



```
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 slides & code

https://github.com/giscience-fsu/daad_summerschool



R/GIS BRIDGES

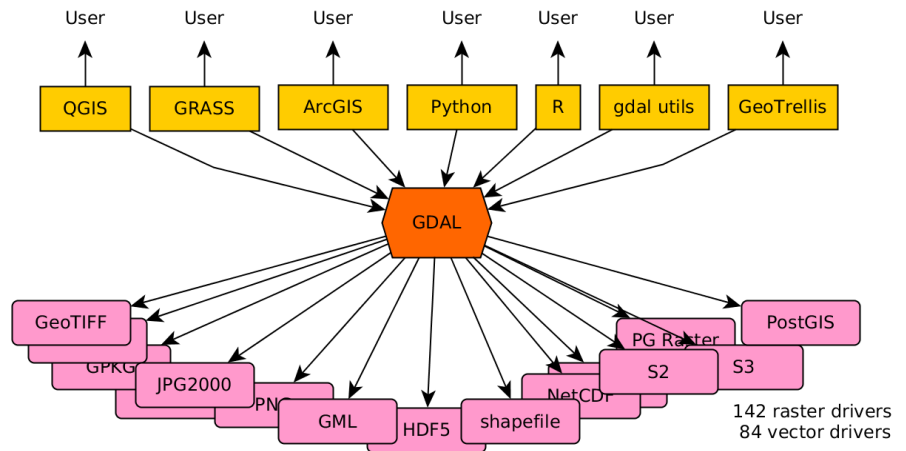


R AS A GIS



R as a GIS

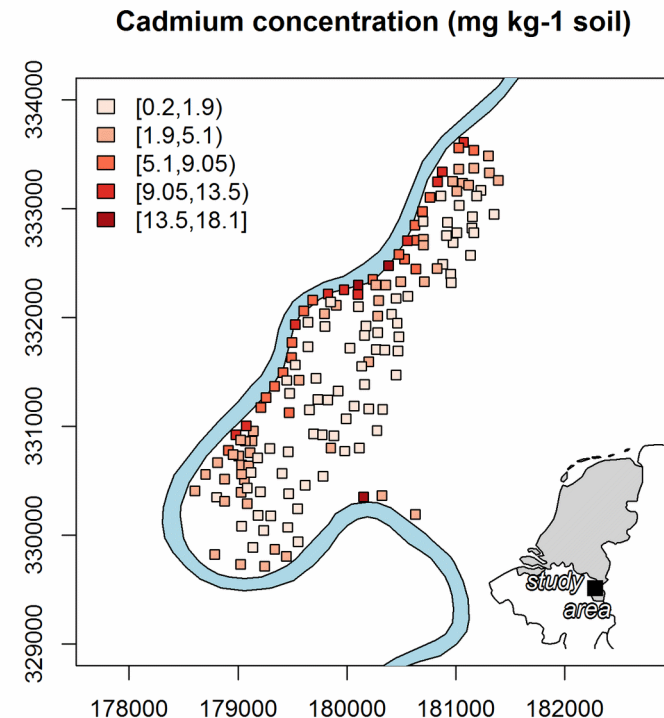
- More than 100 geo-related R packages (
<https://cran.r-project.org/web/views/Spatial.html>
)
- Package **rgdal** for importing and exporting geodata



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

R as a GIS

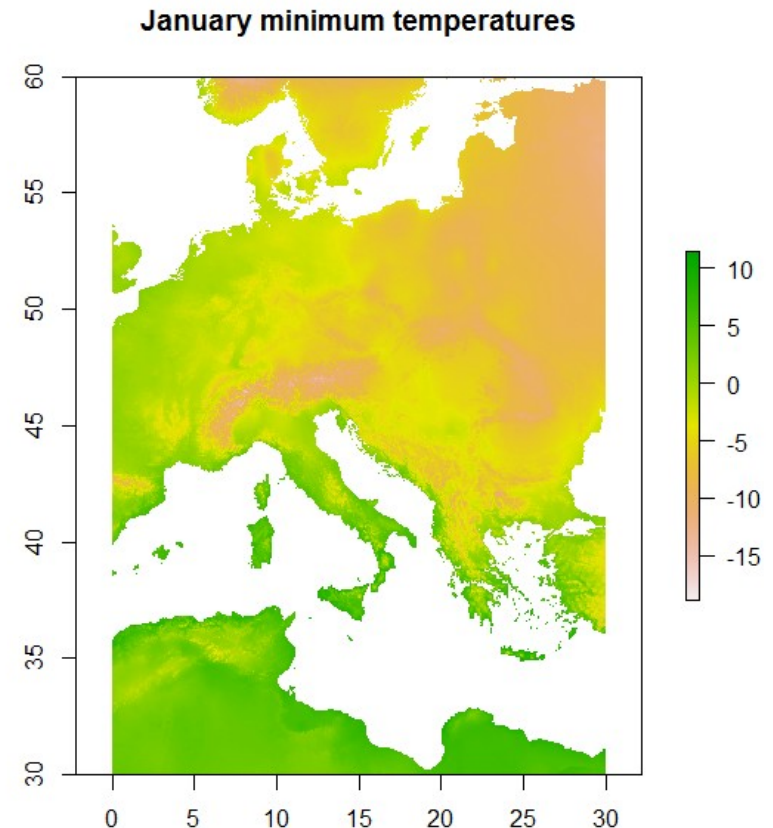
- More than 100 geo-related R packages (<https://cran.r-project.org/web/views/Spatial.html>)
- Package **rgdal** for importing and exporting geodata
