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Desenvolvimento de aplicações em QGIS para modelos de gestão de risco

QGIS applications development for risk models

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Introduction – Groundwater vulnerability

- Foster (1987), employs the expression "aquifer pollution vulnerability" to represent the intrinsic characteristics which determine the sensitivity of the groundwater system to being adversely affected by an imposed pollutant load.

- NAP (1993), defines groundwater vulnerability to pollution as the tendency or likelihood for pollutants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer.

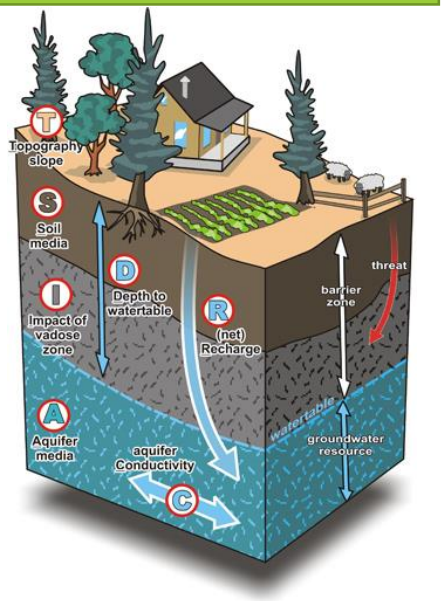
DRASTIC – groundwater vulnerability

- DRASTIC index is composed by seven parameters and it is a result of weighted average of these seven values.

$$DRASTIC = Dp \times Di + Rp \times Ri + Ap \times Ai + Sp \times Si + Tp \times Ti + Ip \times Ii + Cp \times Ci$$

D – Depth to Groundwater
R – Net Recharge
A – Aquifer Media
S – Soil Media
T – Topography
I – Impact of Vadose Zone
C – Hydraulic Conductivity

