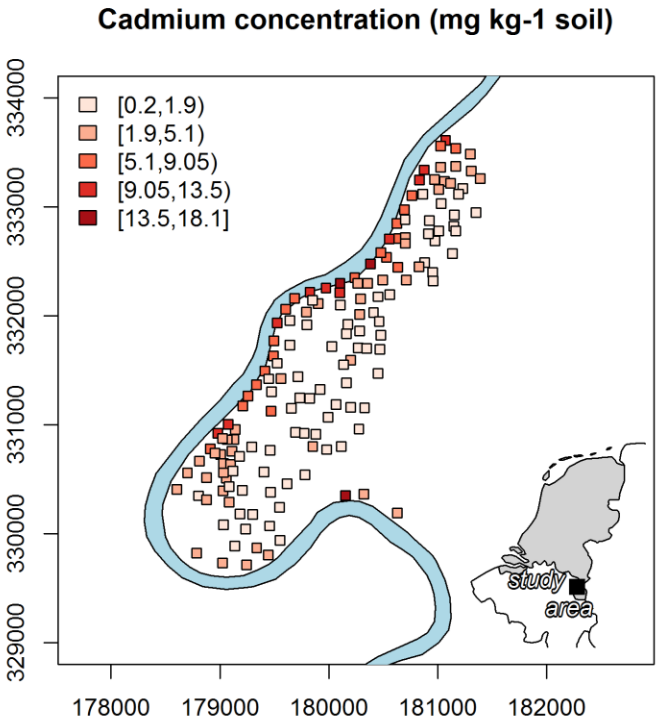
- More than 100 geo-related R packages (https://cran.r-project.org/web/views/Spatial.html)
- Package **`rgdal`** for importing and exporting geodata



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

R as a GIS

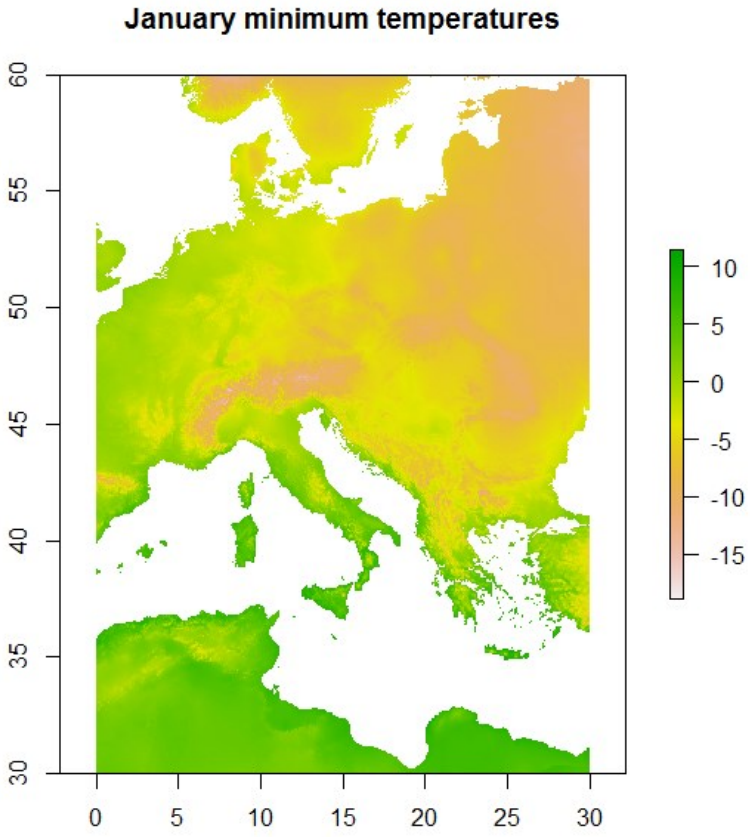
- More than 100 geo-related R packages (https://cran.r-project.org/web/views/Spatial.html)
- Package **`rgdal`** for importing and exporting geodata
- Packages **`sp`** and **`sf`** for vector geodata



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

R as a GIS

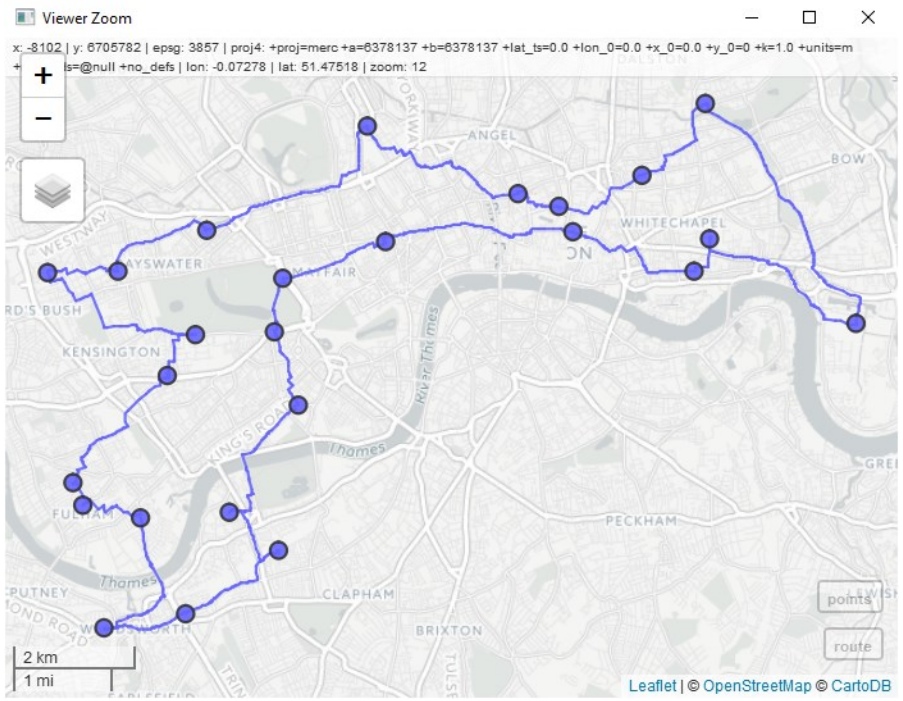
- More than 100 geo-related R packages (https://cran.r-project.org/web/views/Spatial.html)
- Package **`rgdal`** for importing and exporting geodata
- Packages **`sp`** and **`sf`** for vector geodata
- Package **`raster`** for raster geodata



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

Interactive map handling

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



R as a GIS

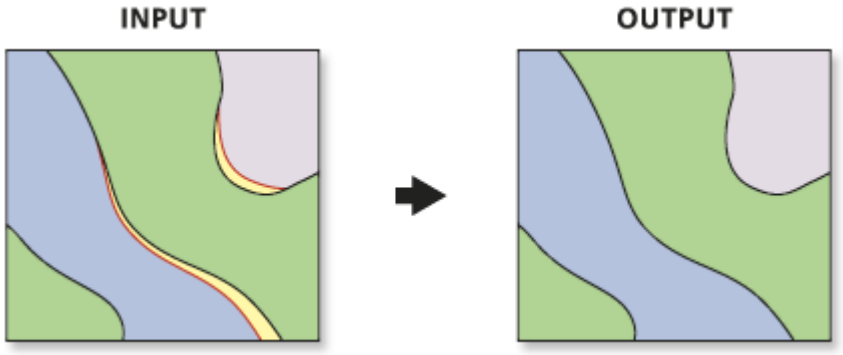
Defining a GIS as a system for the analysis, manipulation and visualization of geographical data (Longley, Goodchild, Maguire, and Rhind 2011), one could argue that R has become a GIS

But what about…

(digitizing)