- Packages **sp** and **sf** for vector geodata



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

R as a GIS

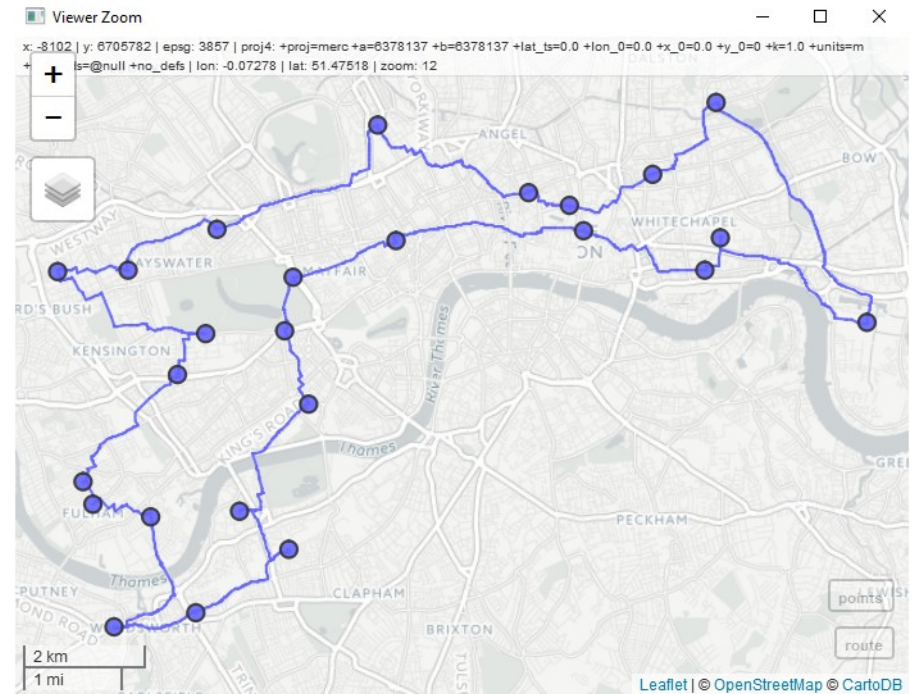
- More than 100 geo-related R packages (
<https://cran.r-project.org/web/views/Spatial.html>
)
- Package **rgdal** for importing and exporting geodata
- Packages **sp** and **sf** for vector geodata
- Package **raster** for raster geodata



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...

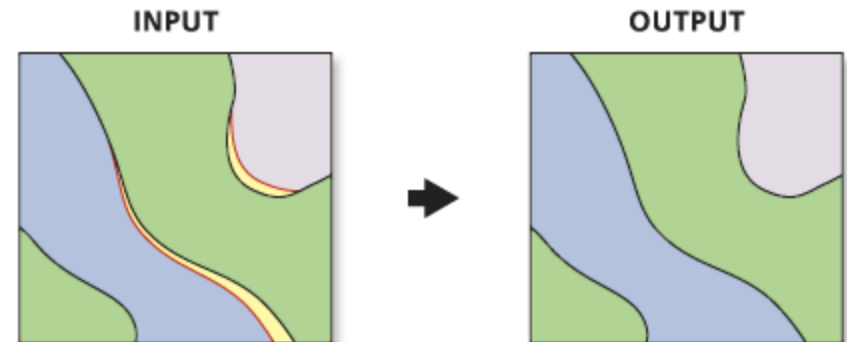


(digitizing)



(Geodatabase-functionality
and topology rules)

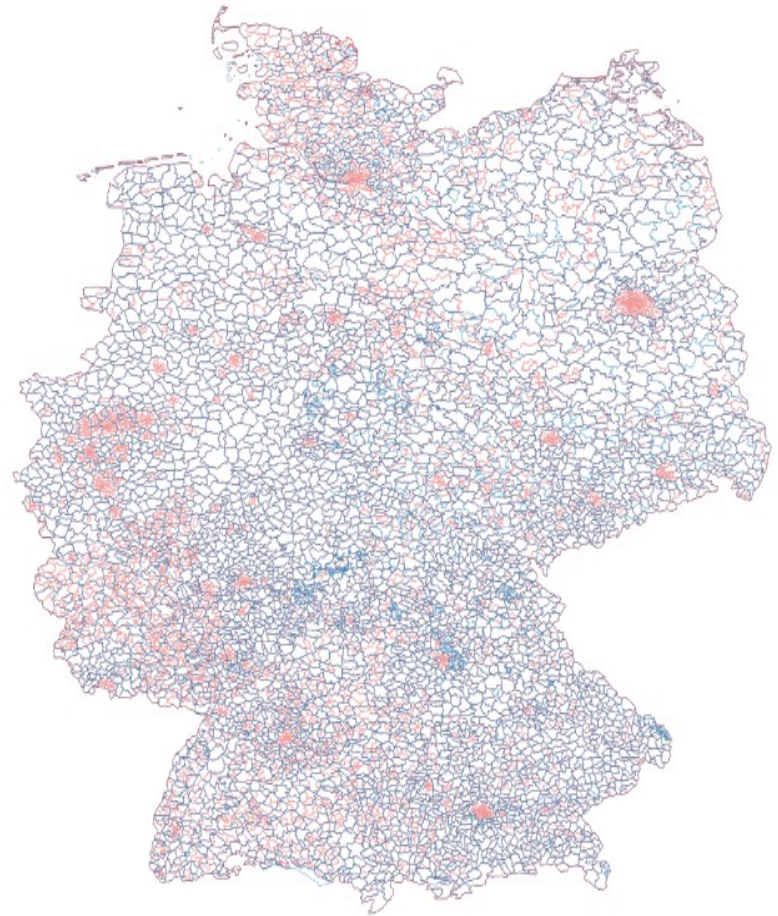
<http://www.unioneag.org>



Computationally demanding operations