i-index
p-weight

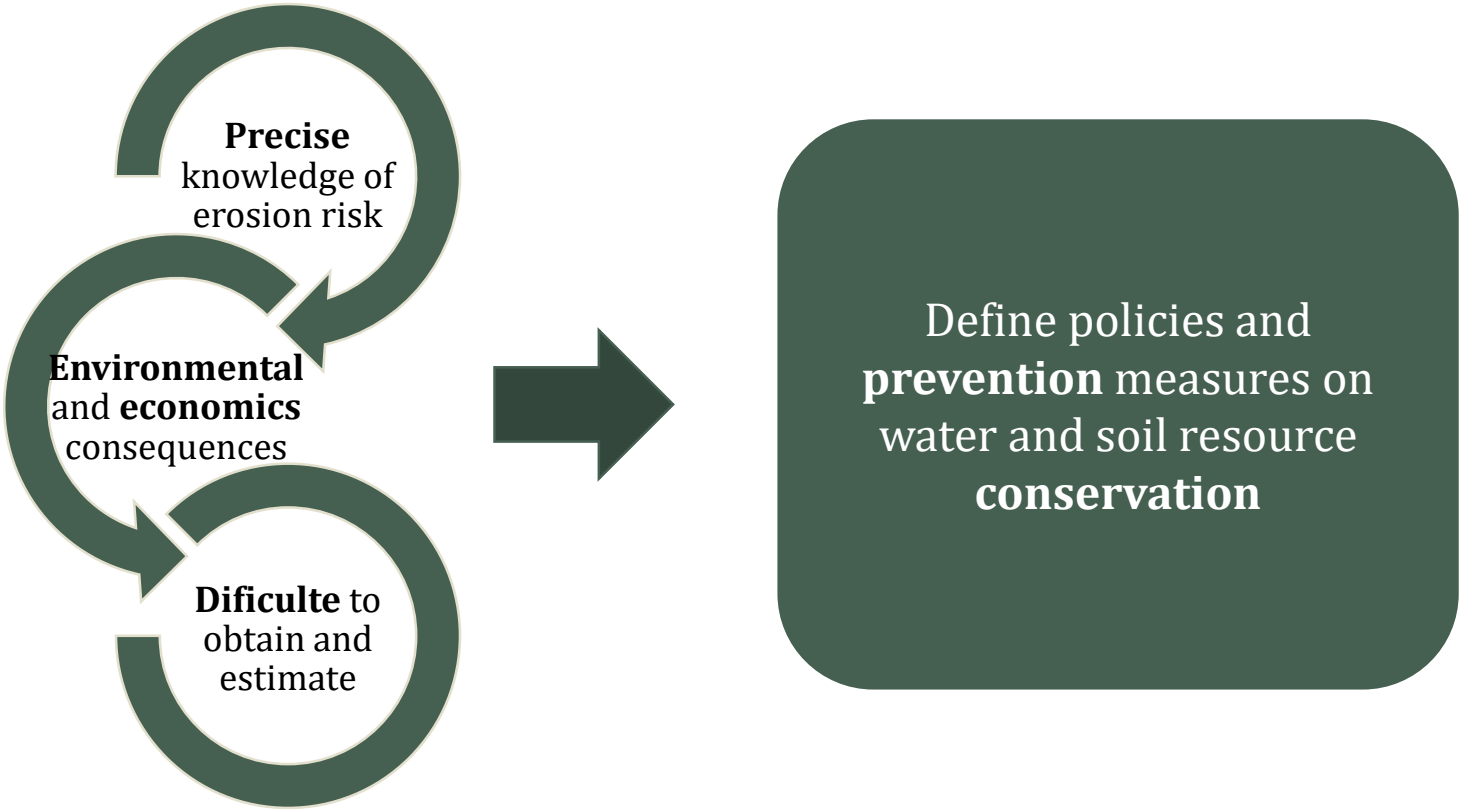


Introduction – Soil erosion

- Considered a serious and major environmental problem in many parts of the world, endangering areas such as agriculture, environment, natural resources, flooding and habitat destruction

- Soil erosion consists in the detachments of individual soil particles from the soil mass which are transported by erosive agents, such as water or wind

