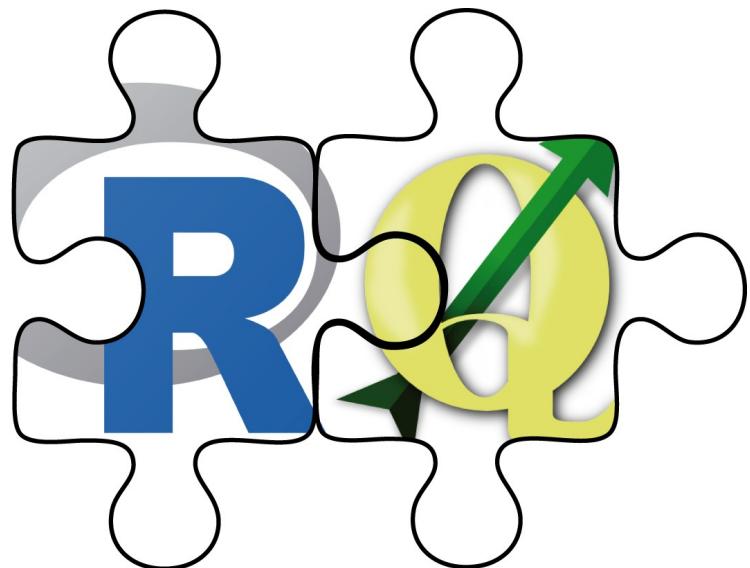




```
882 #' # the three output rasters are returned in a list of length 3  
883 #' terrain  
884 #' }  
885  
886 run_qgis <- function(alg = NULL, ..., params = NULL, load_output = FALSE,  
887                         show_output_paths = TRUE, qgis_env = set_env()) {  
888  
889 # check if the QGIS application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

R-GIS bridges for Statistical Geocomputing

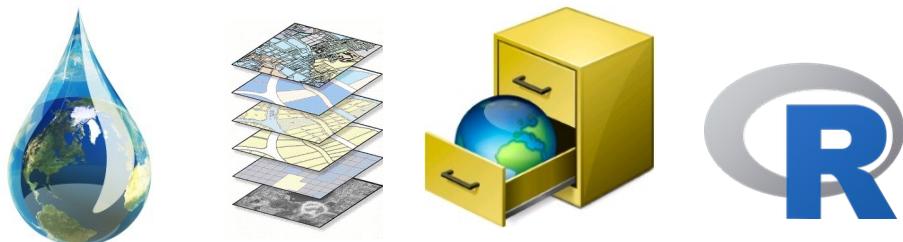
Jannes Muenchow





Where to find the material

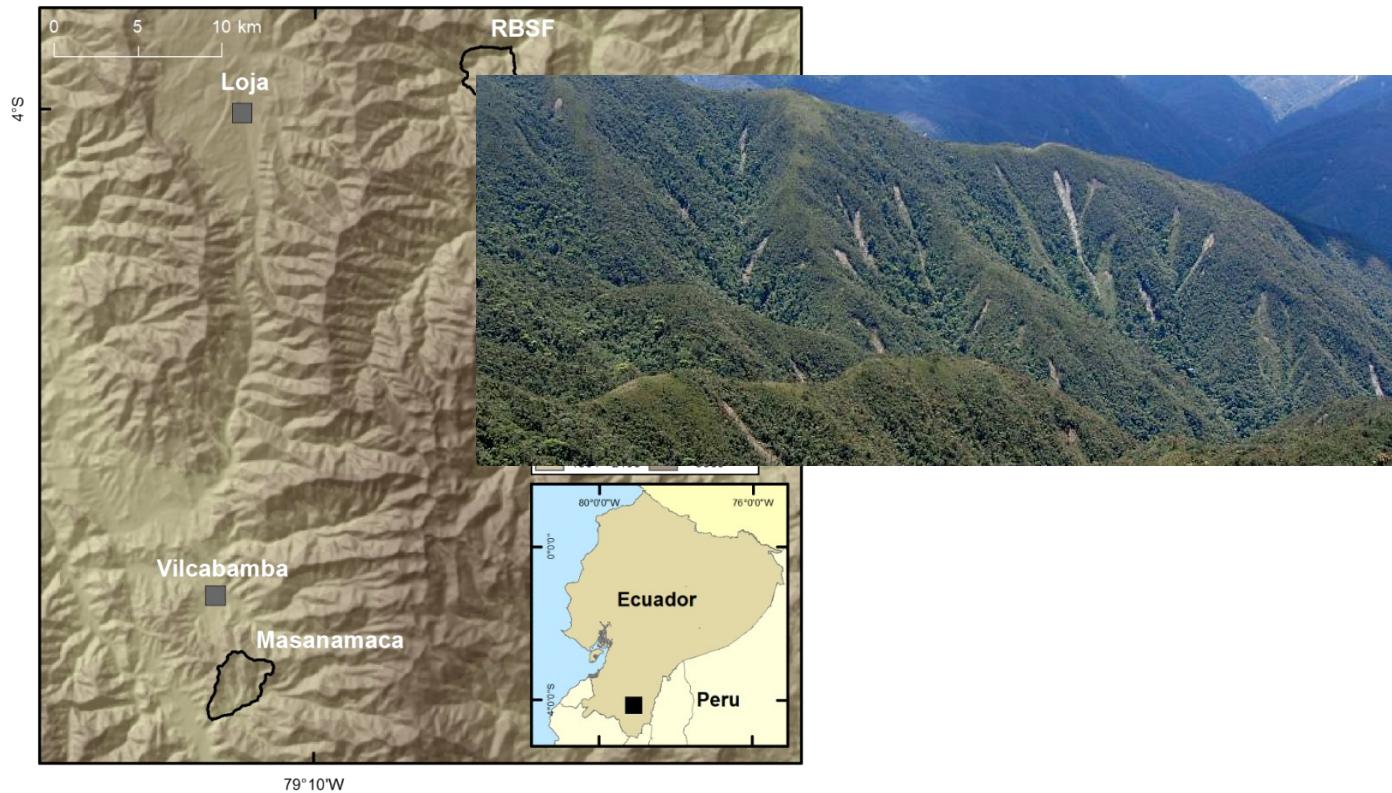
https://github.com/geocompr/geostats_18



WHO AM I?

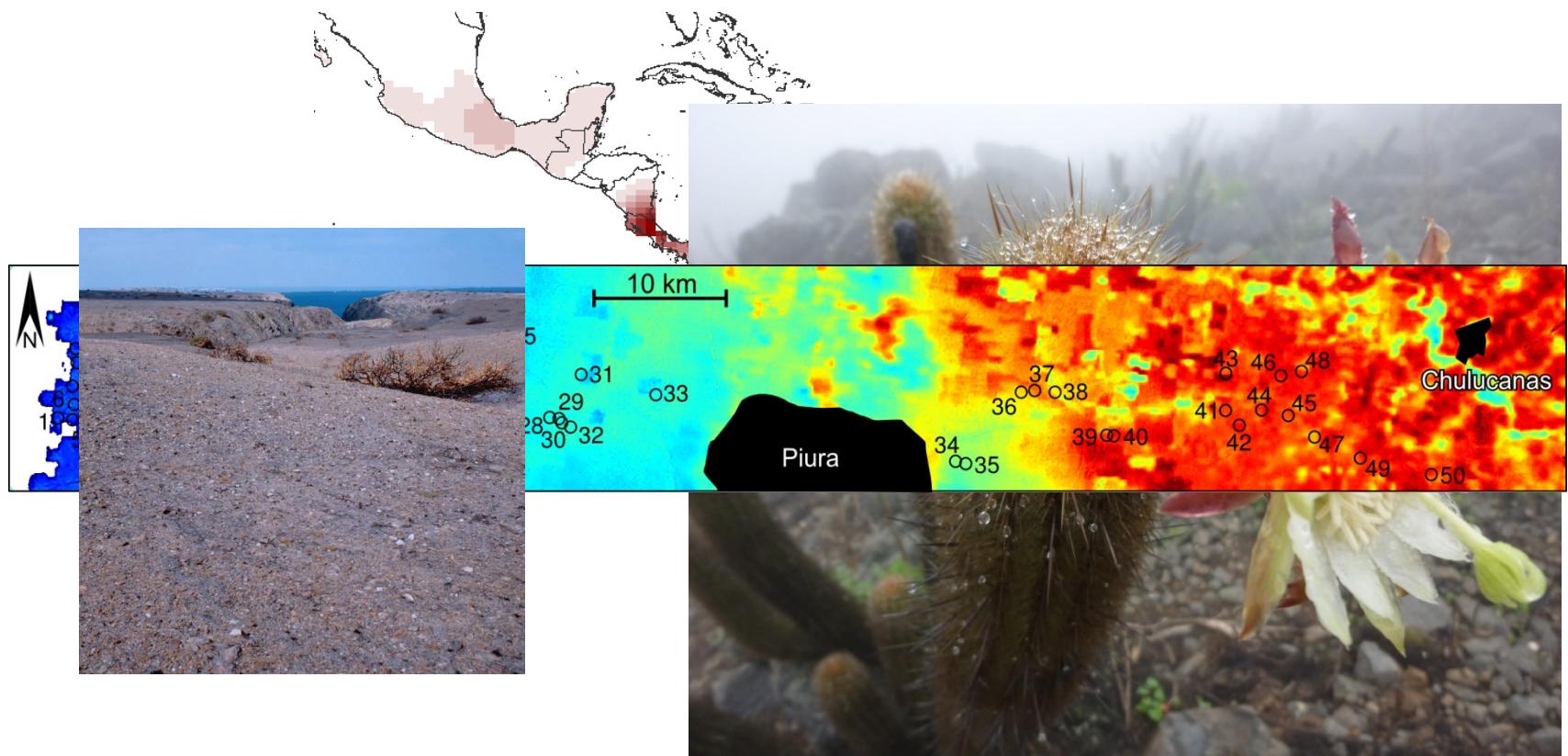


Landslide modeling





Tropical gradient studies





Geomarketing

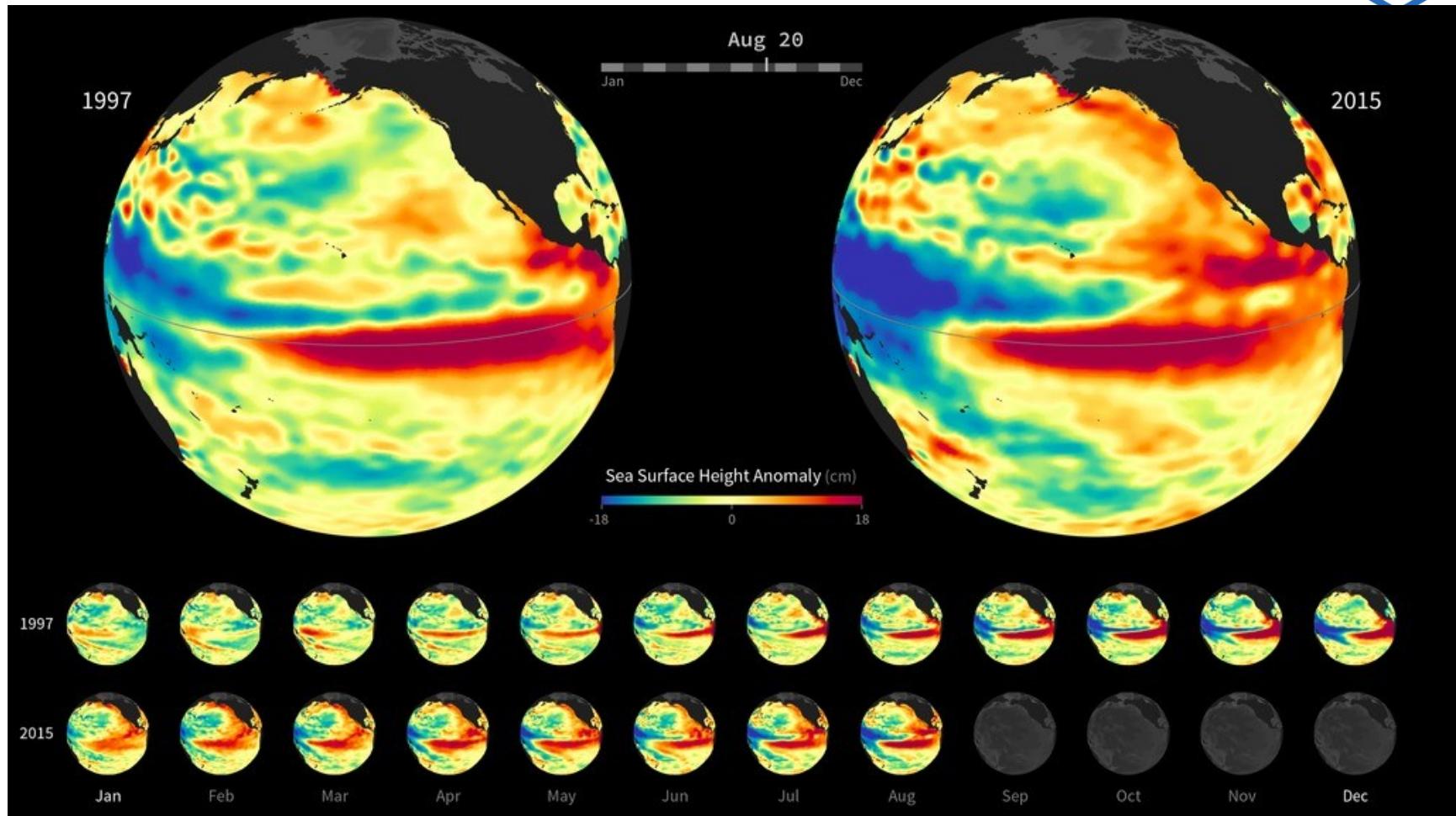
GfK's geomarketing solutions deliver answers to the many "where" questions that companies face.



<http://www.gfk-geomarketing.de/en/home.html>