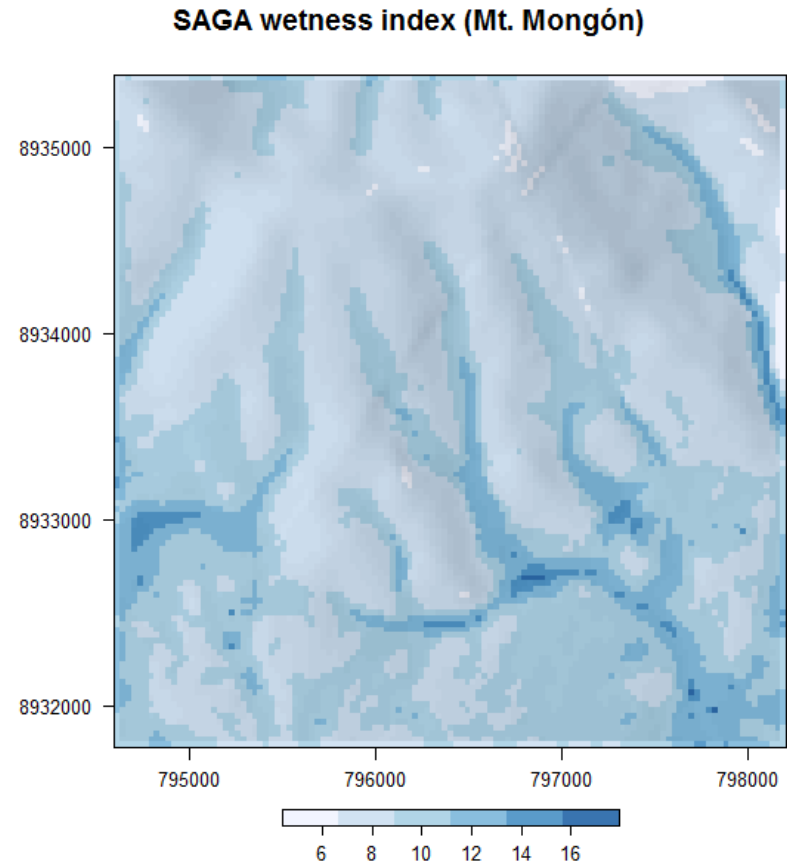


- Computationally demanding operations



Missing geoalgorithms

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

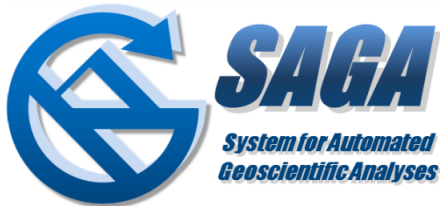


Interface



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

R-GIS bridges



RSAGA



RQGIS



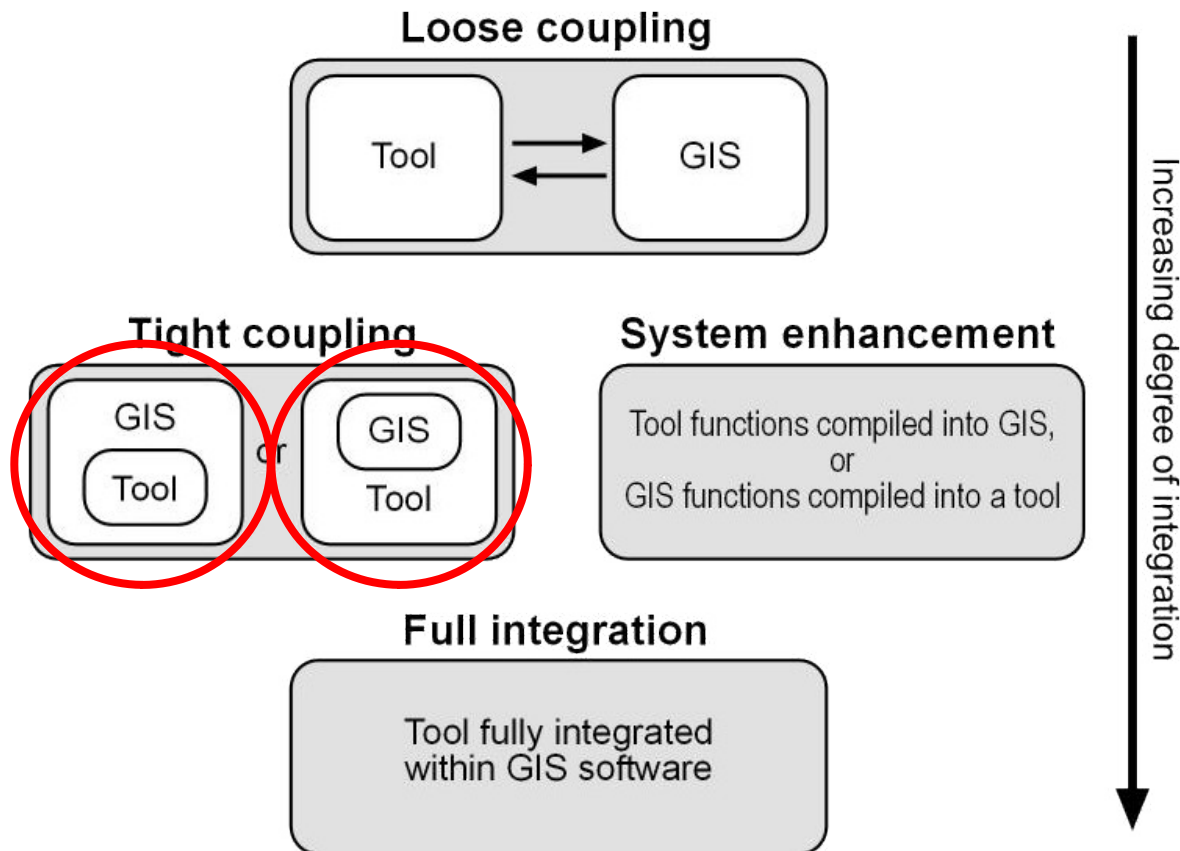
GRASS GIS

rgrass7



RPyGeo

GIS interfaces



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

GIS-R bridges - GRASS



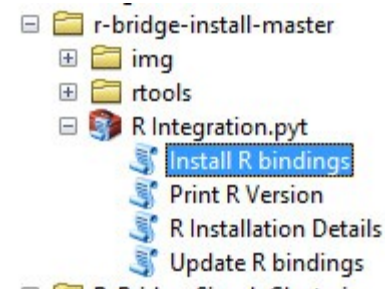
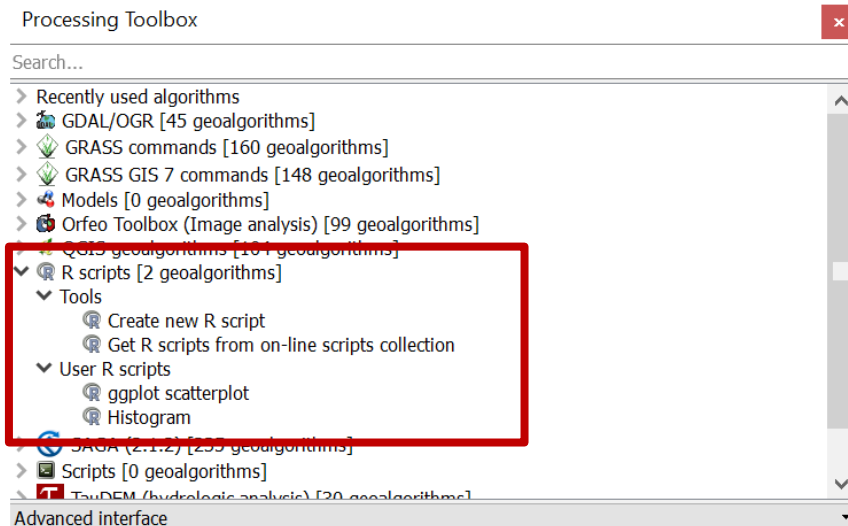
```
GRASS GIS 7.2.1 Ebenen-Manager
Datei  Einstellungen  Raster  Vektor  Bildverarbeitung  3D raster  Datenbank  Temporal  Hilfe