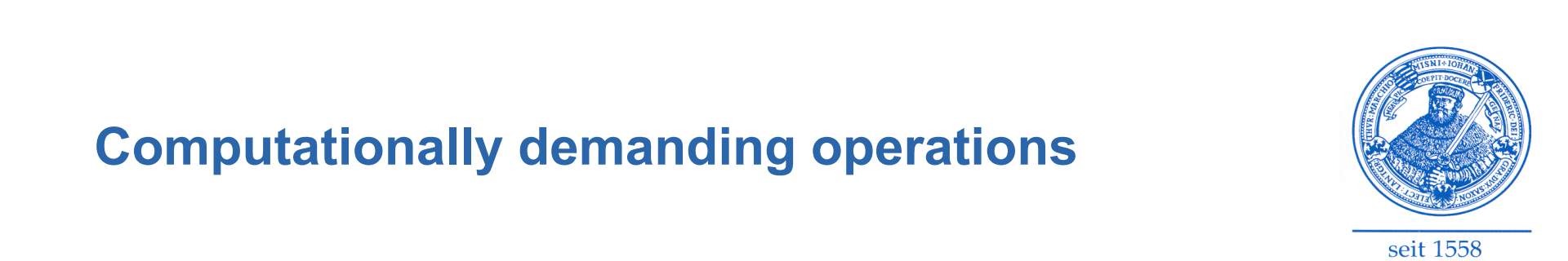
(Geodatabase-functionality and topology rules)

http://www.unioneag.org

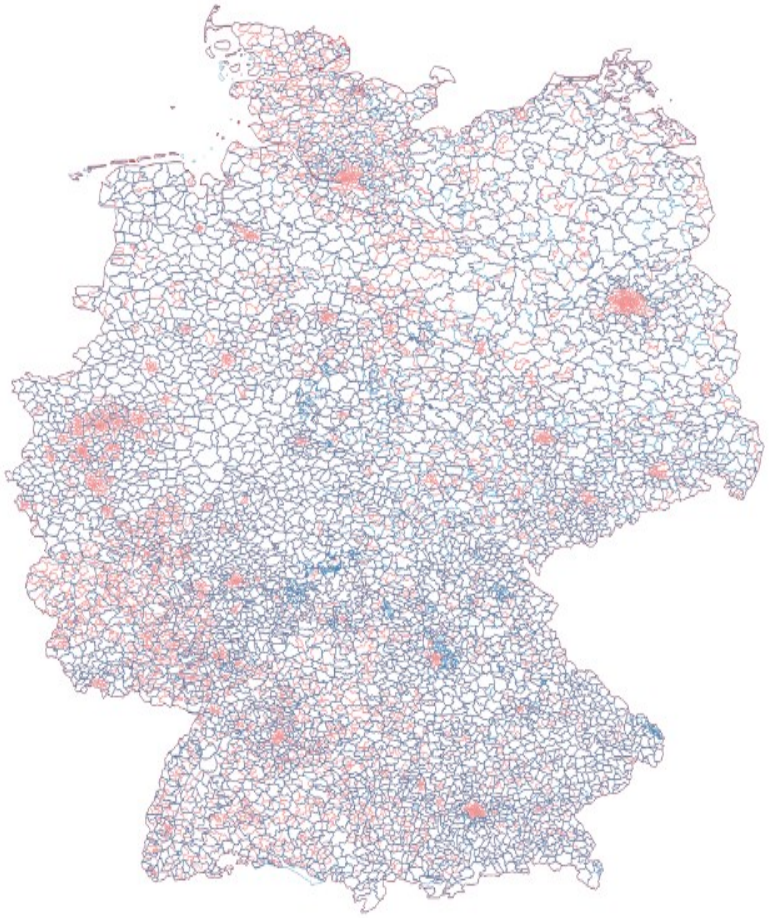


http://help.arcgis.com/

Computationally demanding operations

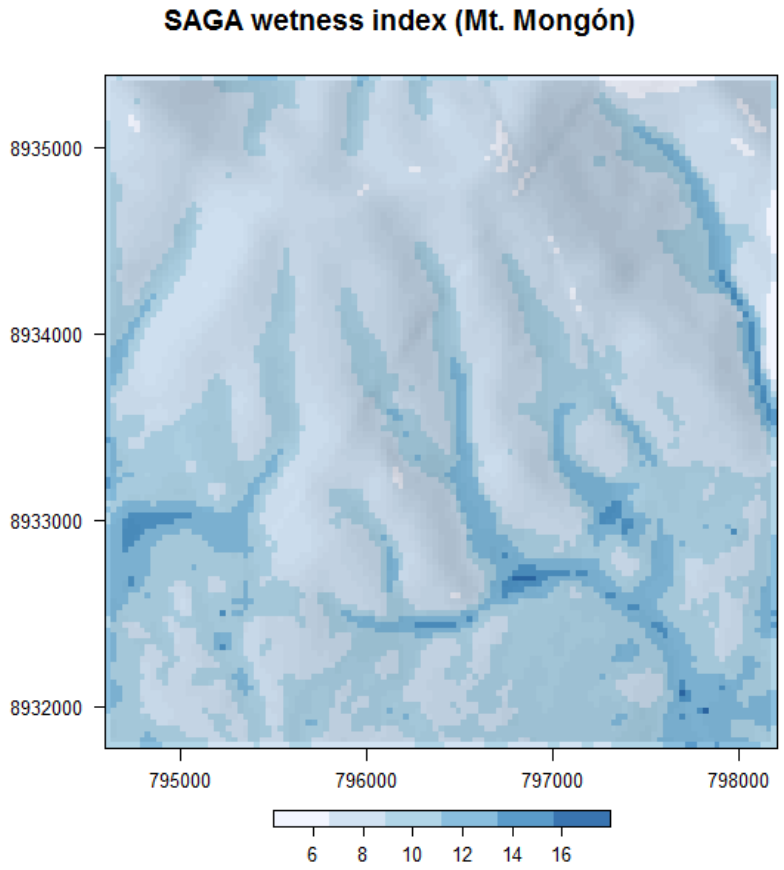


- Computationally demanding operations



Missing geoalgorithms

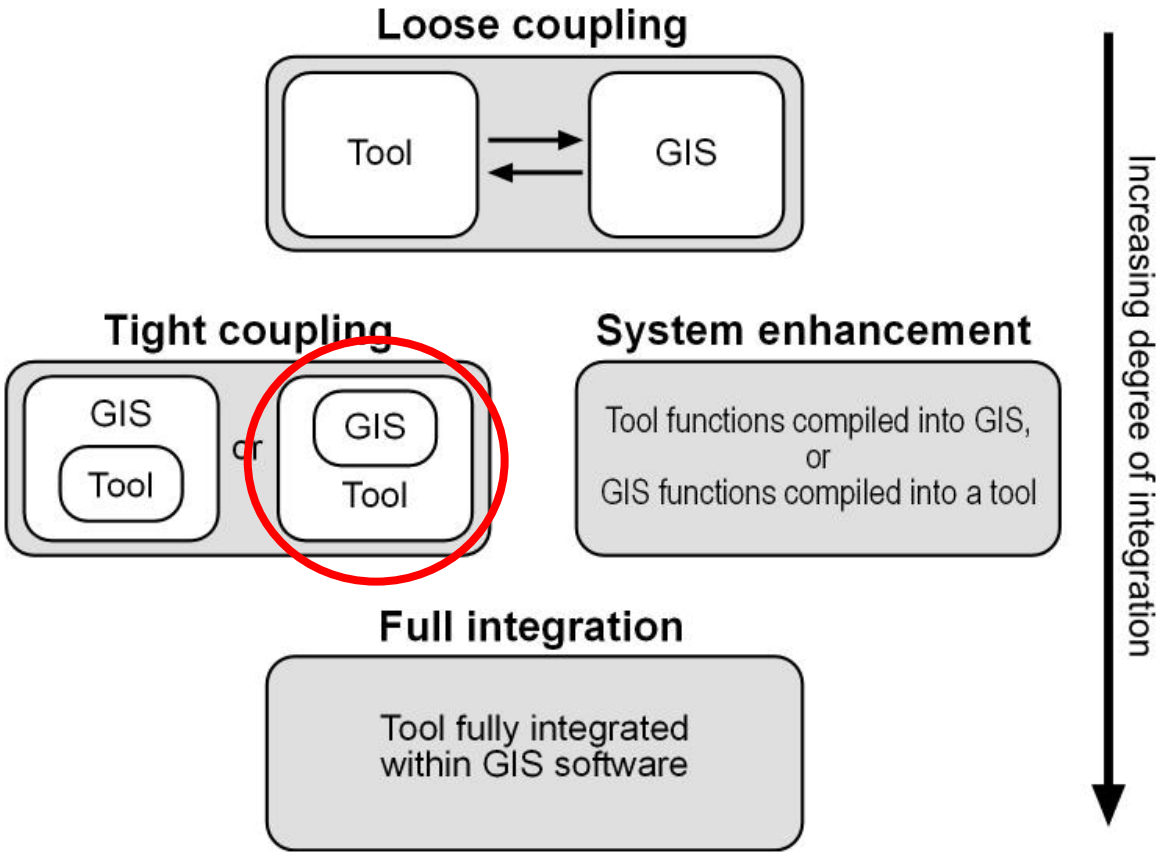
- Catchment area
- Catchment slope
- Saga Wetness Index
- Lidar processing
- …