El Niño

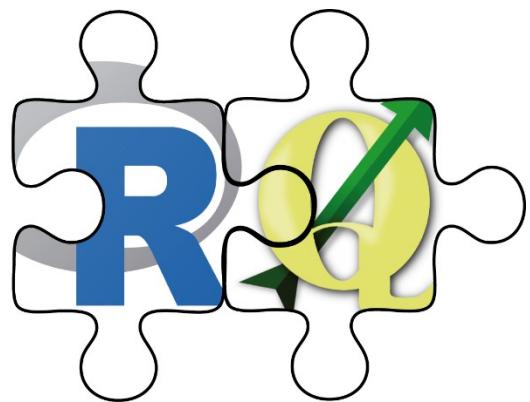


[http://snowbrains.com/noaa-so-is-this-the-strongest-el-nino-on-record-or-what/.](http://snowbrains.com/noaa-so-is-this-the-strongest-el-nino-on-record-or-what/>.)



2016 vs. 2017



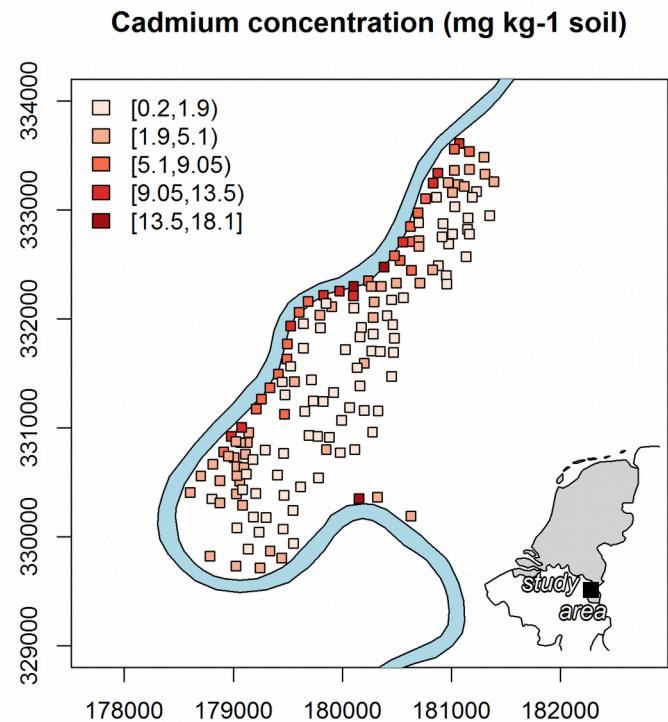


R/GIS BRIDGES



Contents

1. R as a GIS

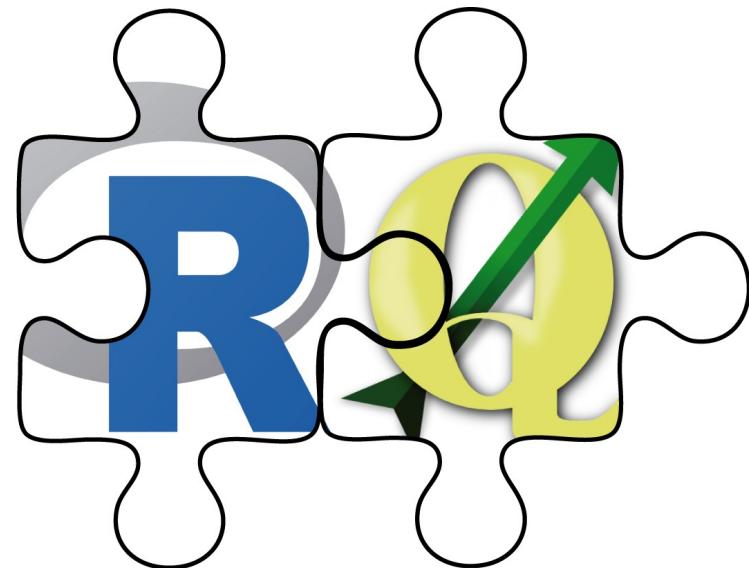


Data: Rikken, M.G.J & Van Rijn, R.P.G. (1993).



Contents

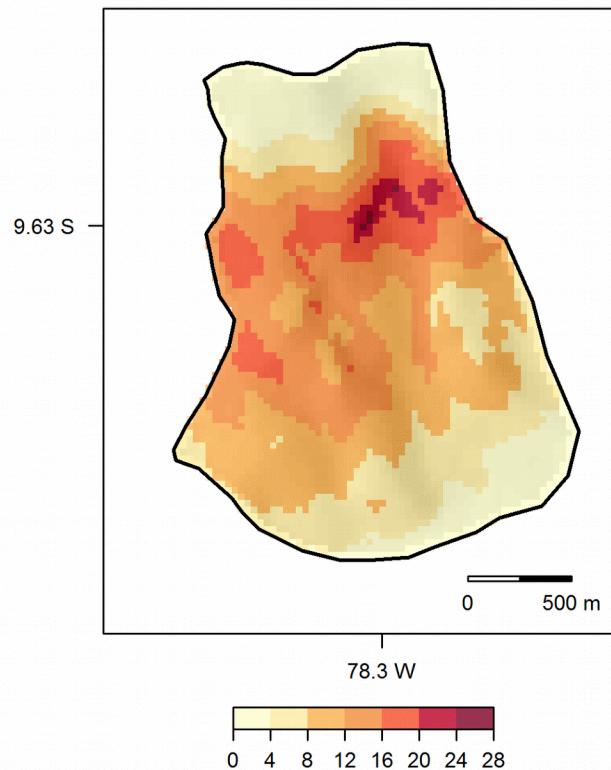
1. R as a GIS
2. R-GIS bridges





Contents

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



Contents



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



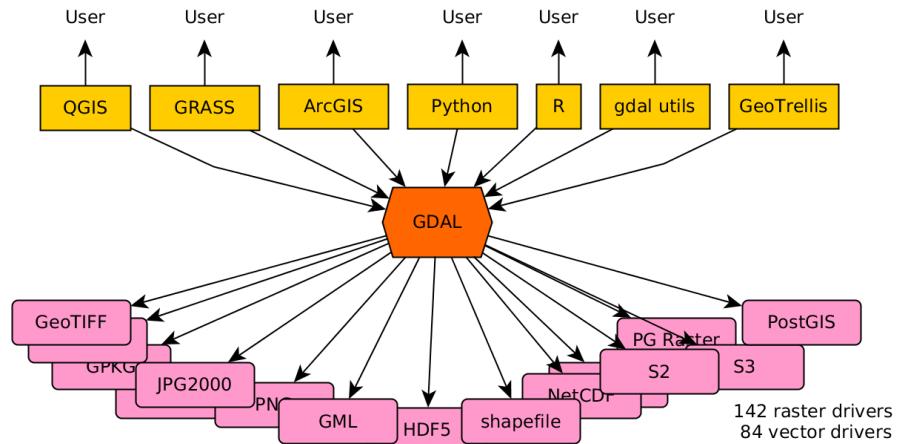


R AS A GIS



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

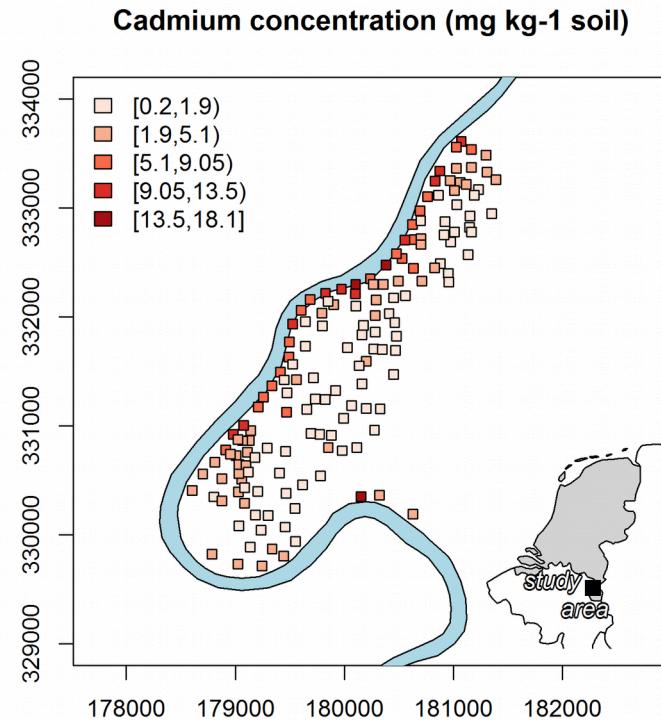


<http://r-spatial.org//2016/11/29/openeo.html>



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