Rterm (64-bit)
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
> 
```


GIS-R bridges – QGIS & ArcGIS



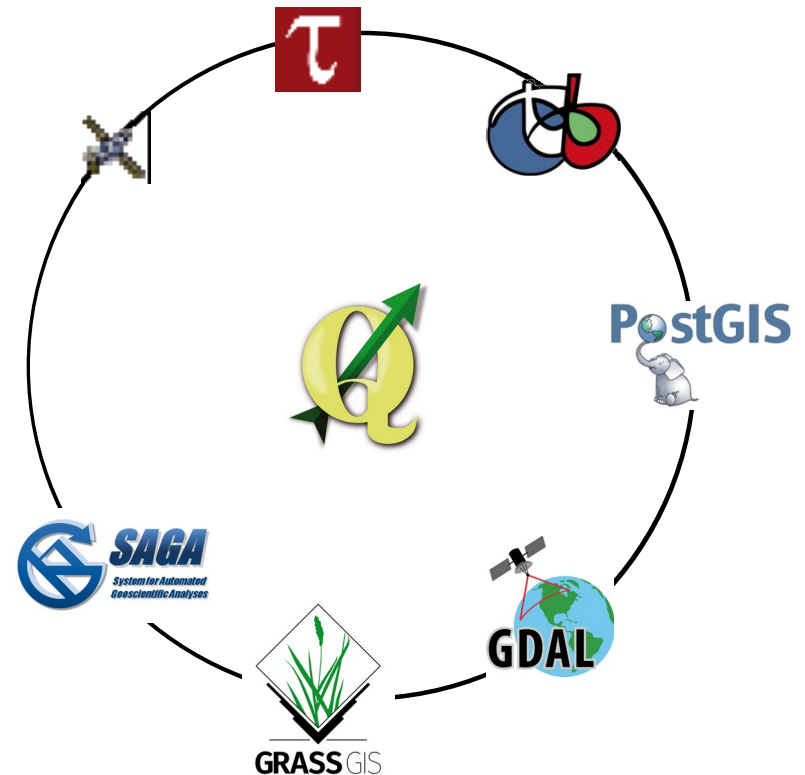
<https://www.r-bloggers.com/combining-arccgis-and-r-clustering-toolbox/>



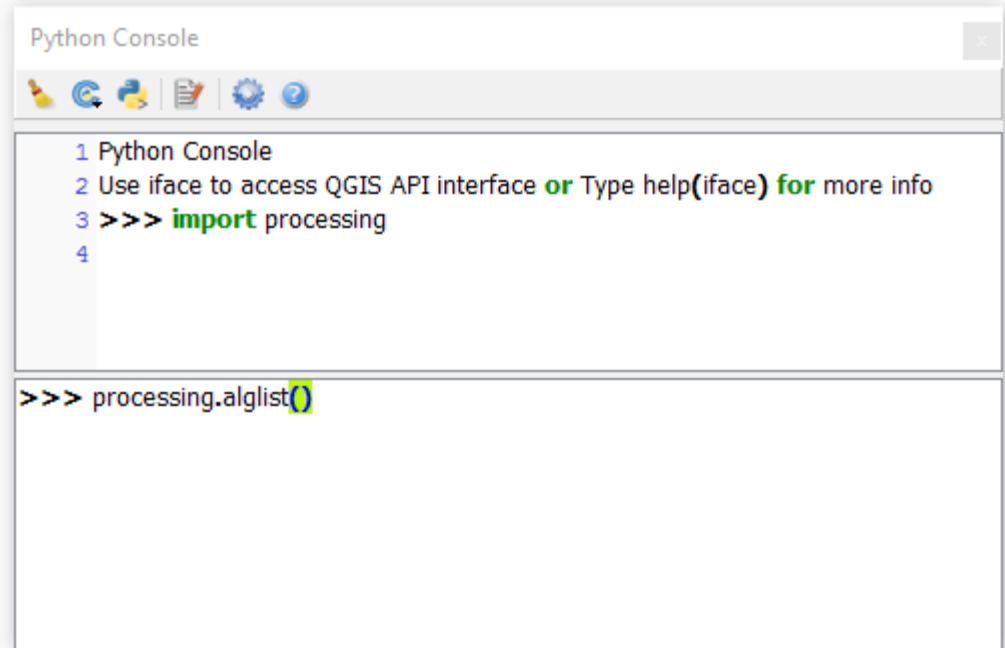
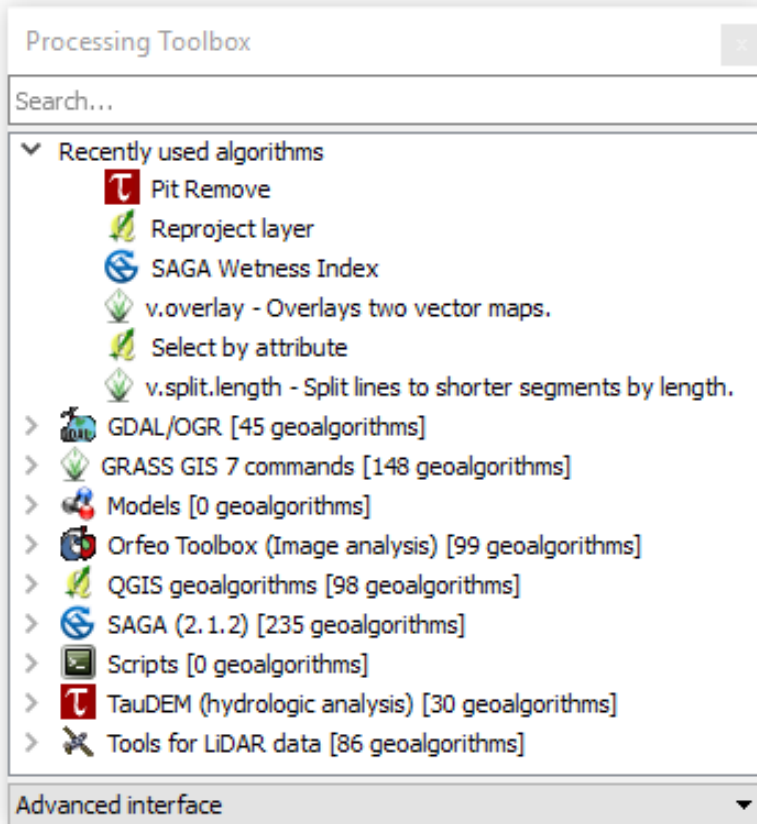
R-GIS BRIDGES

Why (R)QGIS?

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

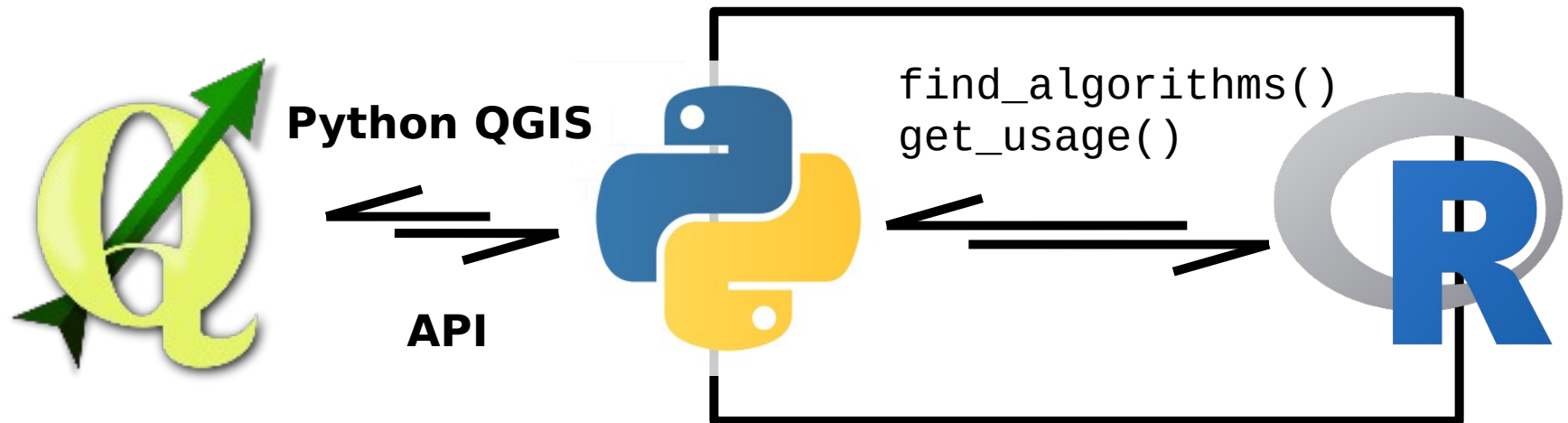


QGIS – Python API



Python tunnel via reticulate

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



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")
```