Interface

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

GIS interfaces



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

R-GIS bridges

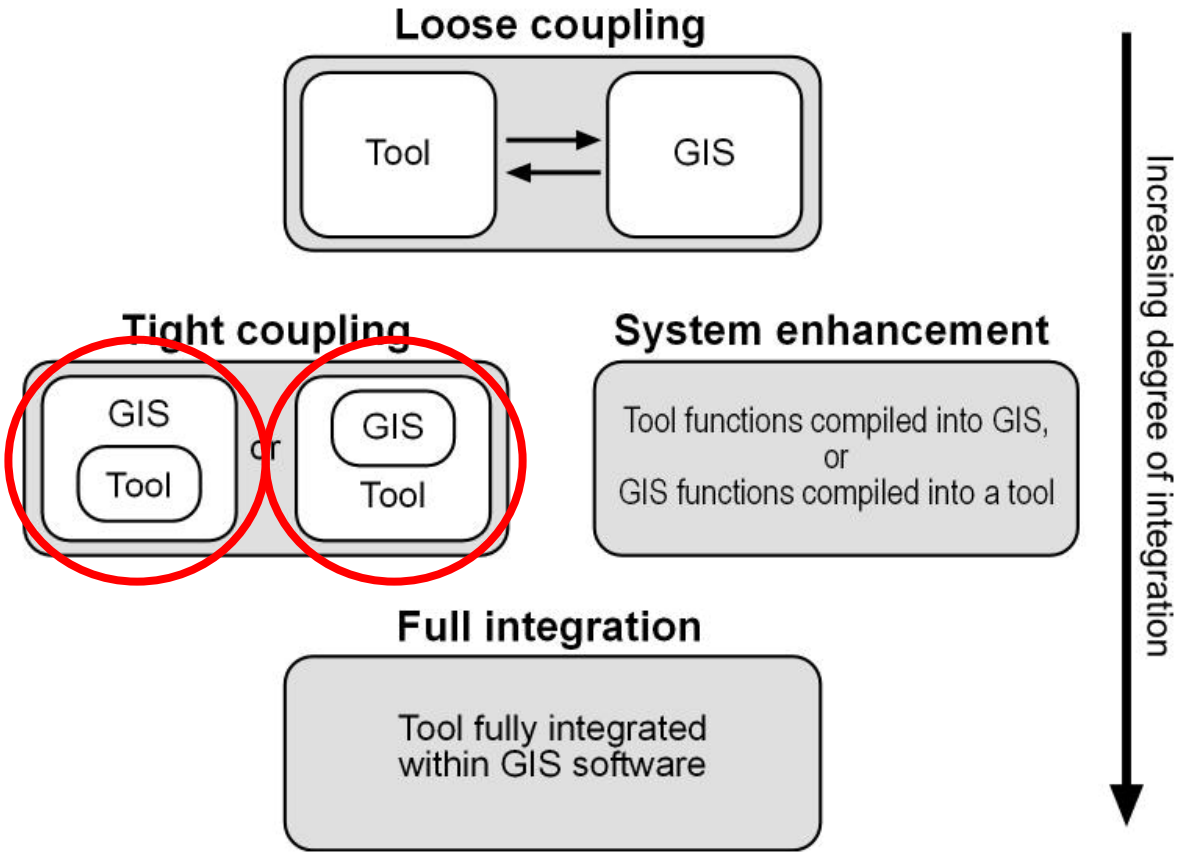
RSAGA

RQGIS

rgrass7

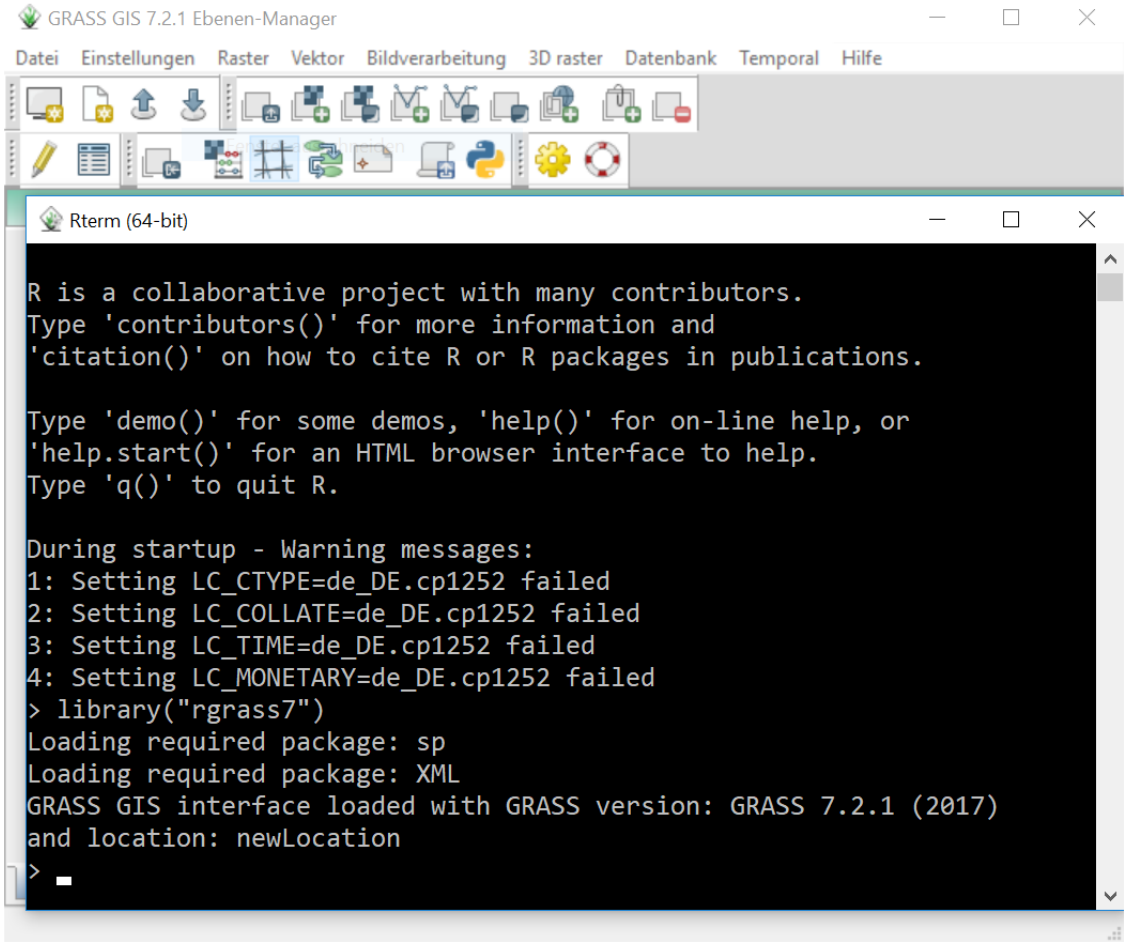
RPyGeo

GIS interfaces

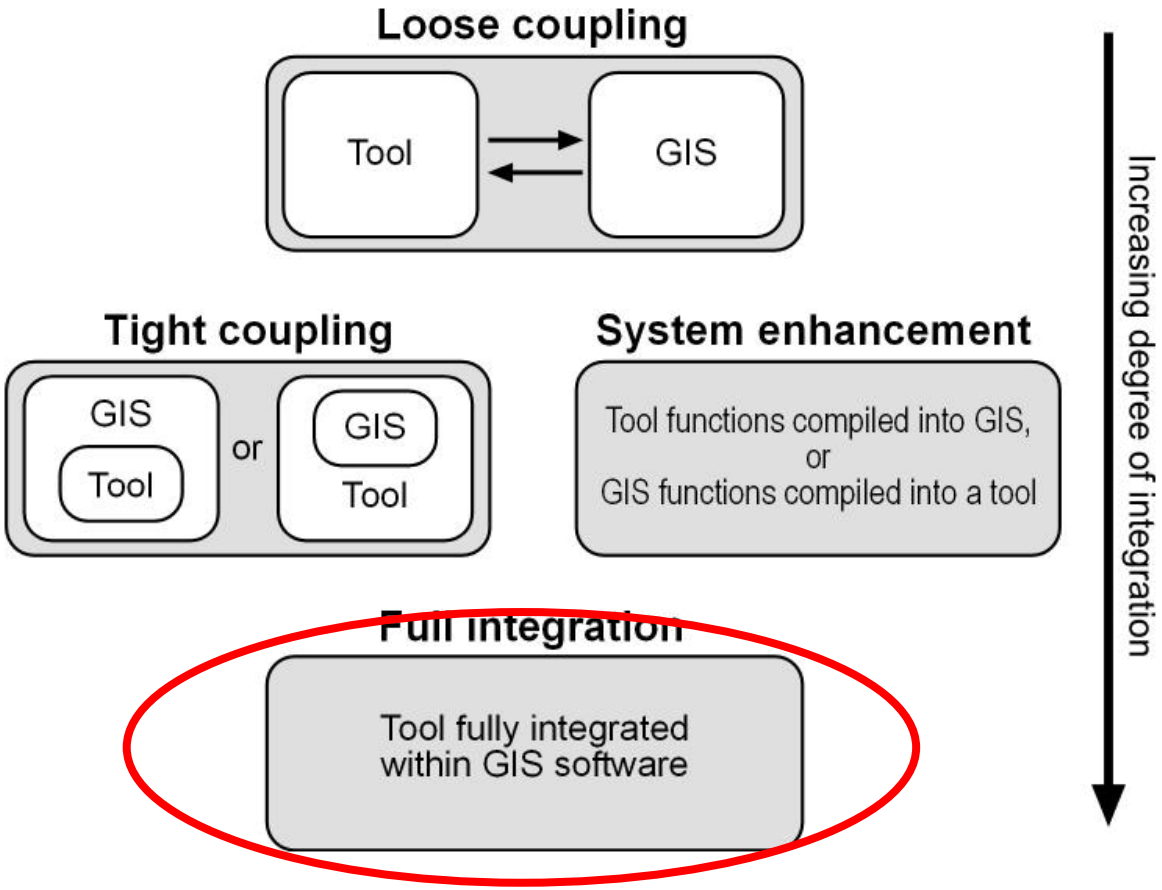


http://www.geocomputation.org/2000/GC009/Gc009.htm

GIS-R bridges - GRASS