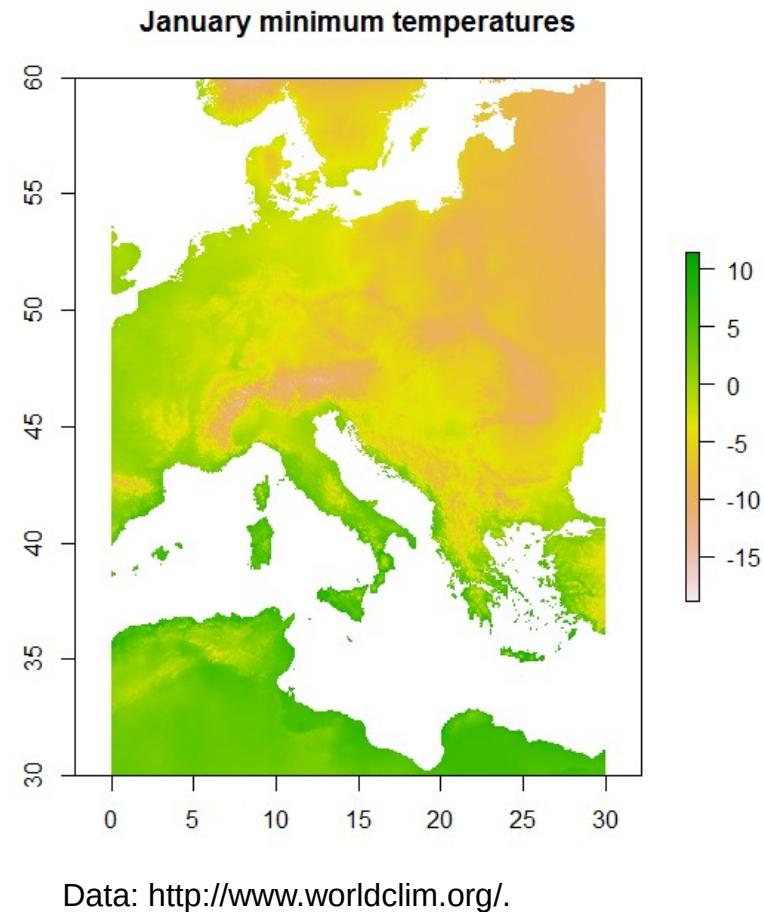


Data: Rikken, M.G.J & Van Rijn, R.P.G. (1993).



R as a GIS

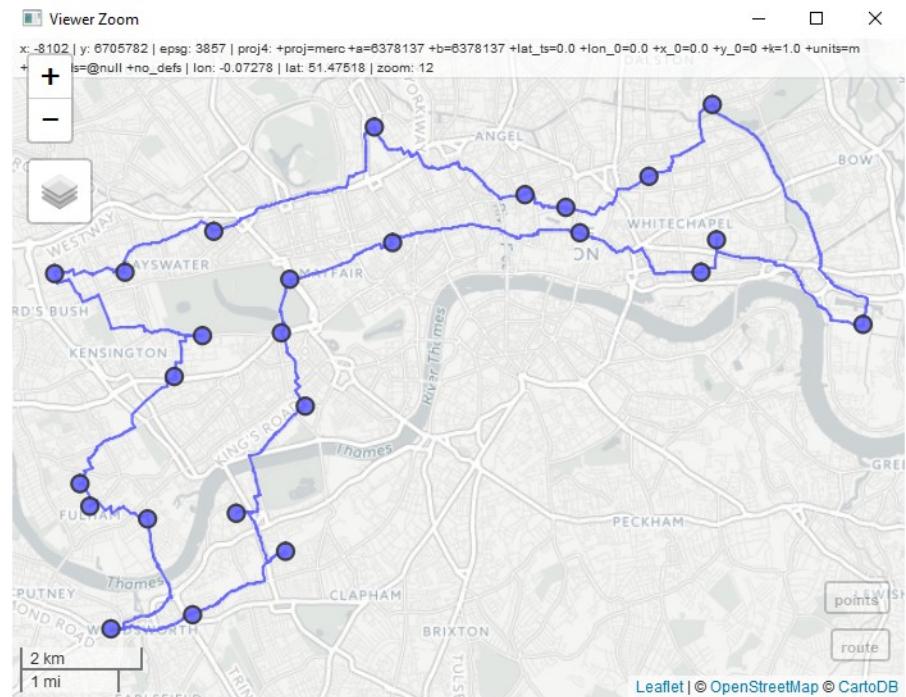
- More than 100 geo-related R packages (
<https://cran.r-project.org/web/views/Spatial.html>
)
- Package **rgdal** for importing and exporting geodata
- Packages **sp** and **sf** for vector geodata
- Package **raster** for raster geodata





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...

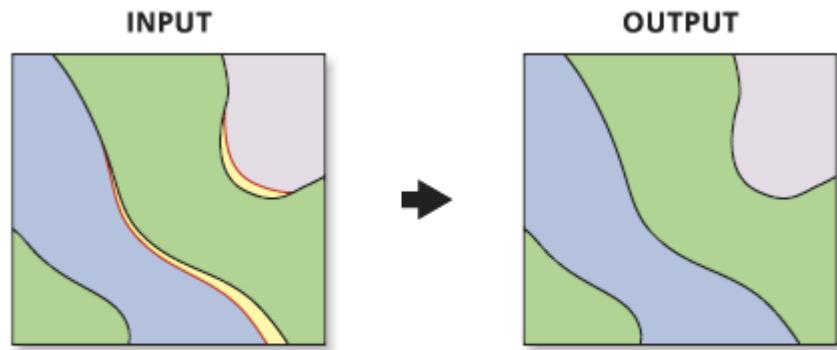


(digitizing)



(Geodatabase-functionality
and topology rules)

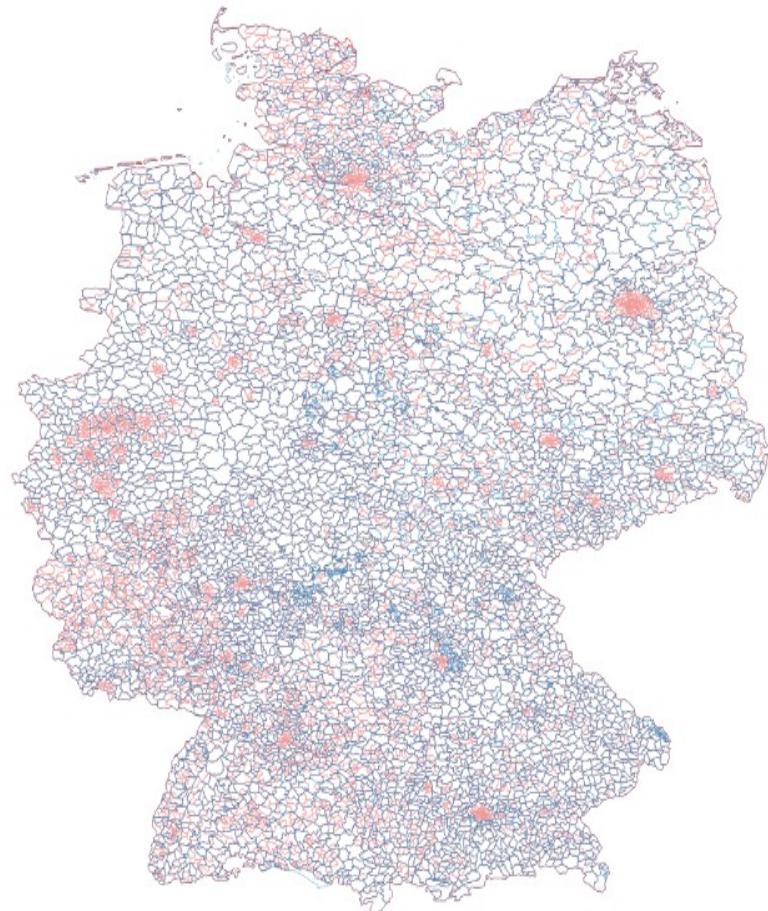
<http://www.unioneag.org>





Computationally demanding operations

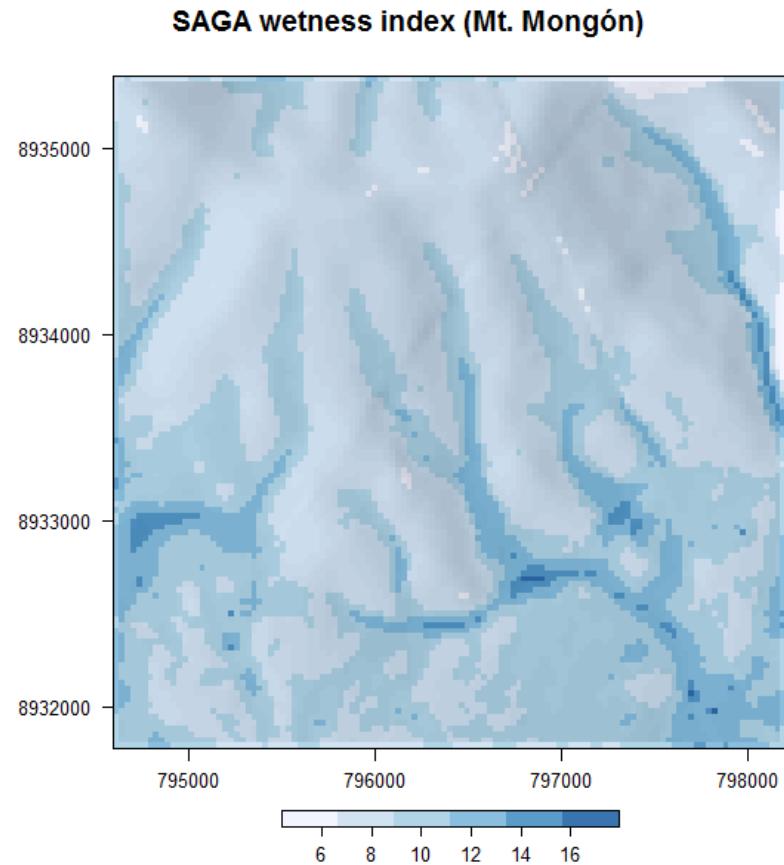
- Computationally demanding operations





Missing geoalgorithms

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



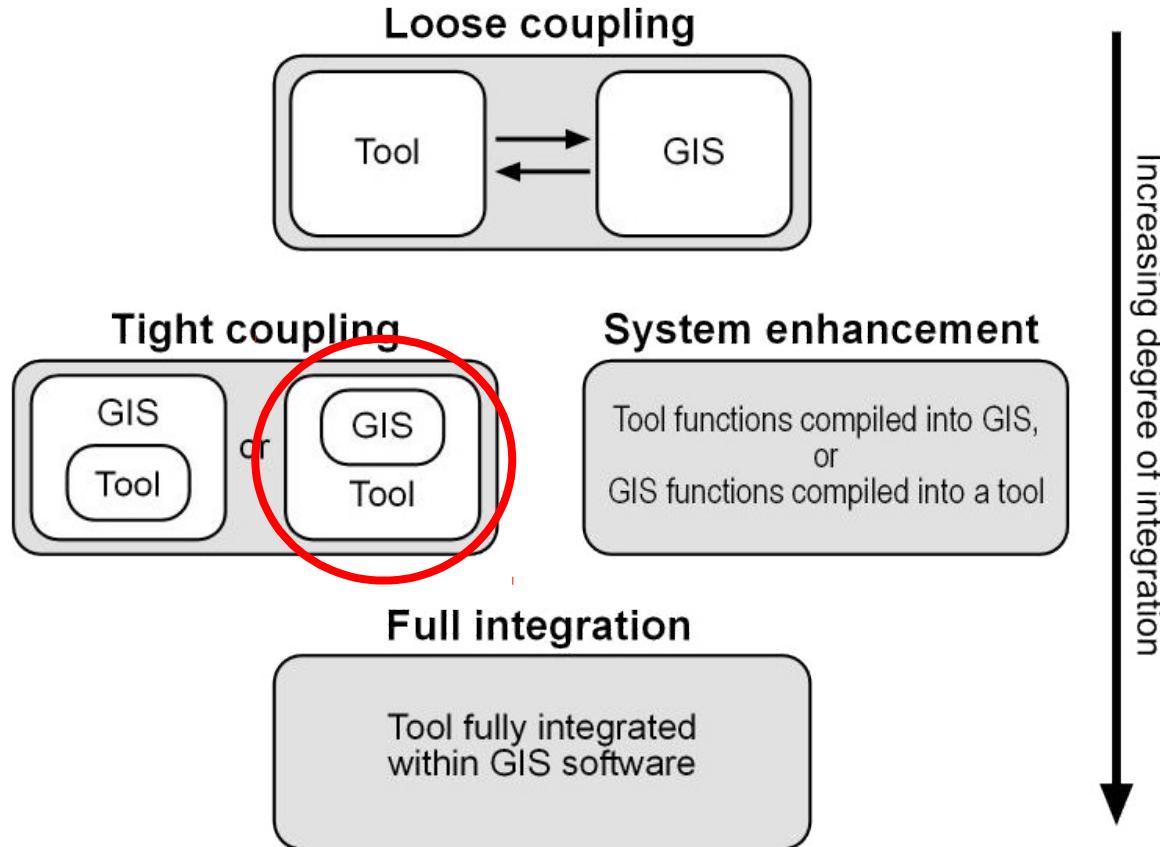
Interface



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