Most notable features of RQGIS

- Access to native QGIS geoalgorithms
- Access to hundreds of further geoalgorithms, especially SAGA- and GRASS-geoalgorithms but also other third-party providers
- R users can stay in their environment without having to touch Python
- Support of R named arguments and automatic retrieval of default values
- Data conversions

(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.asci.grid`



The R-GRASS interface

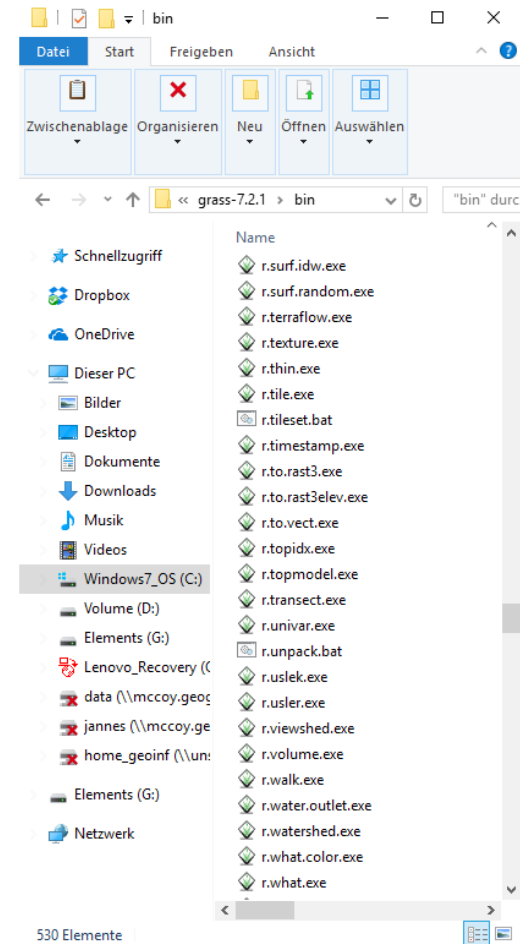
- First released in 1984
- In the beginning developed by the US Army (1982 – 1995), also with a focus on raster processing
- Since 1997 developed by scientists/user community
- >500 geoalgorithms
- Great documentation
- Uses SQLite as a geodatabase in the background