GIS interfaces



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

GIS-R bridges

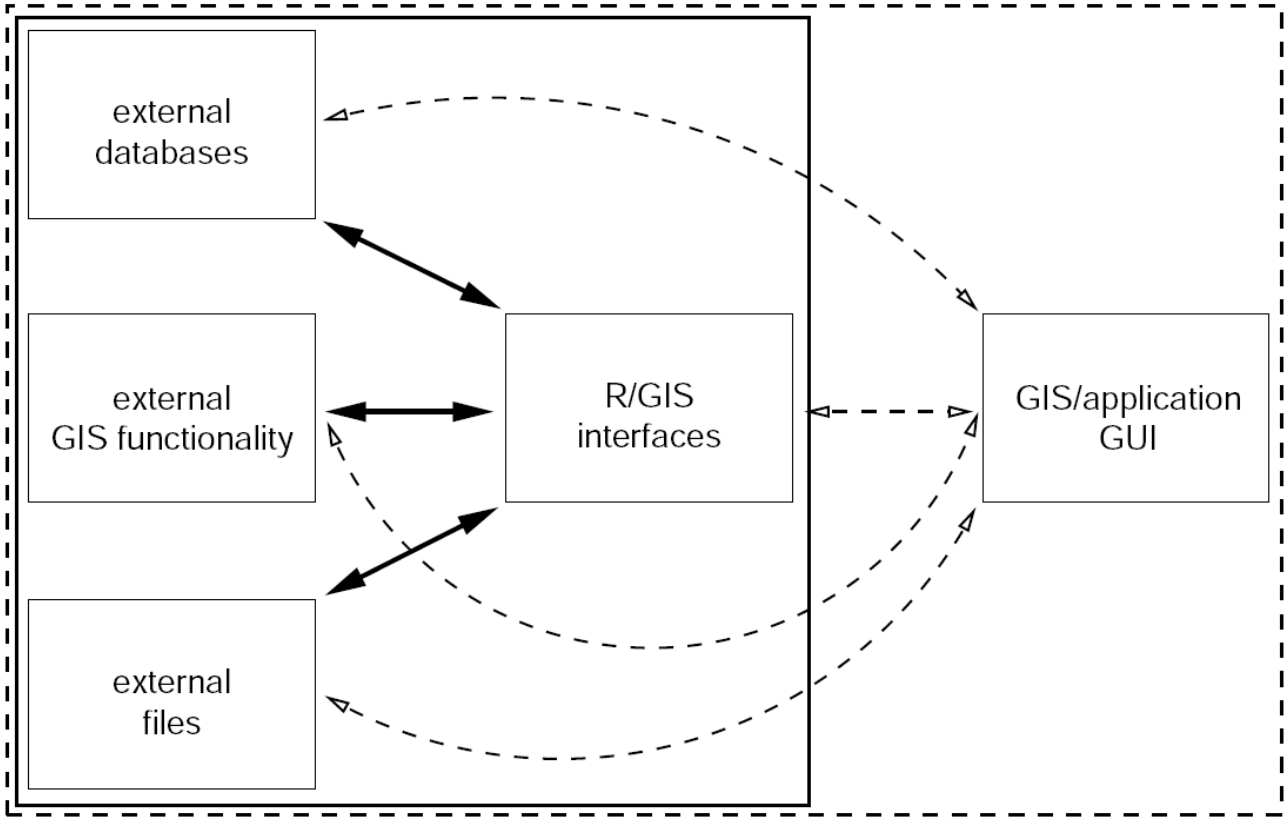
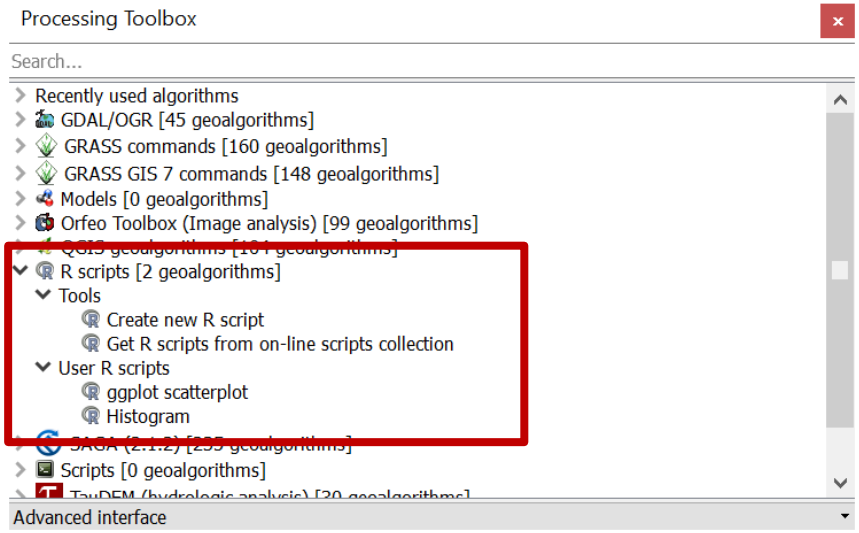
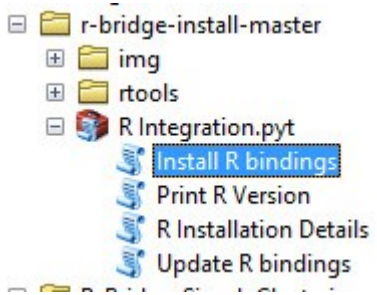


Figure taken from Bivand, 2014.

GIS-R bridges – QGIS & ArcGIS





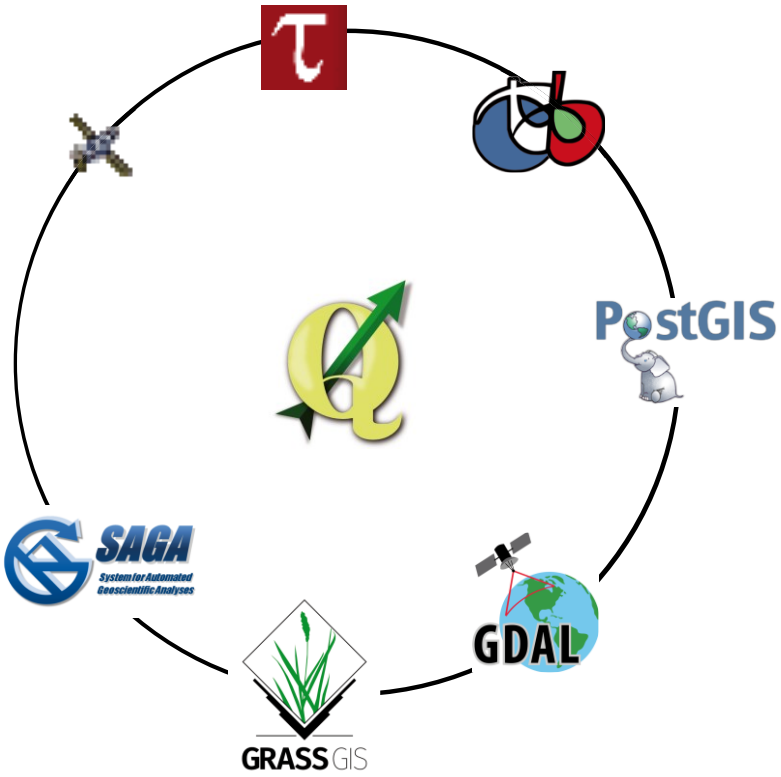
https://www.r-bloggers.com/combining-arcgis-and-r-clustering-toolbox/