GIS interfaces



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

R-GIS bridges



RSAGA



RQGIS



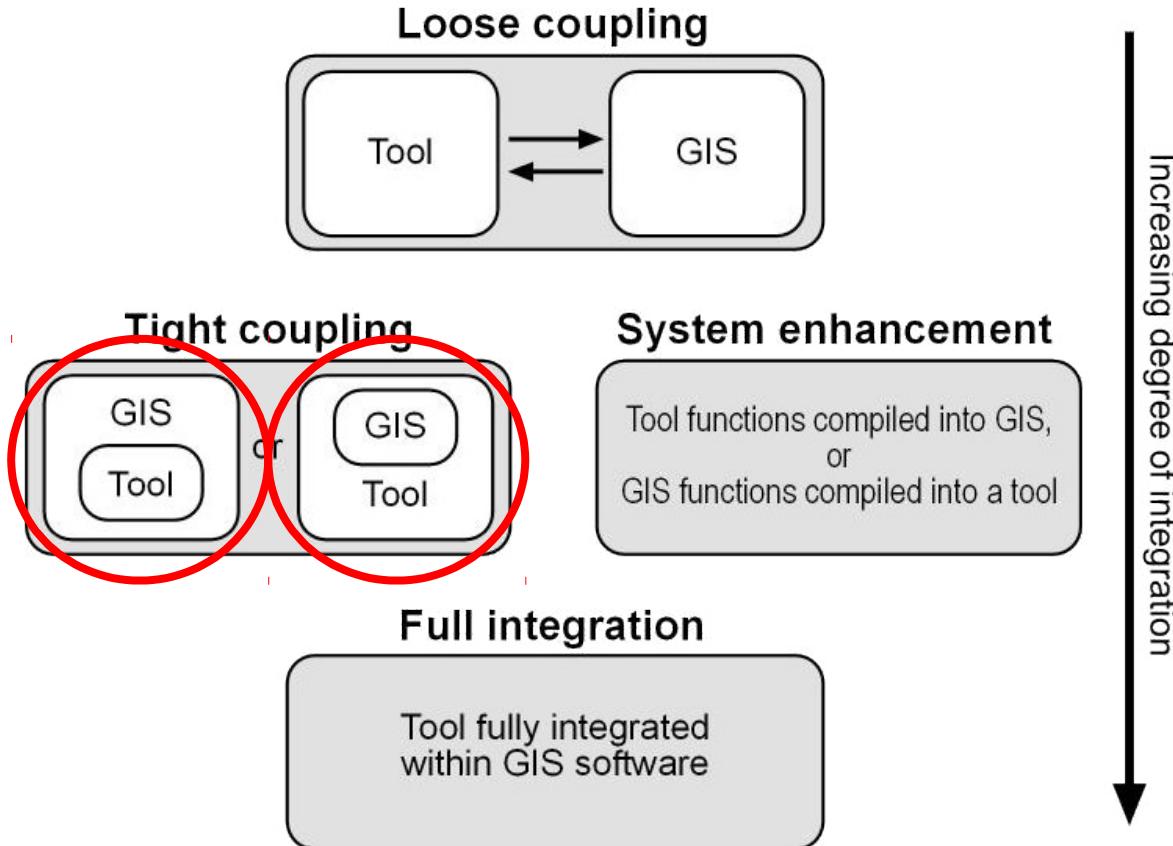
rgrass7



RPyGeo



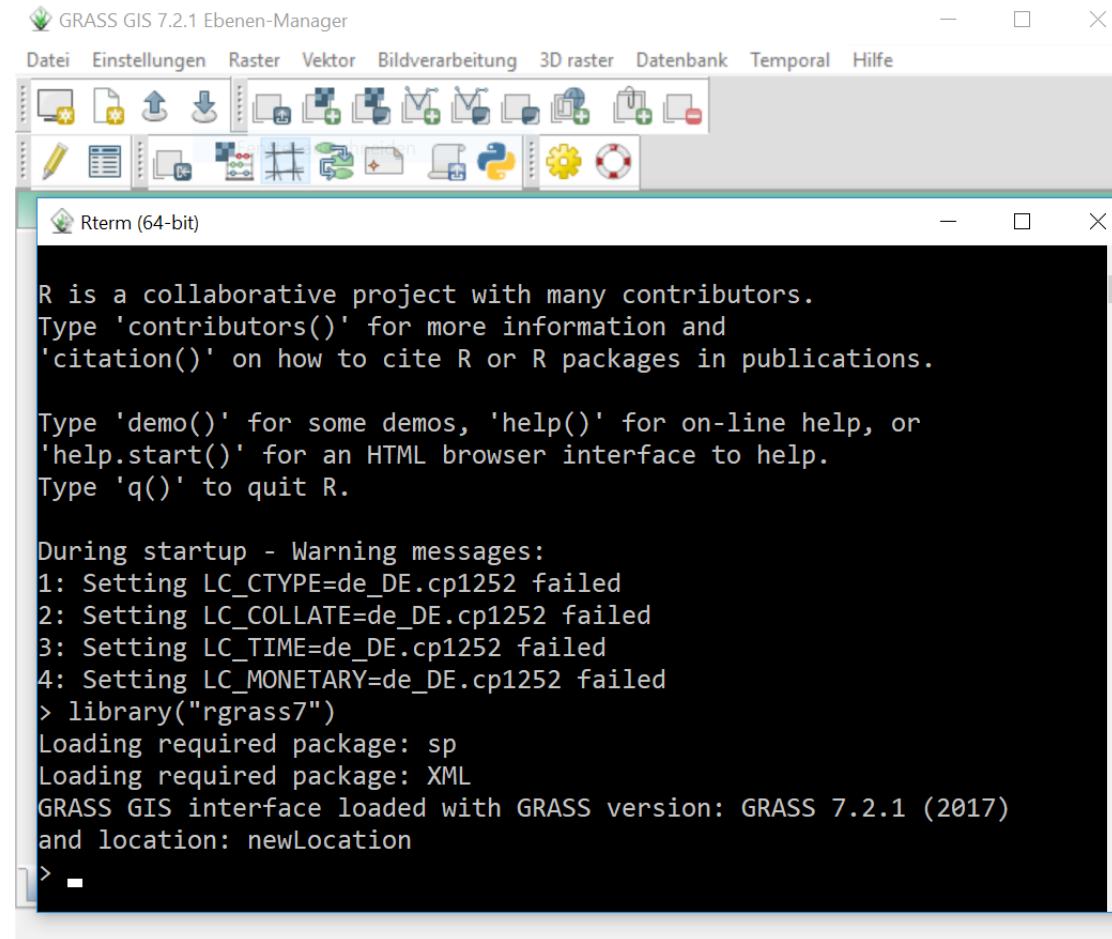
GIS interfaces



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



GIS-R bridges - GRASS

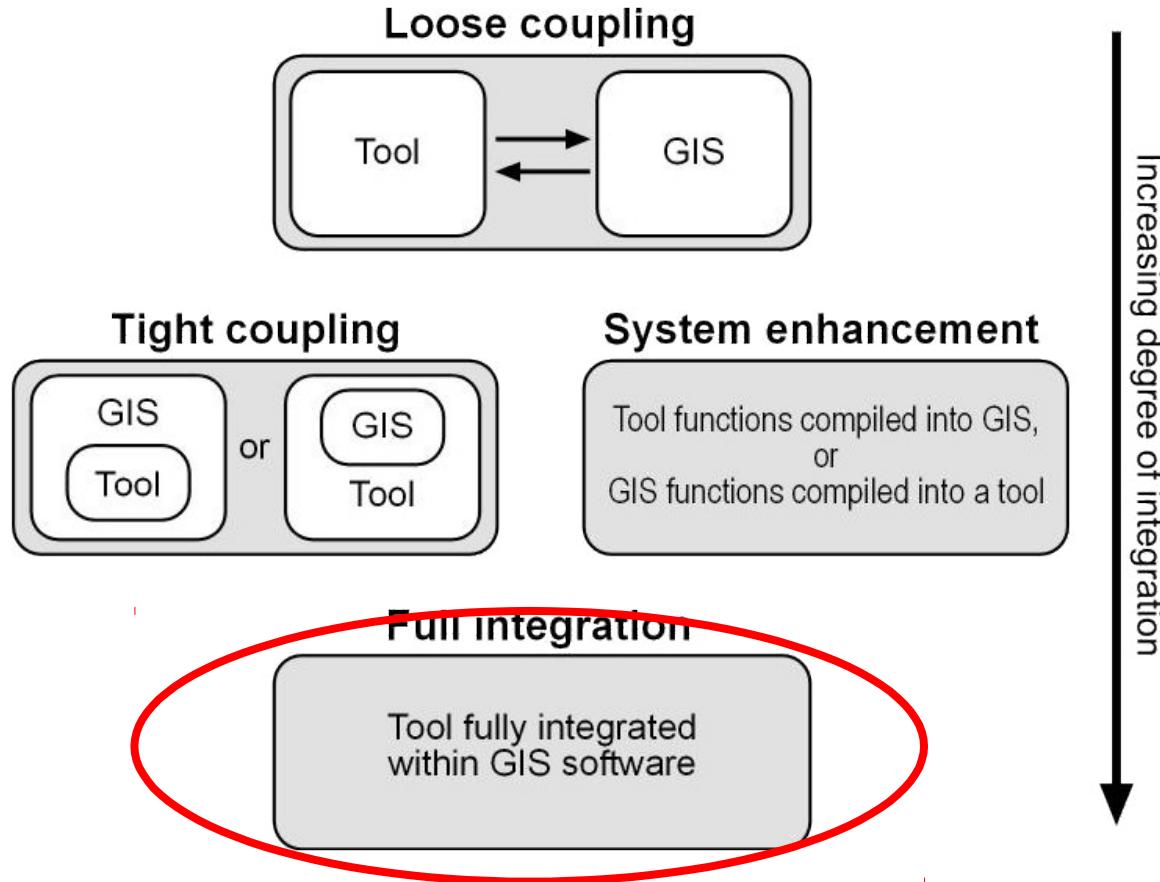


The screenshot shows the GRASS GIS 7.2.1 Ebenen-Manager application window. At the top, there is a menu bar with German labels: Datei, Einstellungen, Raster, Vektor, Bildverarbeitung, 3D raster, Datenbank, Temporal, and Hilfe. Below the menu is a toolbar with various icons for file operations like opening, saving, and zooming. A second toolbar below it contains icons for editing, selection, and analysis. The main area is a terminal window titled "Rterm (64-bit)". It displays the standard R startup message, followed by messages related to GRASS GIS integration:

```
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 interfaces



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



GIS-R bridges

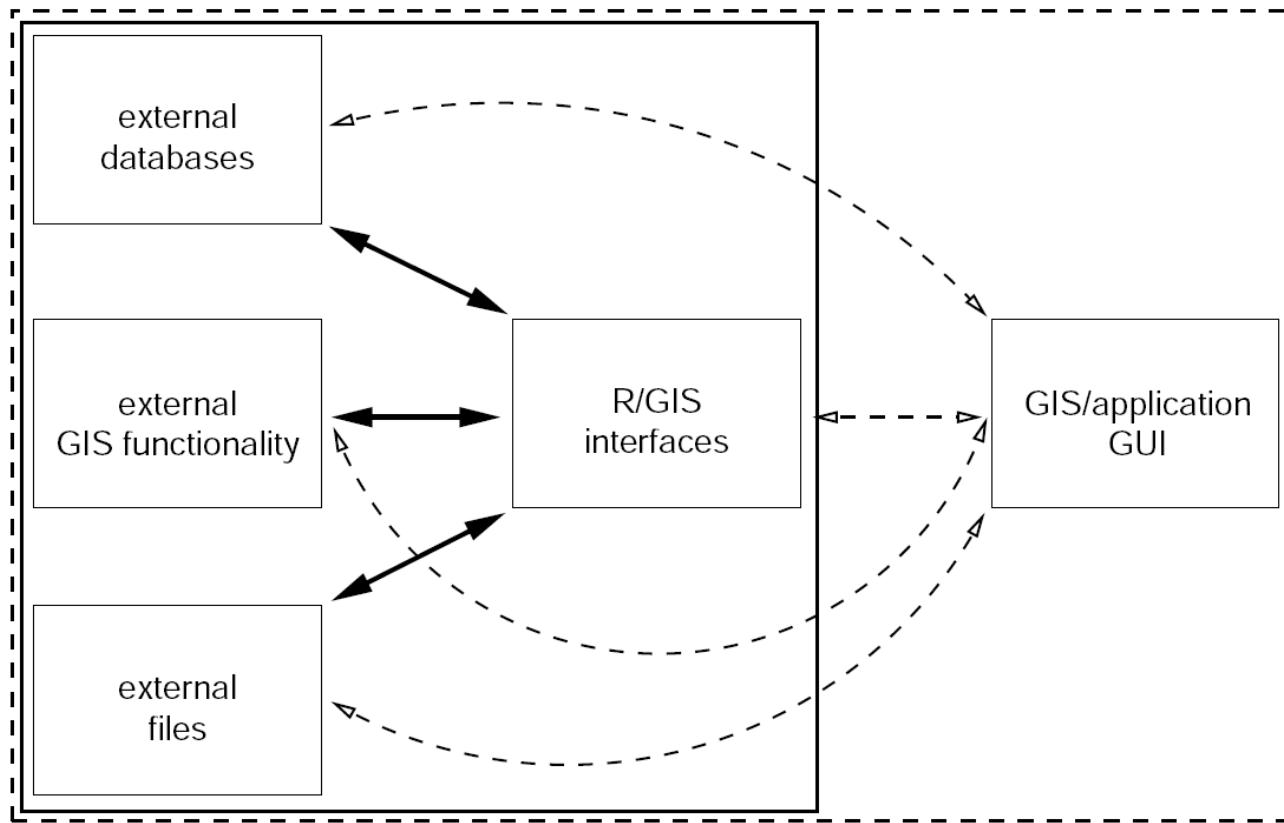


Figure taken from Bivand, 2014.



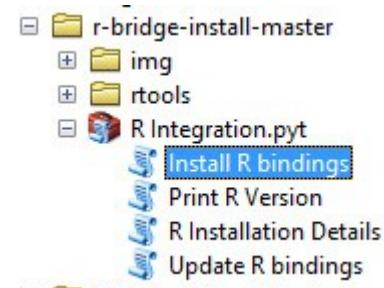
GIS-R bridges – QGIS & ArcGIS

Processing Toolbox

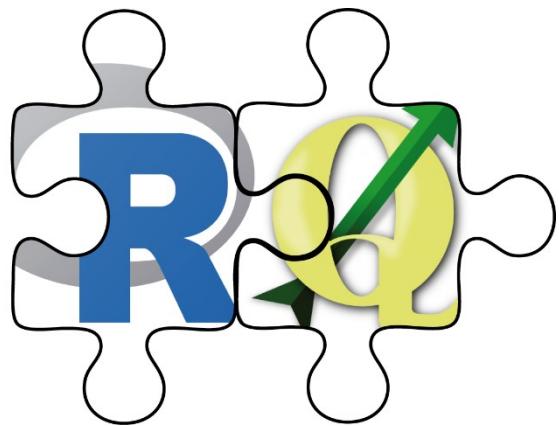
Search...