The R-Grass interface

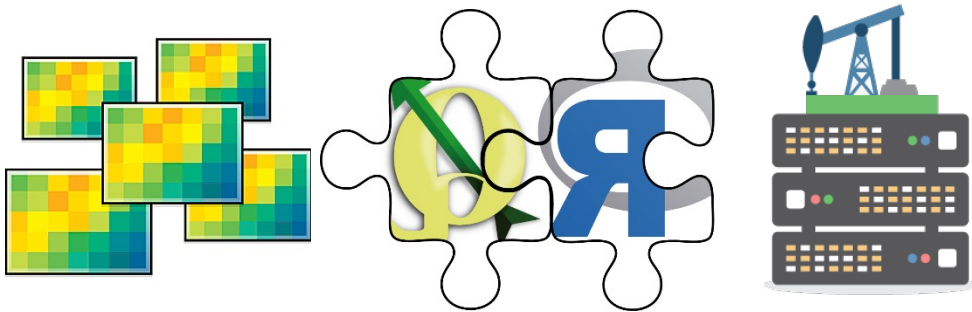
“GRASS is a very large but very simple system – it is run as a collection of separate programs built using shared libraries of core functions. There is then no GRASS ‘program’, just a script setting environment variables needed by the component programs” (Bivand et al. 2008: 99).



If you want to know more...



- [Bridges to GIS software](#)
- [RQGIS R Journal paper](#)



R-GIS EXAMPLES

Study area – Mount Mongón



Source: Google Earth.

Lomas – scientific context

- 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



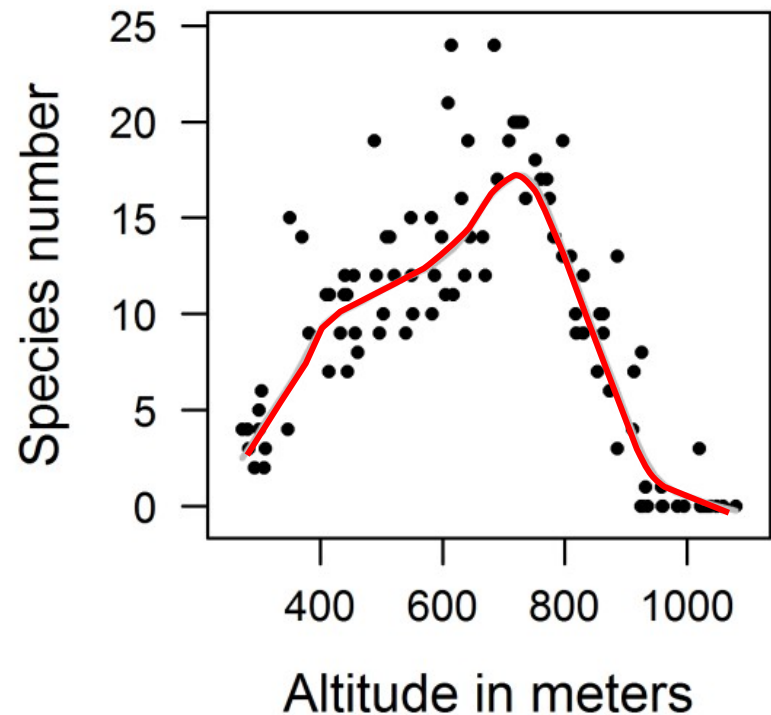
Austral winter



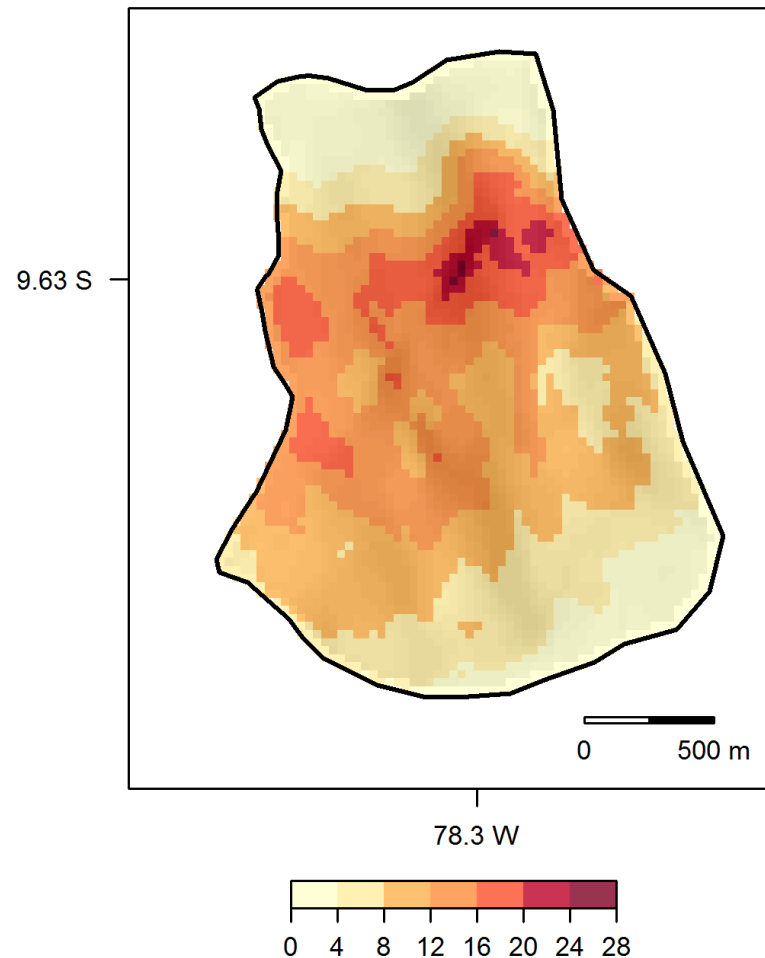
Non-linear Poisson model

Predictors:

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

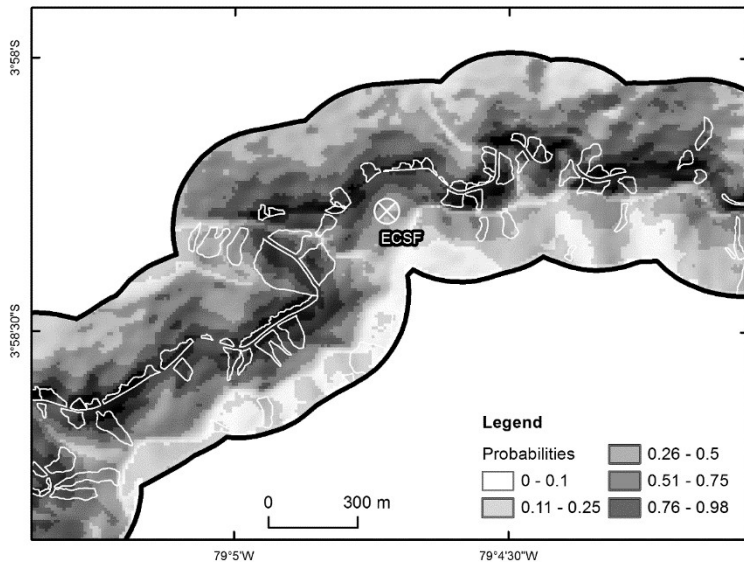


Spatial prediction of plant species diversity



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

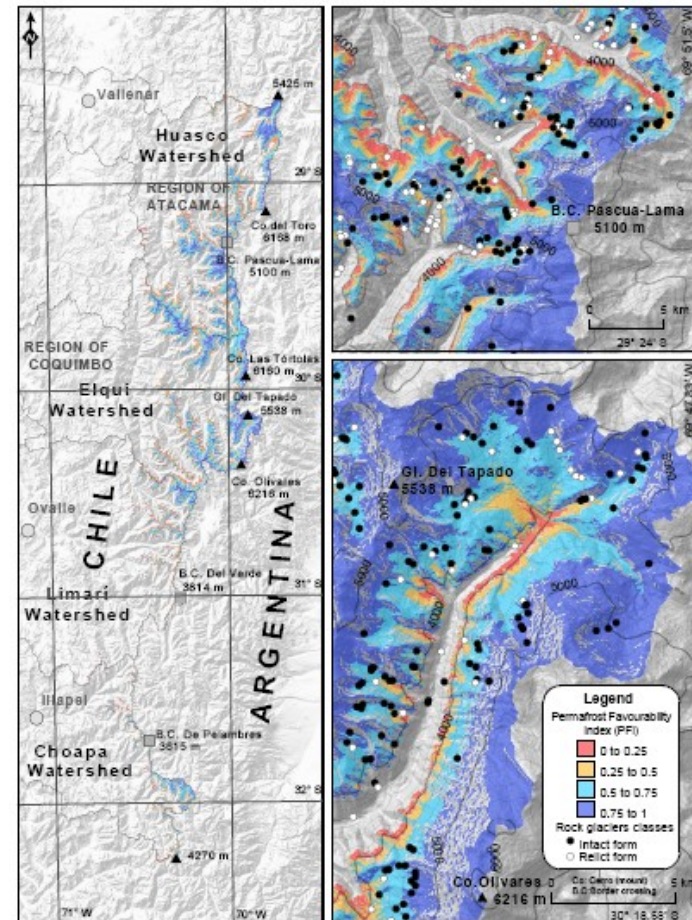
Landslide susceptibility



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

Rock glaciers/permafrost

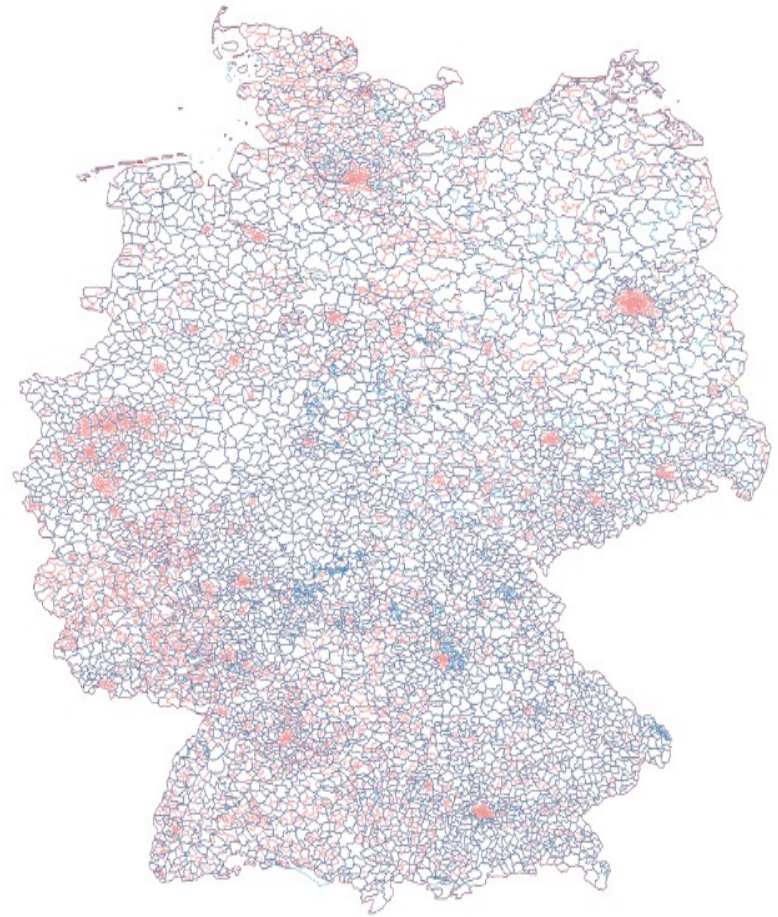
- Computation of direct and diffuse incoming solar radiation