Soil erosion

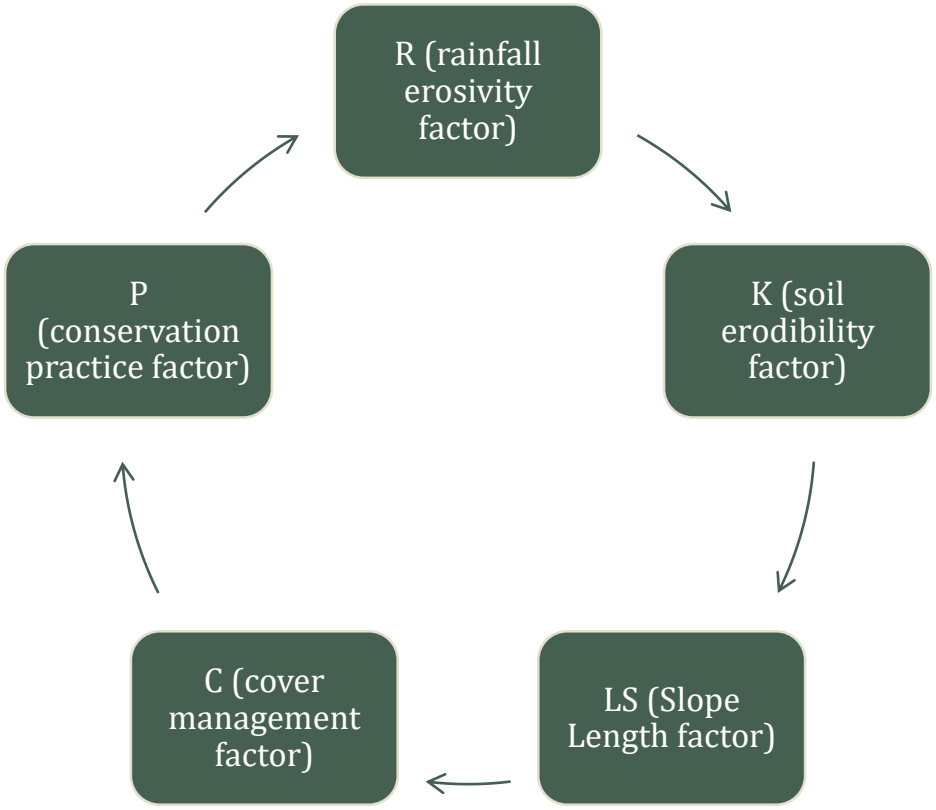


Factors that induce soil erosion

- Natural
  - Soil degradation
  - Water quality
  - Hydrogeological systems
  - Agricultural production
  - Vegetation cover
  - Topographic features
  - Climatic variables
  - Soil characteristics
  - Slope
  - Precipitation
- Human
  - Agriculture activity