R-GIS BRIDGES

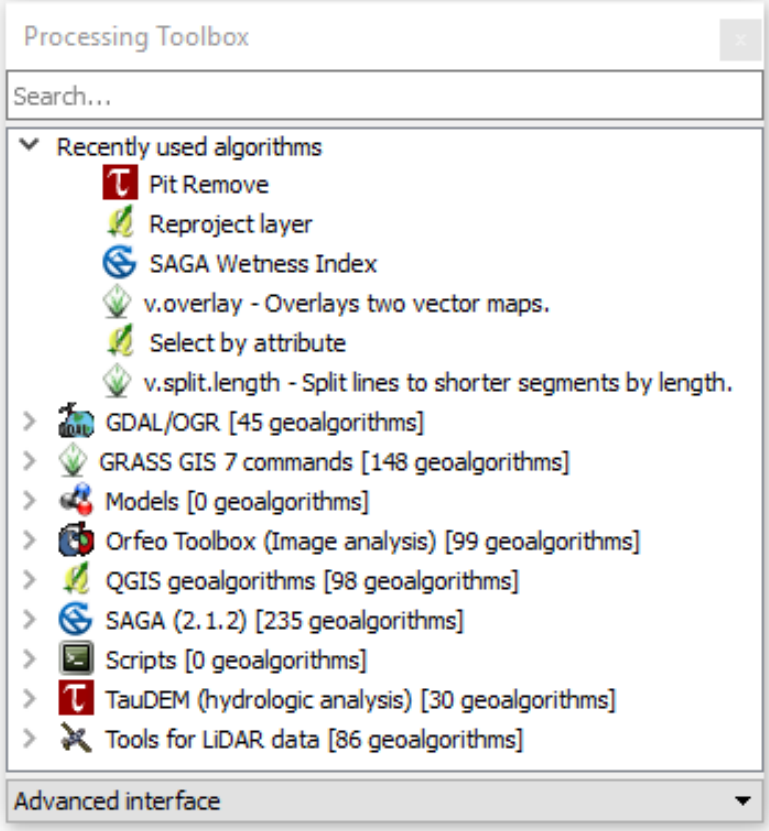
Why (R)QGIS?