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

Geomarketing

- Unioning postal code with municipality layers



Further applications

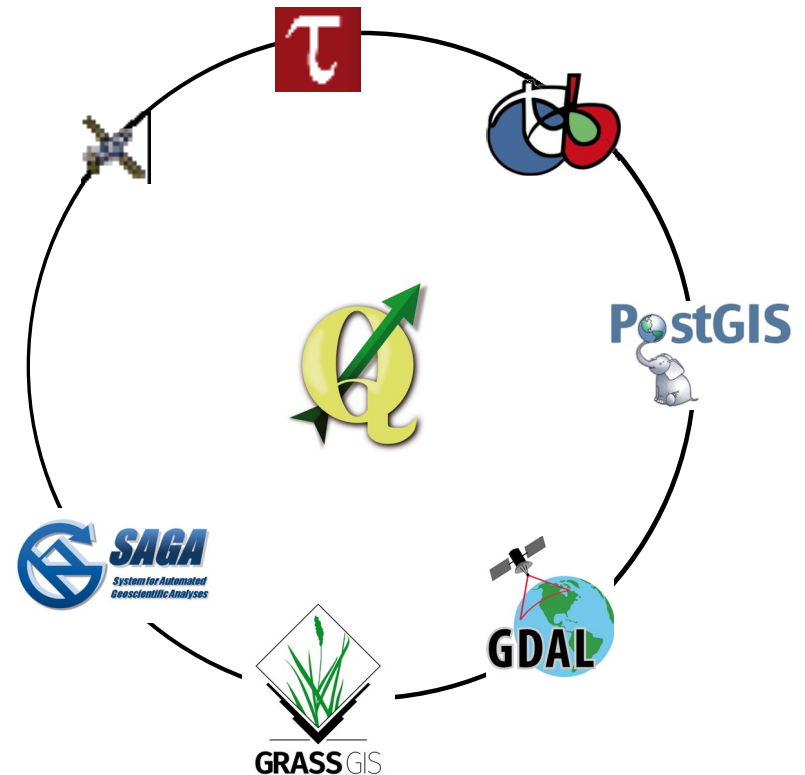
- Soil classes and mapping (e.g., Brungard et al. 2015)
- Stream networks (e.g., Hengl et al. 2010)
- Climatology (rainfall prediction; e.g., Hengl et al. 2010)
- Archeology (e.g., Borck 2016)
- Socio-demography (population index prediction; e.g., Bajat et al. 2012)
- ...



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:

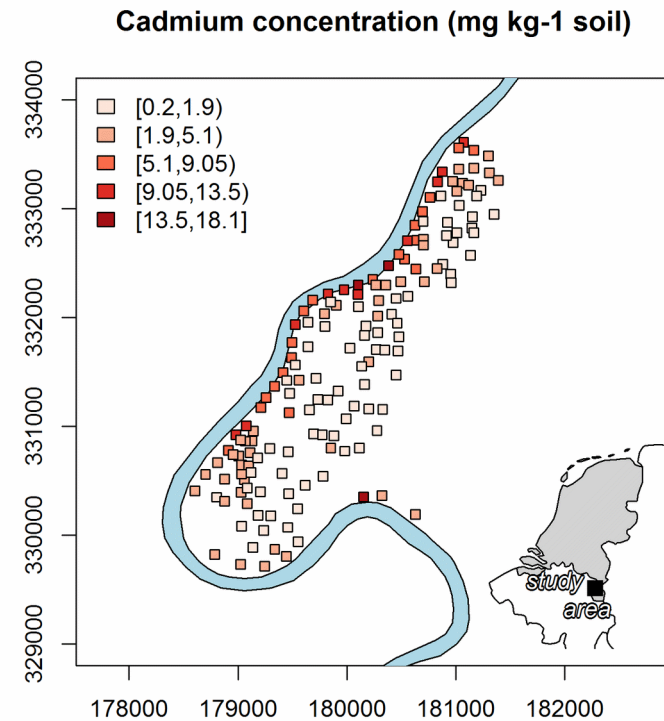
- QGIS does not provide access to all SAGA and GRASS functionalities
- RSAGA has special geocomputing functions (written in R)
- QGIS establishes a new GRASS session for each call and barely supports the GRASS geodatabase



Wrap-up



- We can use R as a GIS



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

Wrap-up



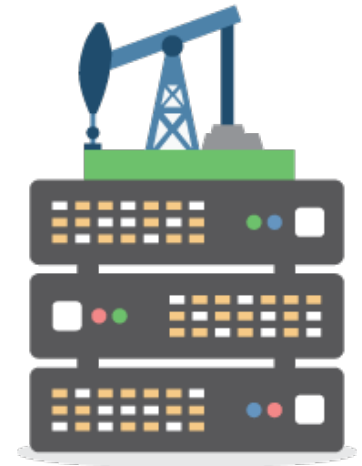
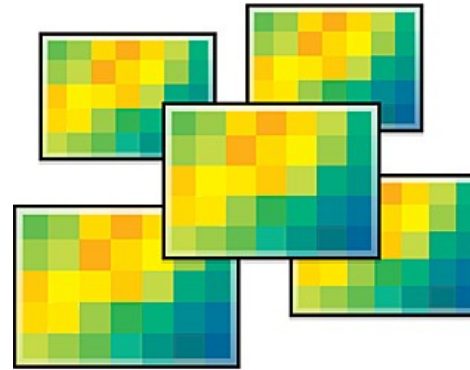
- We can use R as a GIS
- Geoprocessing is (often) better done with the help of a GIS



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



Literature

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