- > Recently used algorithms
- > GDAL/OGR [45 geoalgorithms]
- > GRASS commands [160 geoalgorithms]
- > GRASS GIS 7 commands [148 geoalgorithms]
- > Models [0 geoalgorithms]
- > Orfeo Toolbox (Image analysis) [99 geoalgorithms]
- > QGIS geoalgorithms [204 geoalgorithms]
- ✓ R scripts [2 geoalgorithms]
 - ▼ Tools
 - >Create new R script
 - Get R scripts from on-line scripts collection
 - ▼ User R scripts
 - ggplot scatterplot
 - Histogram
- ✓ SAGA (2.1.2) [255 geoalgorithms]
- > Scripts [0 geoalgorithms]
- > TauDEM (hydrologic analysis) [20 geoalgorithms]

Advanced interface



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

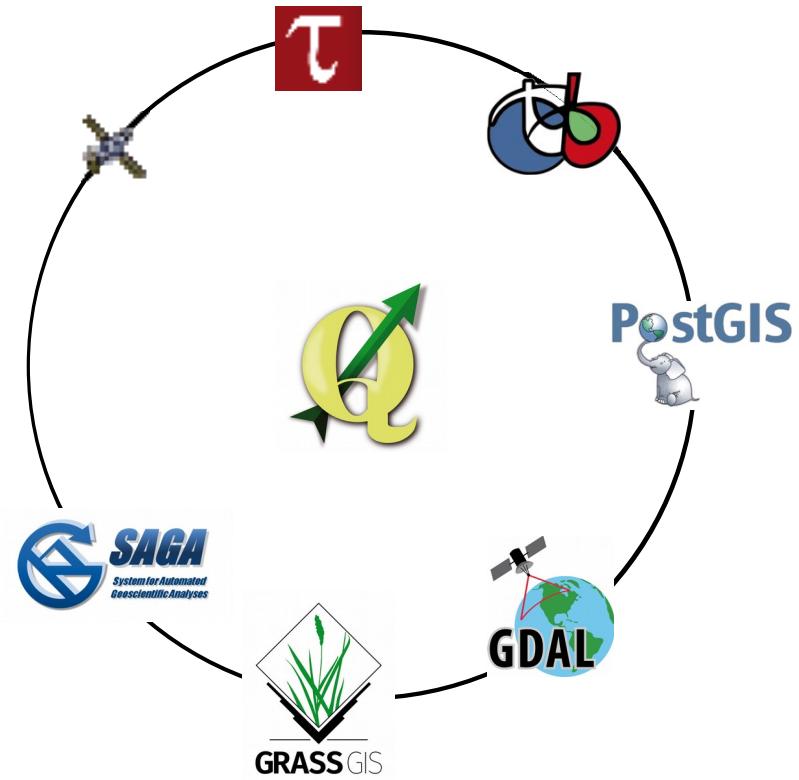


R-GIS BRIDGES



Why (R)QGIS?

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





QGIS – Python API

Processing Toolbox

Search...

Recently used algorithms

- Pit Remove
- Reproject layer
- SAGA Wetness Index
- v.overlay - Overlays two vector maps.
- Select by attribute
- v.split.length - Split lines to shorter segments by length.

GDAL/OGR [45 geoalgorithms]

GRASS GIS 7 commands [148 geoalgorithms]

Models [0 geoalgorithms]

Orfeo Toolbox (Image analysis) [99 geoalgorithms]

QGIS geoalgorithms [98 geoalgorithms]

SAGA (2.1.2) [235 geoalgorithms]

Scripts [0 geoalgorithms]

TauDEM (hydrologic analysis) [30 geoalgorithms]

Tools for LiDAR data [86 geoalgorithms]

Advanced interface ▾

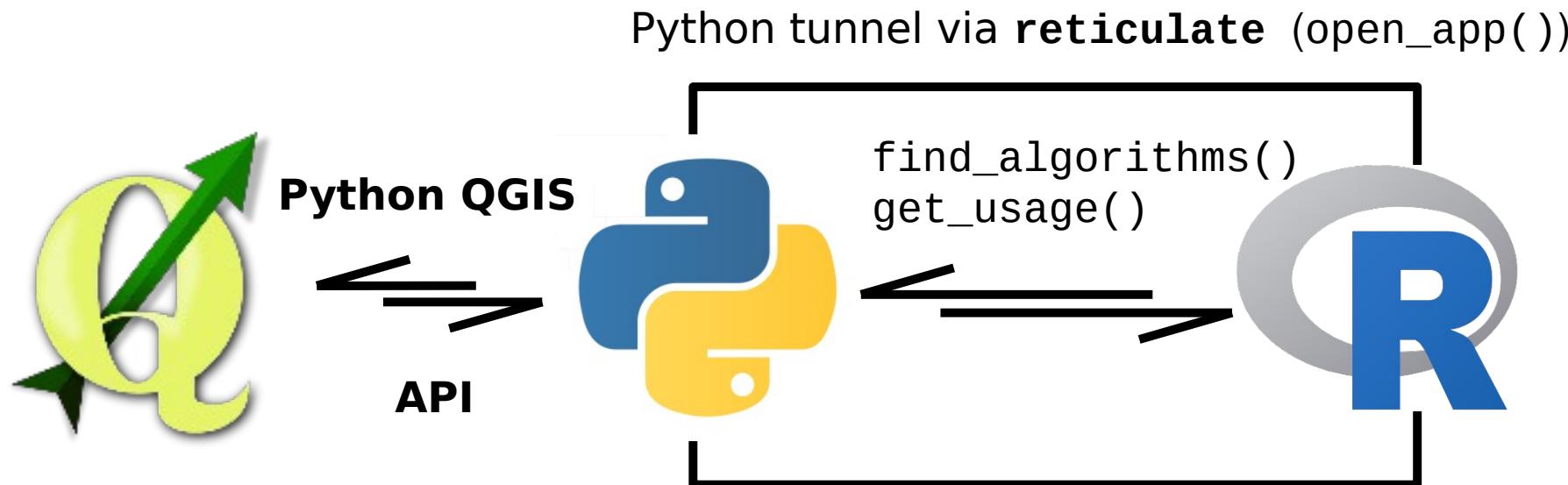
Python Console

1 Python Console
2 Use iface to access QGIS API interface or Type help(iface) for more info
3 >>> import processing
4

```
>>> processing.alglist()
```