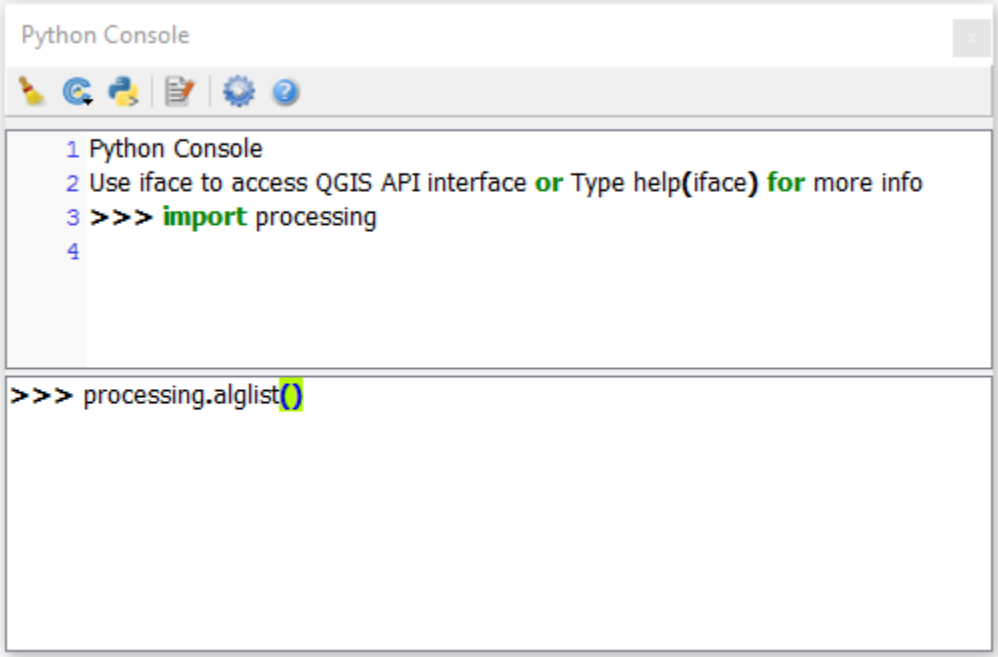
seit 1558

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

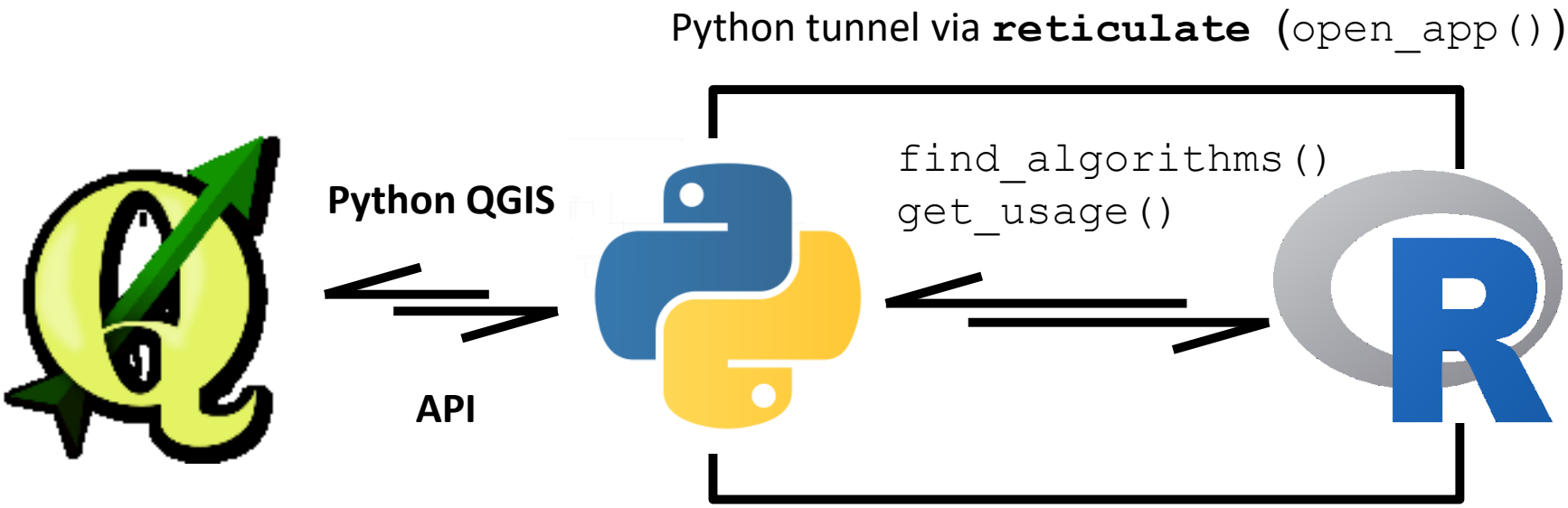


QGIS – Python API

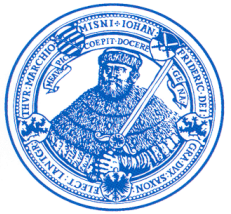




Python tunnel via reticulate



Example



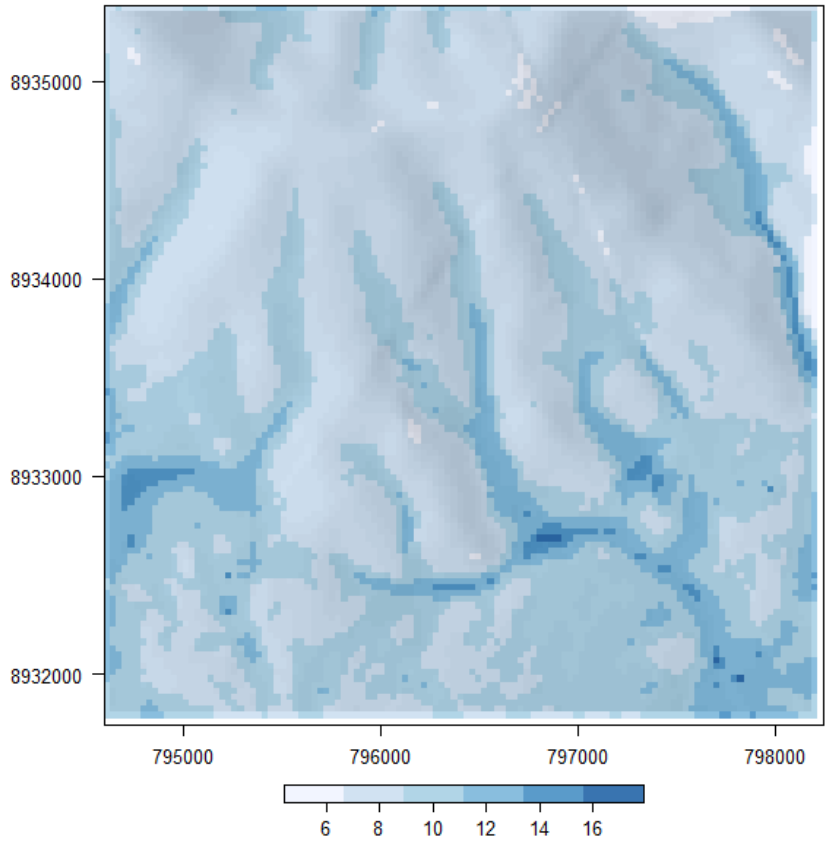

```
library("RQGIS")
get_usage("saga:sagawetnessindex")
```

```
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

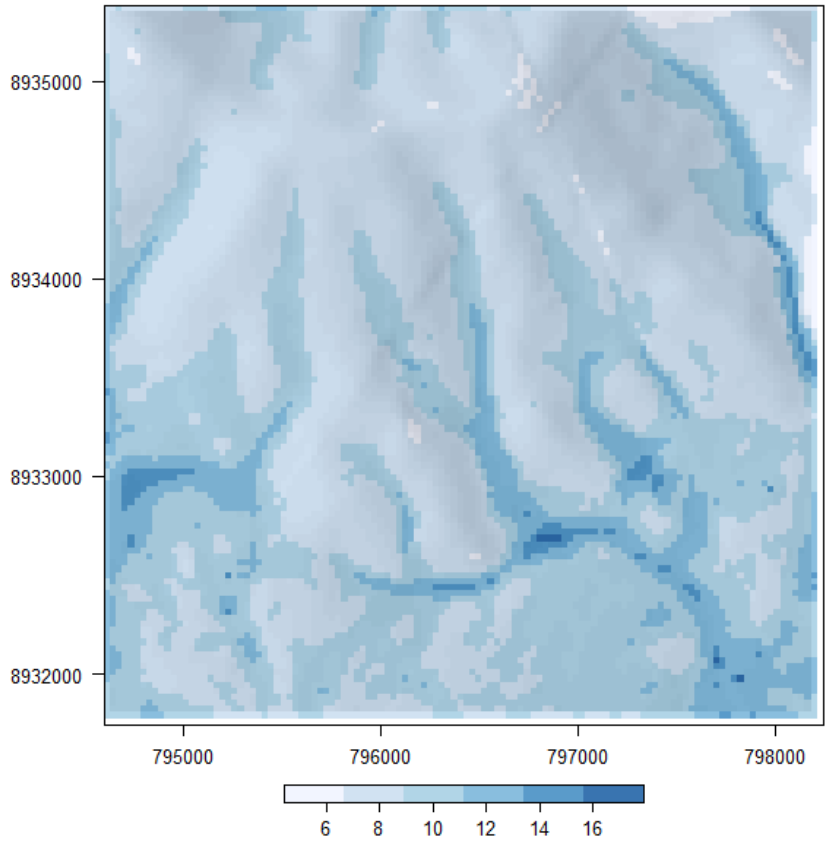

```
data("dem")
twi <- run_qgis(
  "saga:sagawetnessindex",
  DEM = dem,
  TWI = "twi.tif",
  load_output = TRUE)
```



Let's run_qgis

Spatial object residing in R

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

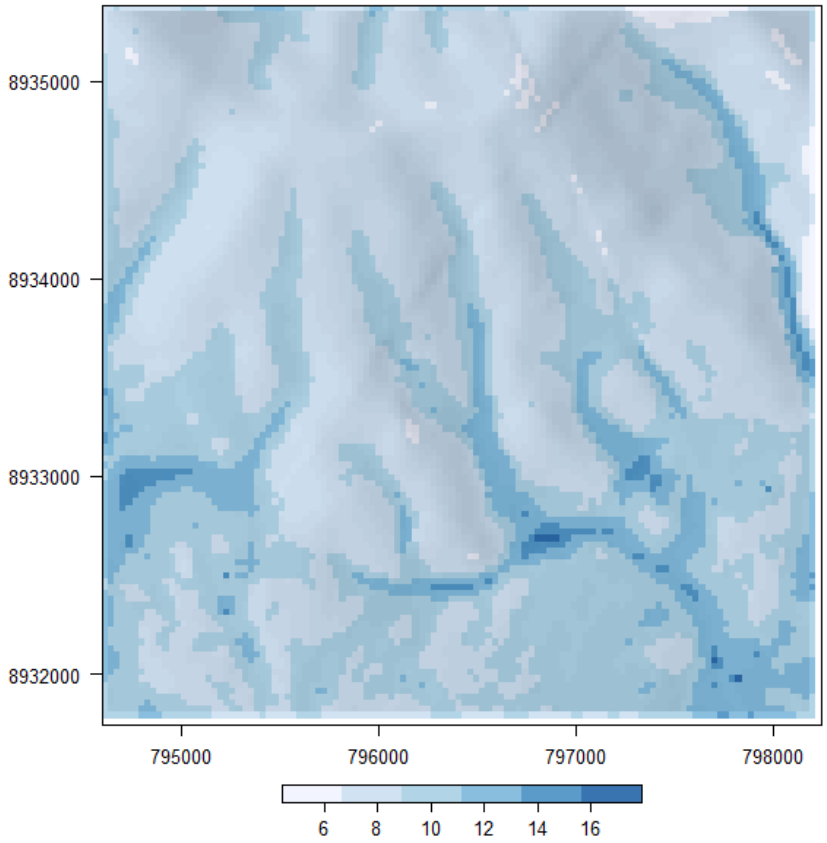


Let's run_qgis

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

- First SAGA release in 2004
- Also open-source
- Started out with a focus on raster processing
- >600 geoalgorithms
- Documentation improvable

RSAGA

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]
```

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`

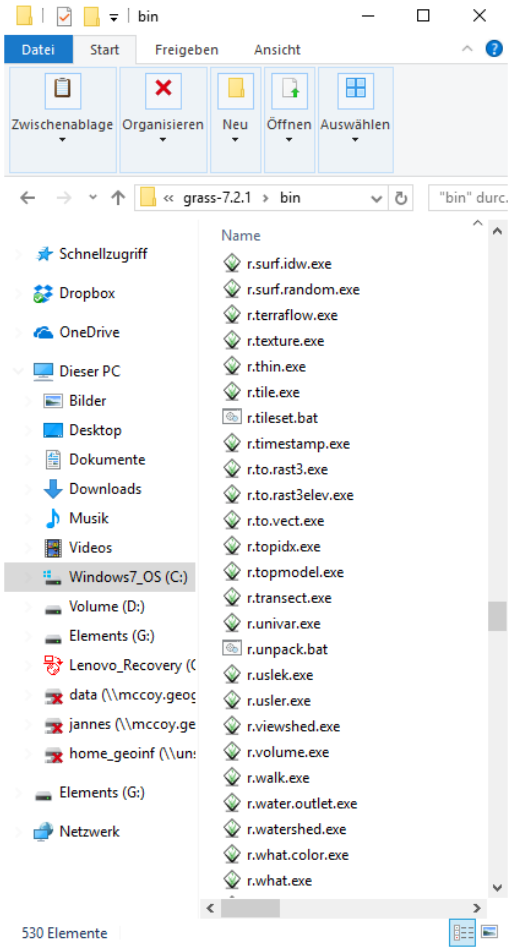
The R-GRASS interface

- 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/user community
- >500 geoalgorithms
- Great documentation
- Uses SQLite as a geodatabase in the background

`rgrass7`

The R-Grass interface

"GRASS is a very large but very simple system – it is run as a collection of separate programs built using shared libraries of core functions. There is then no GRASS 'program', just a script setting environment variables needed by the component programs" (Bivand et al. 2008: 99).

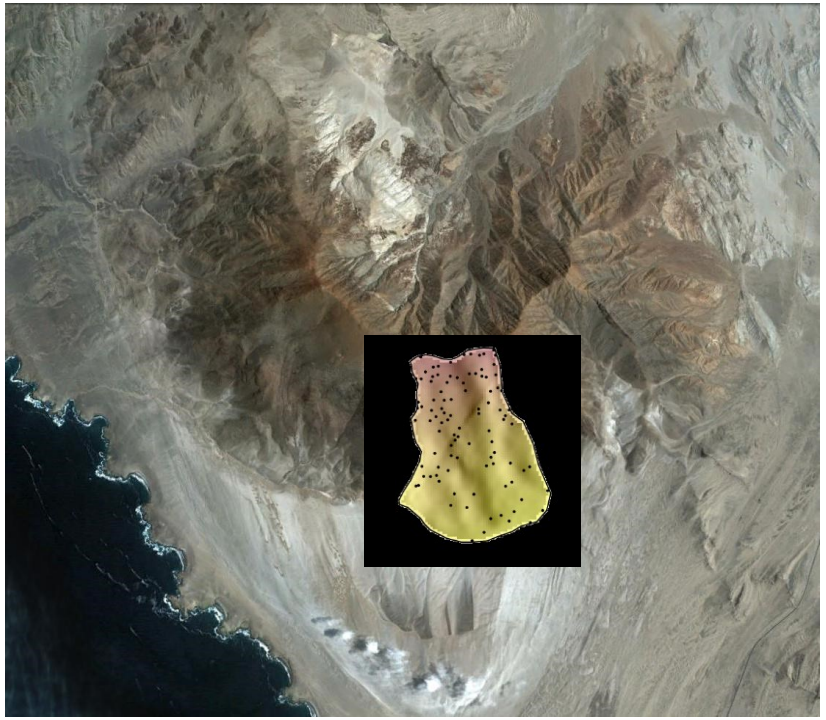


If you want to know more…

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

R-GIS EXAMPLES

Study area – Mount Mongón



Source: Google Earth.

Lomas – scientific context

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- Highly endemic and strongly endangered vegetation formation just living of fog
- Altitudinal gradient
- Influence of ENSO
- Spatial prediction map of species richness to delineate conservation areas

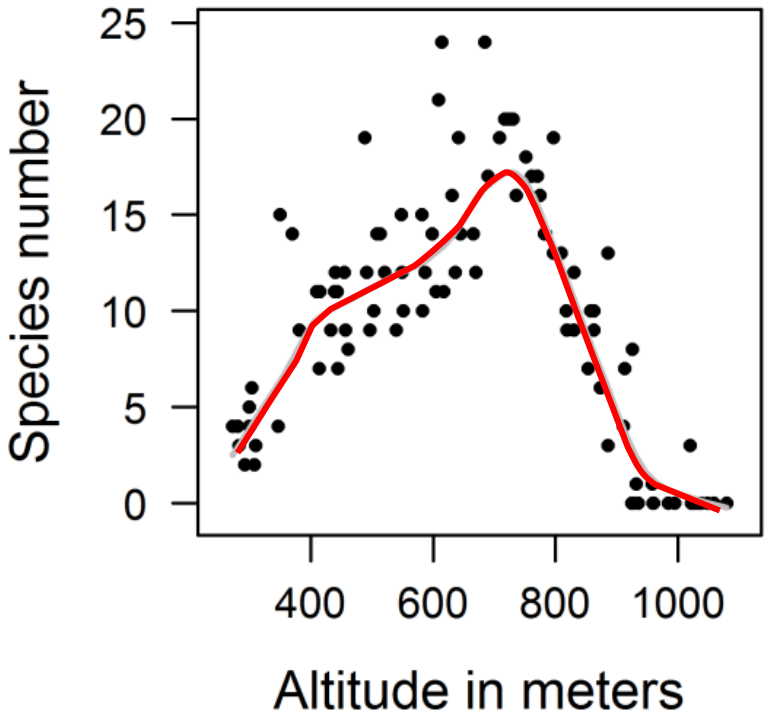
Austral summer

Austral winter

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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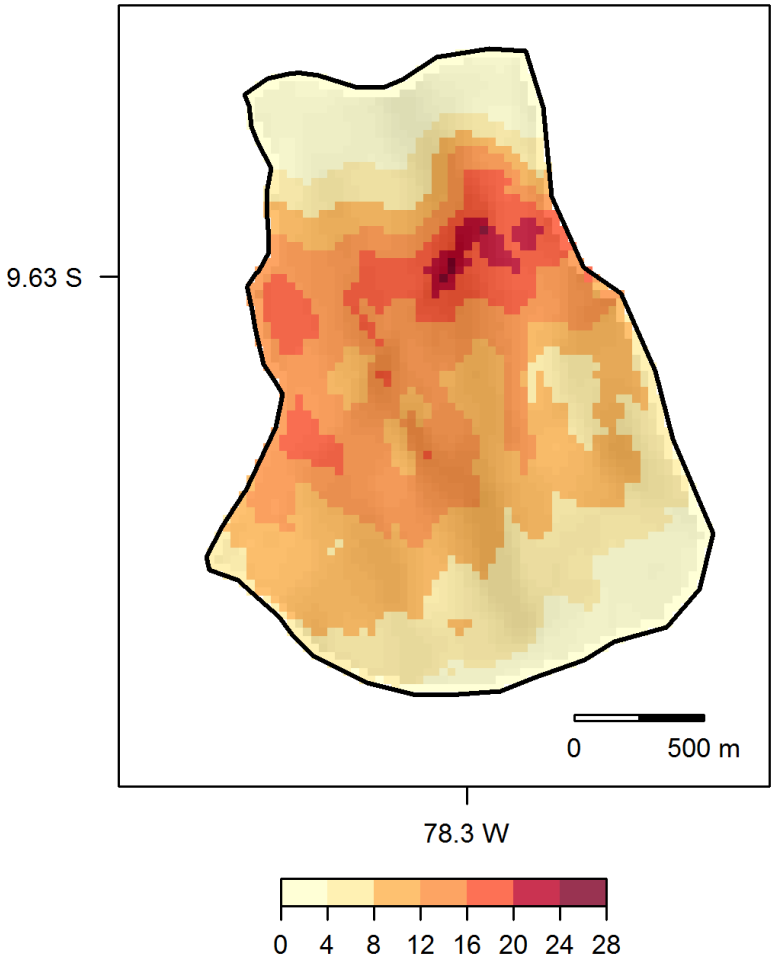
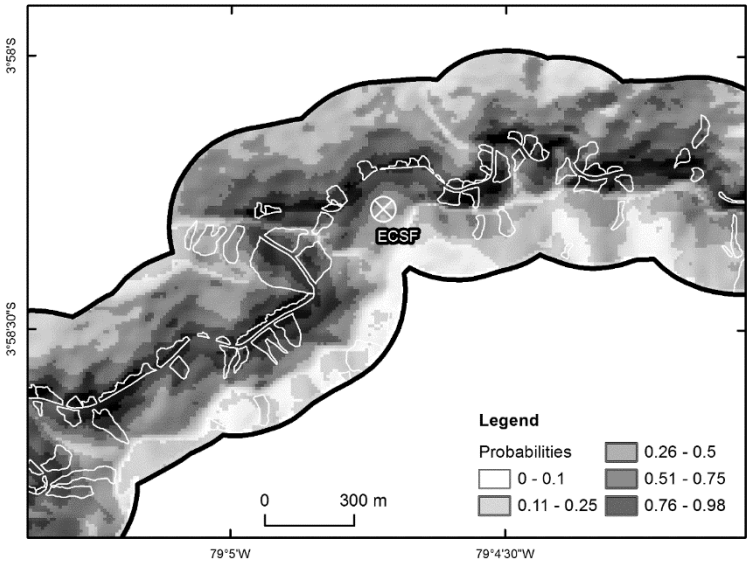


Muenchow et al. (2013): Predictive mapping of species richness and plant species' distributions.

Landslide susceptibility

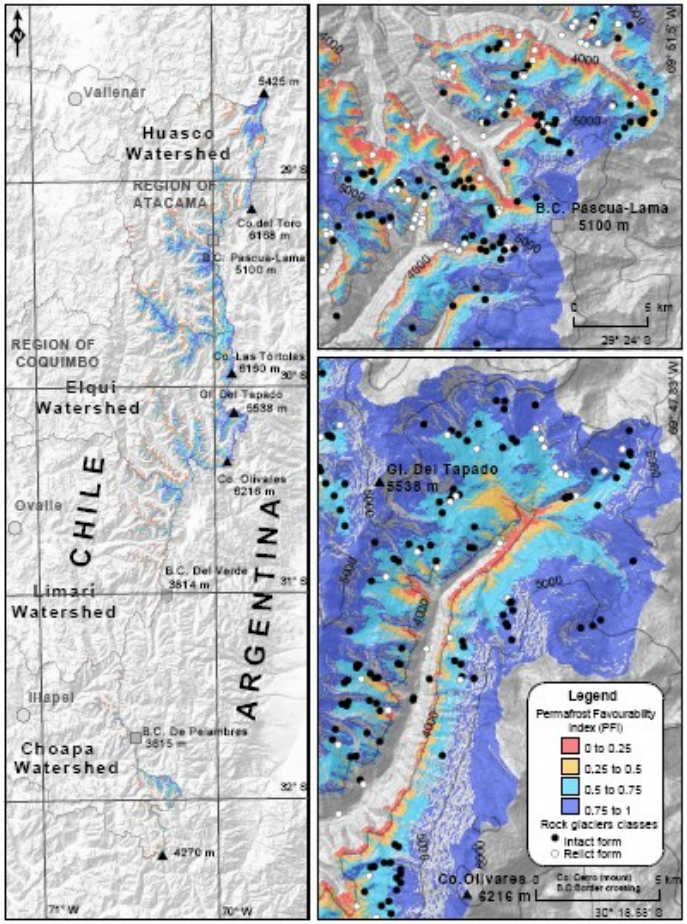


Brenning et al. (2015): Landslide susceptibility near highways.