Python tunnel via **reticulate**





Example

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

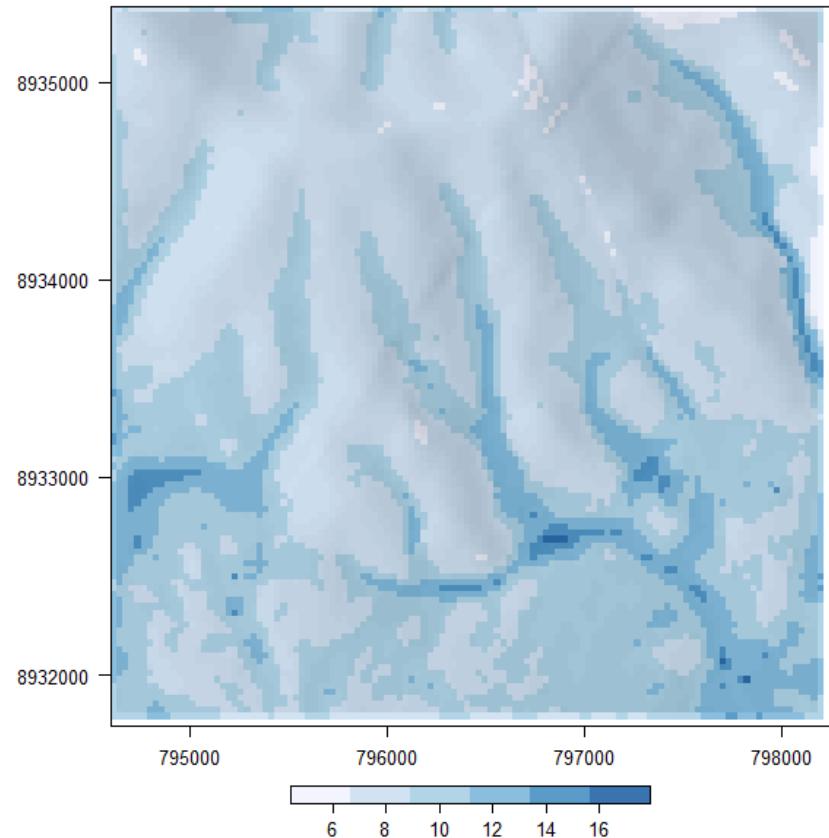
```
ALGORITHM: Saga wetness index
  DEM <ParameterRaster>
  SUCTION <ParameterNumber>
  AREA_TYPE <ParameterSelection>
  SLOPE_TYPE <ParameterSelection>
  SLOPE_MIN <ParameterNumber>
  SLOPE_OFF <ParameterNumber>
  SLOPE_WEIGHT <ParameterNumber>
  AREA <OutputRaster>
  SLOPE <OutputRaster>
  AREA_MOD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

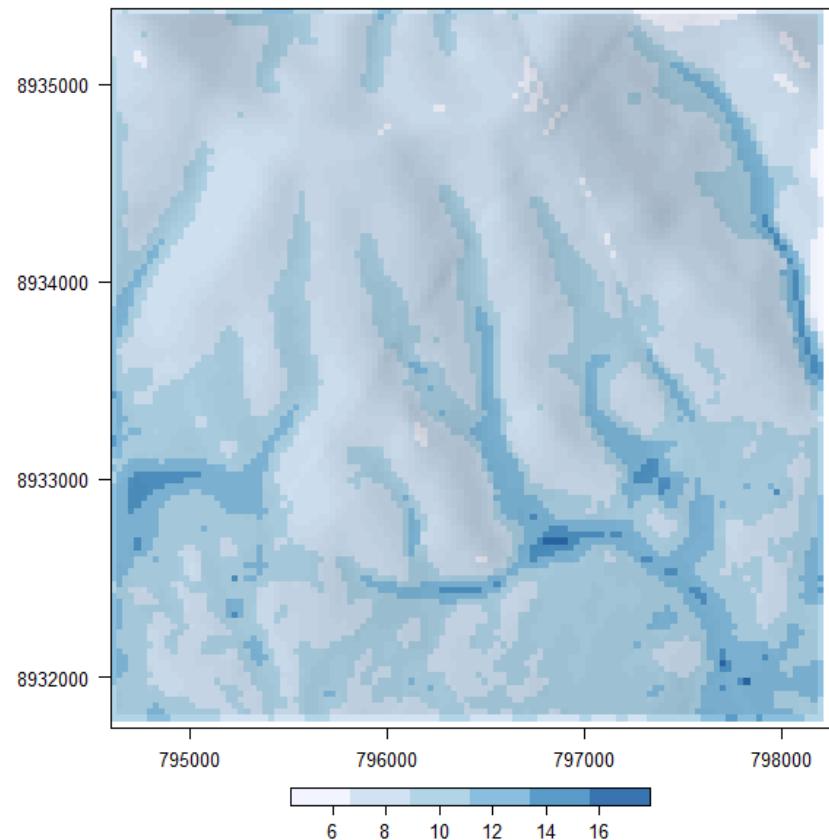




Let's run_qgis

Spatial object residing
in R

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



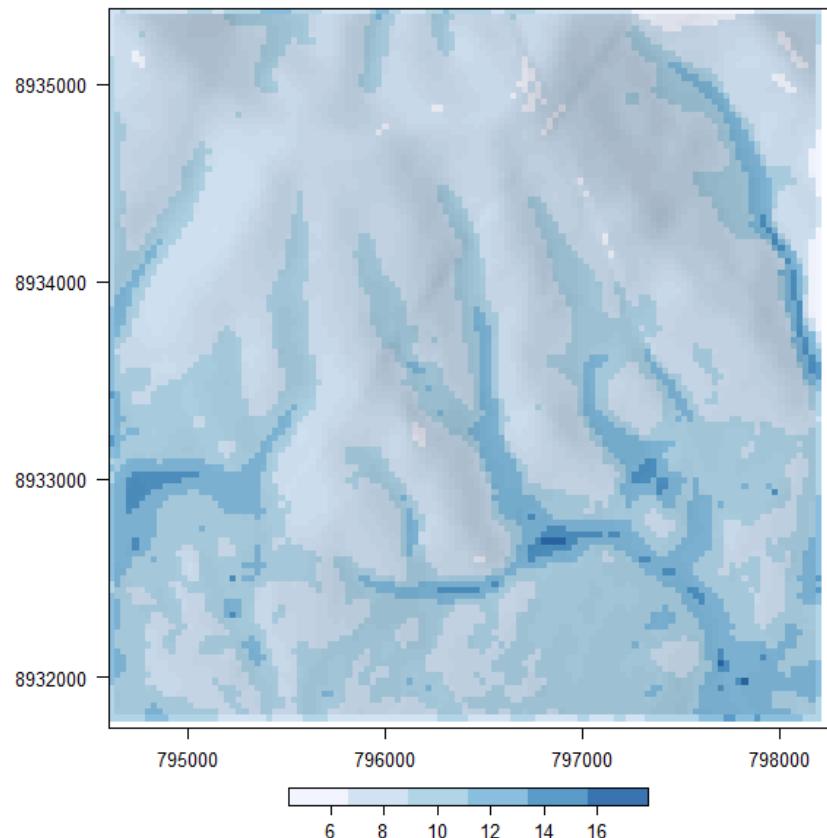


Let's run_qgis

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 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

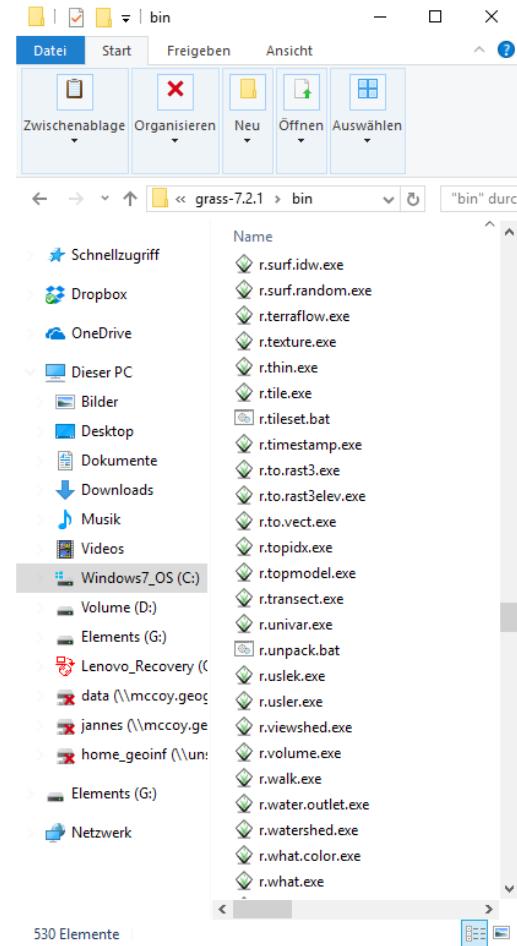
- First released in 1984
- In the beginning developed by the US Army (1982 – 1995), also with a focus on raster processing
- Since 1997 developed by scientists/user community
- >500 geoalgorithms
- Great documentation
- Uses SQLite as a geodatabase in the background





The R-Grass interface

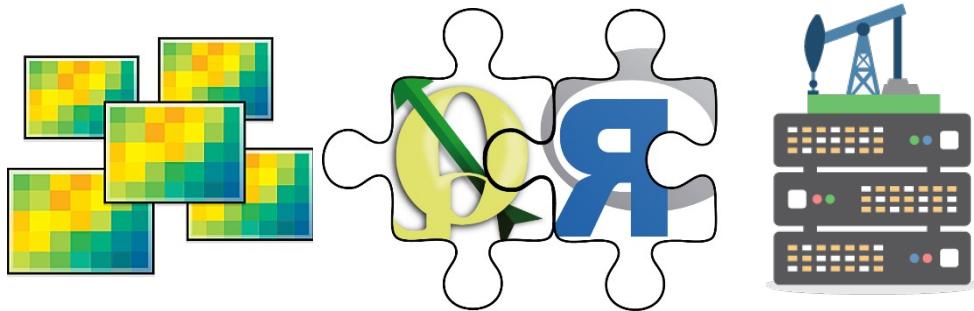
“GRASS is a very large but very simple system – it is run as a collection of separate programs built using shared libraries of core functions. There is then no GRASS ‘program’, just a script setting environment variables needed by the component programs” (Bivand et al. 2008: 99).





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

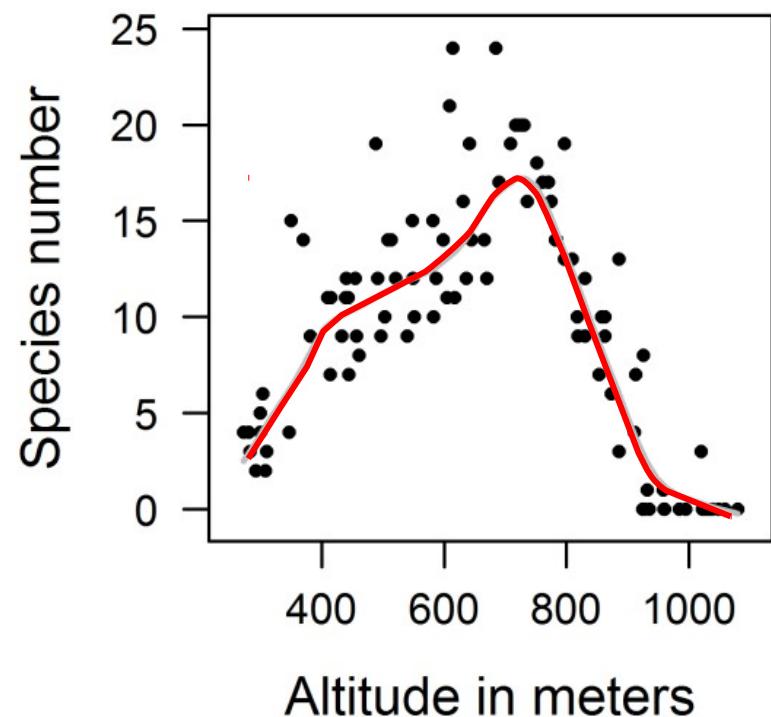




Non-linear Poisson model

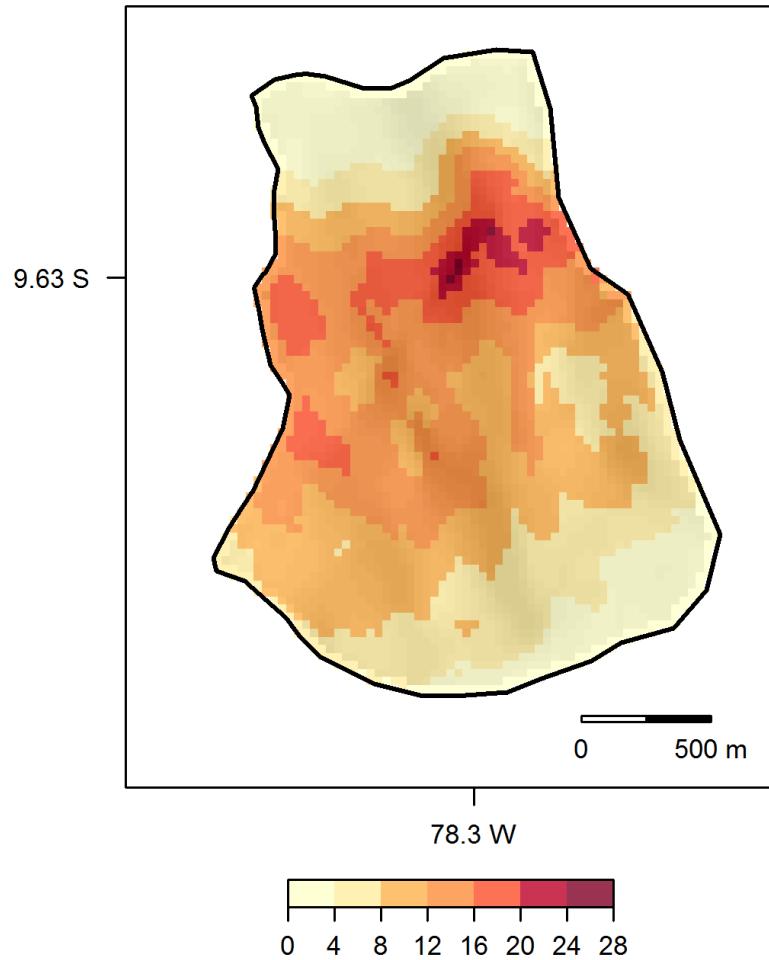
Predictors:

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



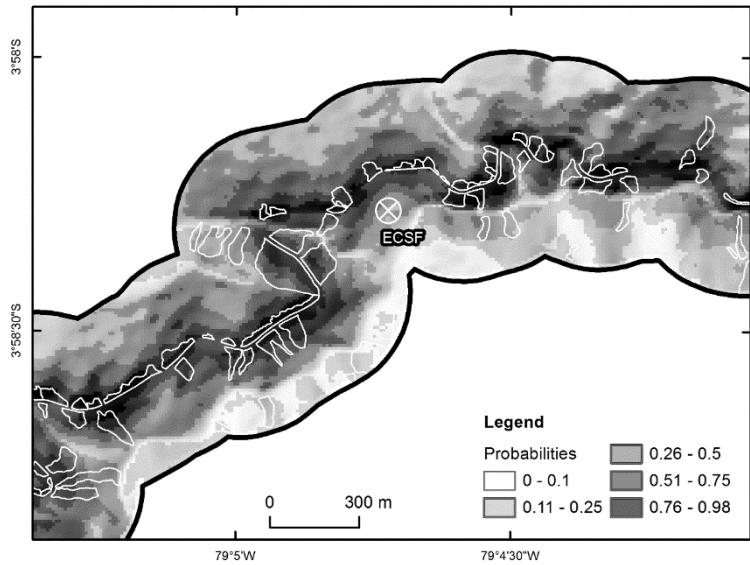


Spatial prediction of plant species diversity



Muenchow et al. (2013): Predictive mapping of species richness and plant species' distributions.
GeoStats 2018 | Jannes Muenchow | R-GIS Bridges

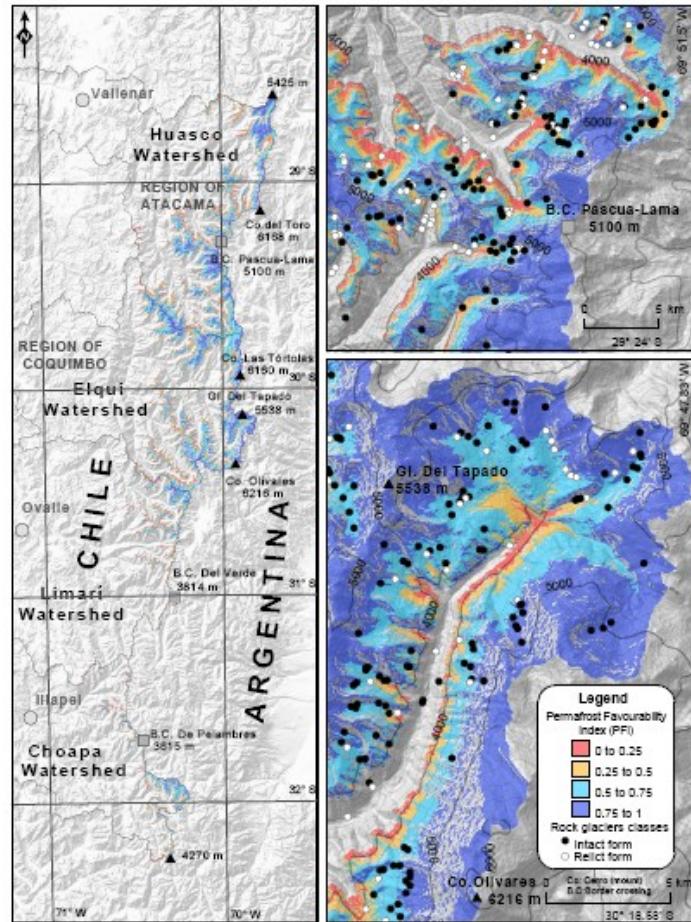
Landslide susceptibility



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

Rock glaciers/permafrost

- Computation of direct and diffuse incoming solar radiation

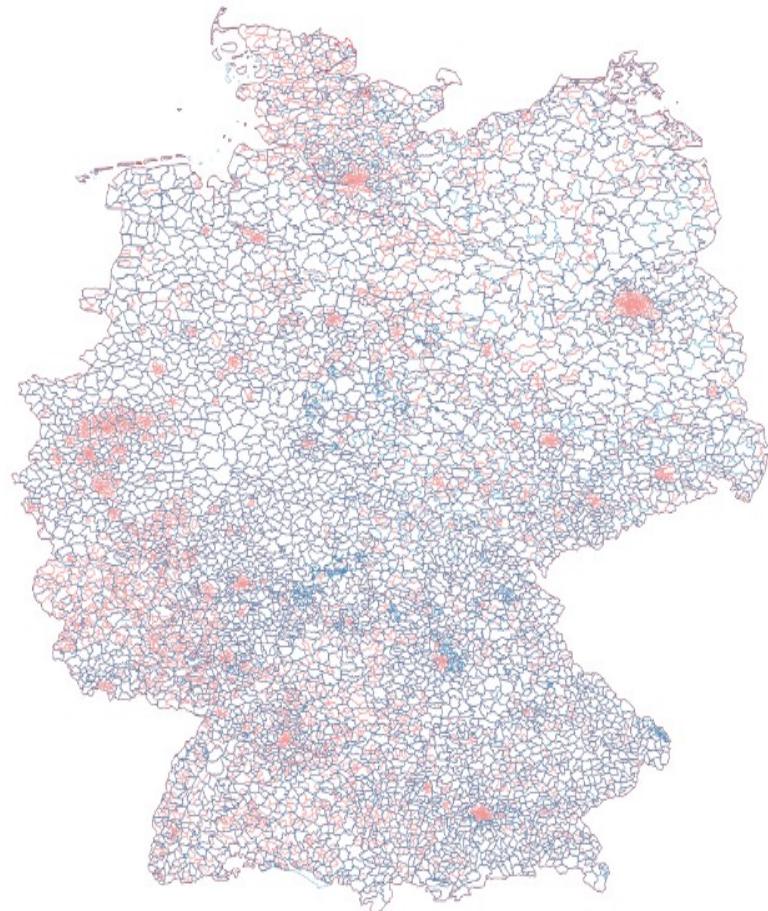


Azócar et al. (2017): Permafrost distribution modeling.



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)
- ...

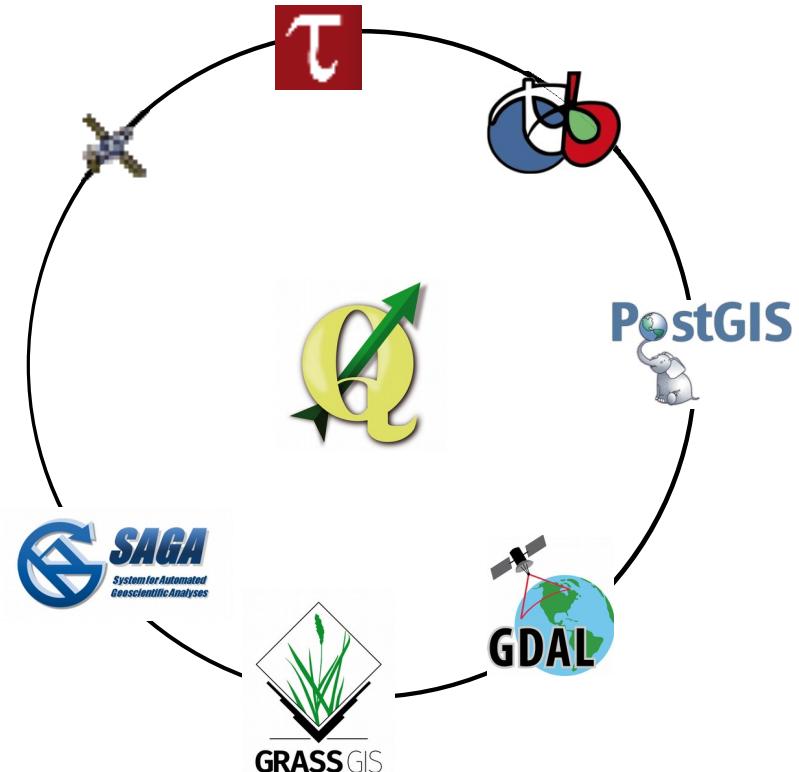


COMPARING R/GIS BRIDGES



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:

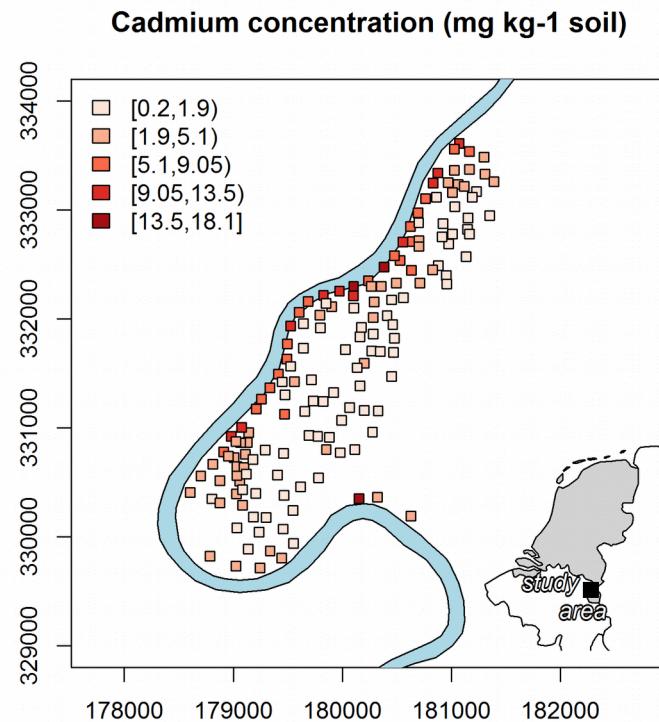
- QGIS does not provide access to all SAGA and GRASS functionalities
- RSAGA has special geocomputing functions (written in R)
- QGIS establishes a new GRASS session for each call and barely supports the GRASS geodatabase





Wrap-up

- We can use R as a GIS



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

Wrap-up



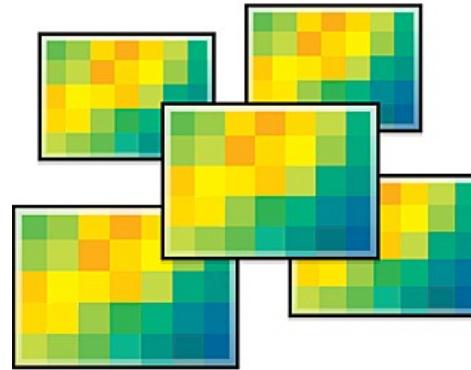
- We can use R as a GIS
- Geoprocessing is (often) better done with the help of a GIS





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





(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:

Please use homebrew (see vignette)



Literature

- Bivand, R., 2014. Geocomputation and open source software: components and software stacks, in: Abrahart, R.J., See, L. (Eds.), *GeoComputation*. CRC Press, Boca Raton, FL.
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