Rock glaciers/permafrost

seit 1558

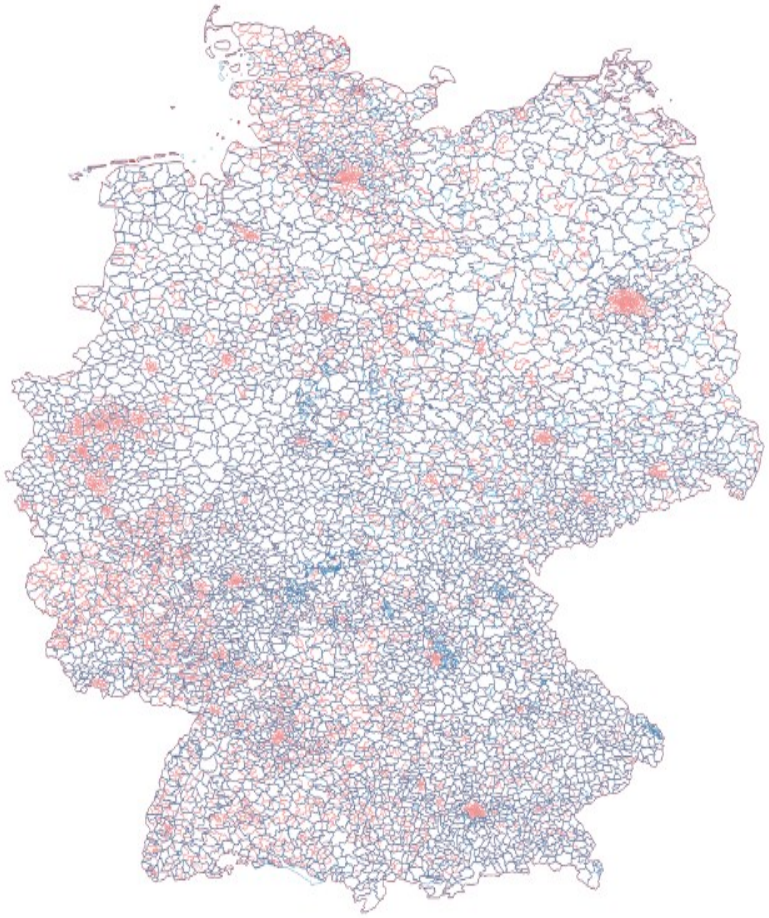
- Computation of direct and diffuse incoming solar radiation



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

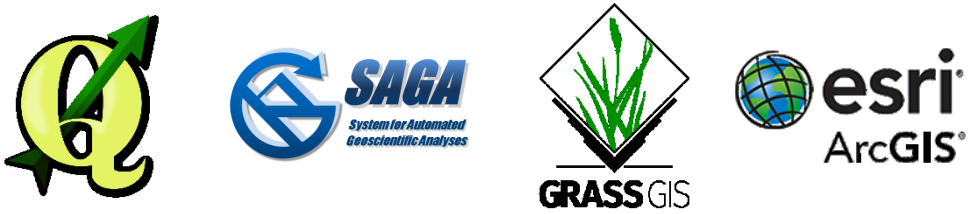
Geomarketing

- Unioning postal code with municipality layers



Further applications

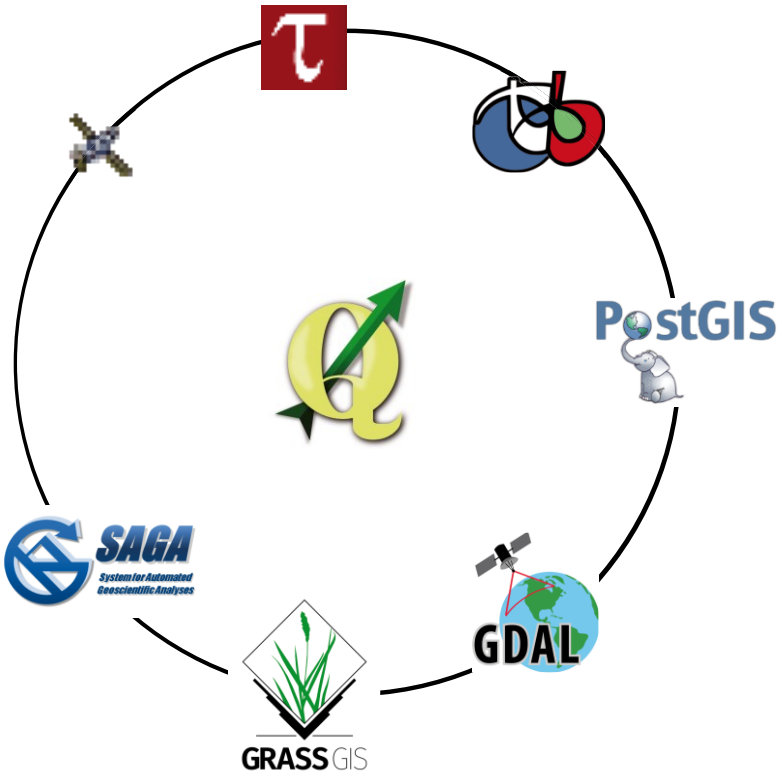
- Soil classes and mapping (e.g., Brungard et al. 2015)
- Stream networks (e.g., Hengl et al. 2010)
- Climatology (rainfall prediction; e.g., Hengl et al. 2010)
- Archeology (e.g., Borck 2016)
- Socio-demography(population index prediction; e.g., Bajat et al. 2012)
- …



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.)

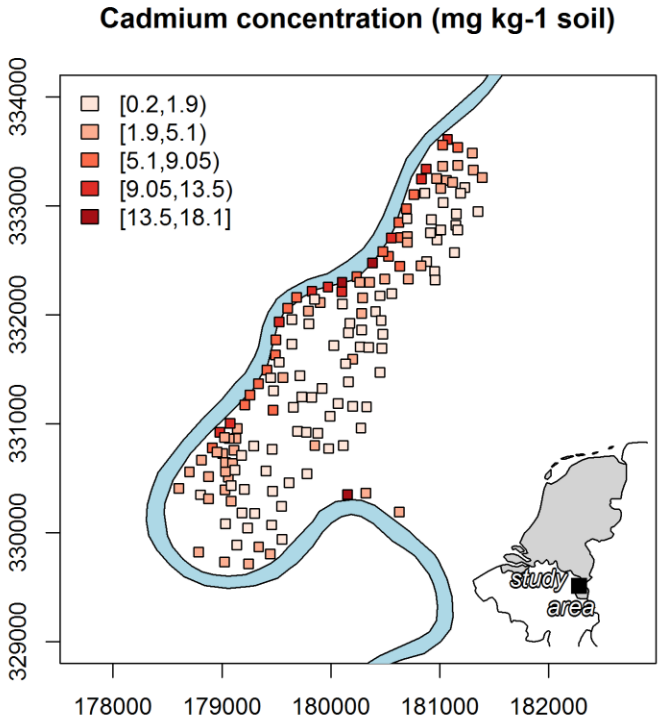


But:

- 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

- We can use R as a GIS



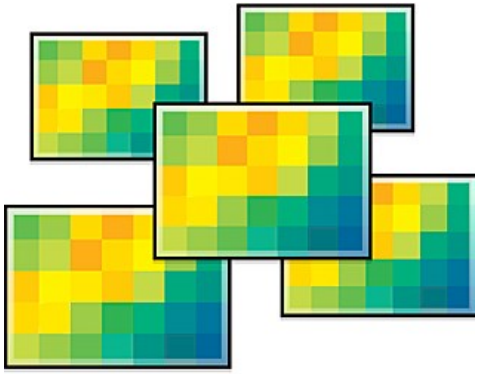
Data: Rikken, M.G.J & Van Rijn, R.P.G. (1993).

Wrap-up

- We can use R as a GIS
- Geoprocessing is (often) better done with the help of a GIS

Wrap-up

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



(R)QGIS installation instructions

Please follow the installation guide:

http://jannes-m.github.io/RQGIS/articles/install_guide.html

Windows Users:

Use the OSGeo4W-installer (http://trac.osgeo.org/osgeo4w/)

Mac Users:

Due to some strange issues, you need to install the QGIS Kynchaos version (otherwise GRASS might not work)

Literature

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