RUSLE – Revised Universal Soil Loss Equation

- Control soil erosion
- Assess soil erosion risk
- Estimate soil erosion loss

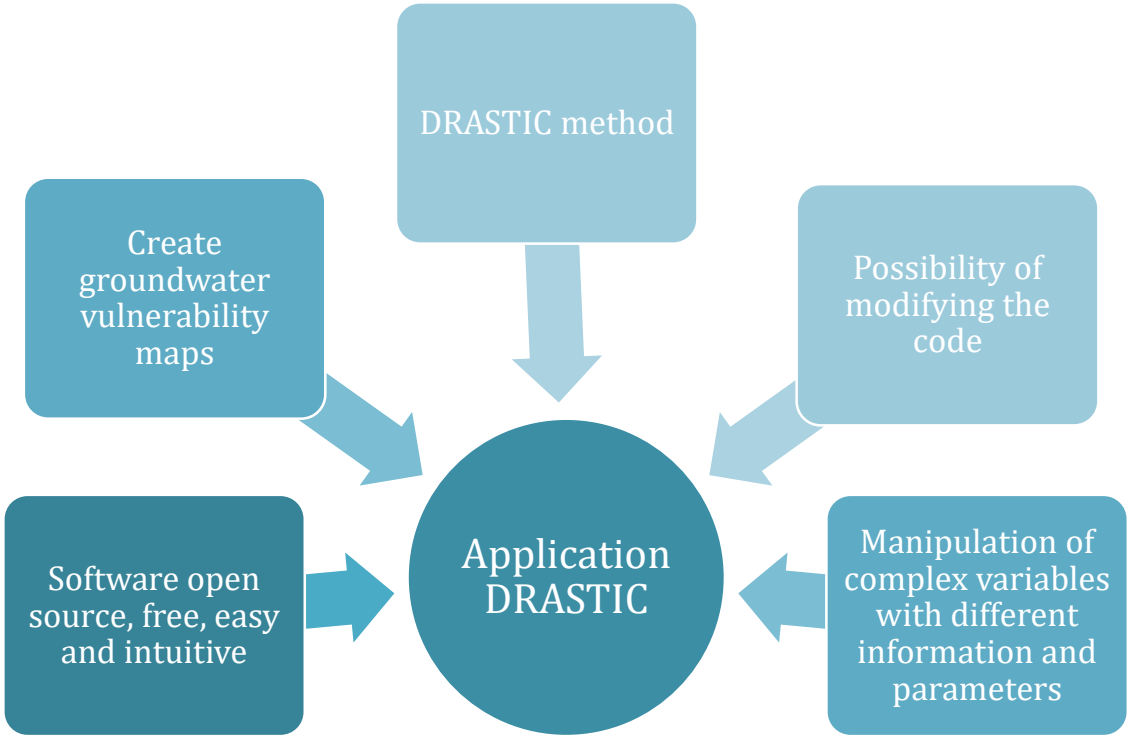


$$RUSLE = R \times K \times LS \times C \times P$$

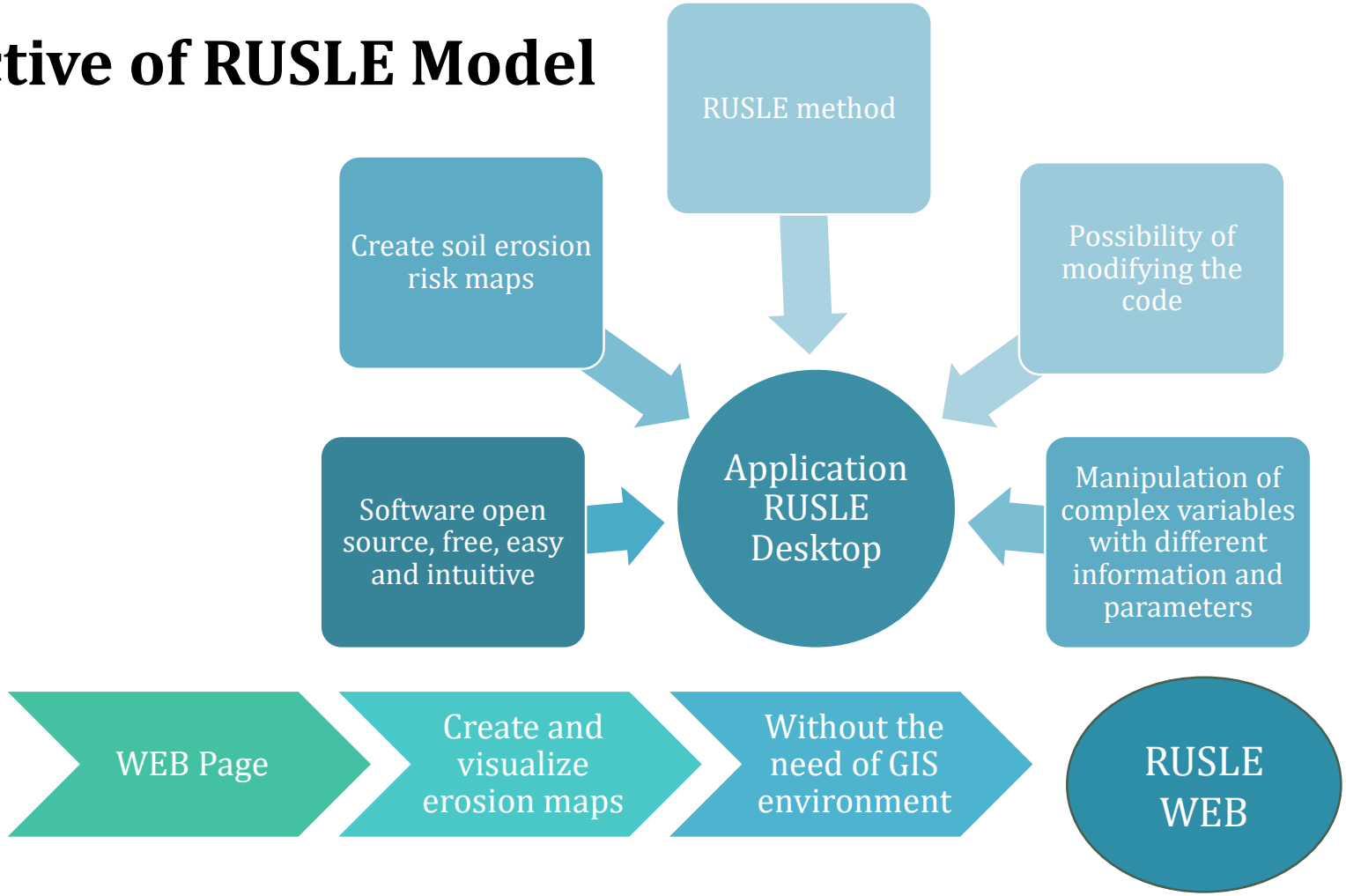
Geographic Information System (GIS)

- GIS are often combined with soil erosion models as an effective approach to estimate the magnitude and distribution of erosion
- GIS provide powerful tools in modelling geospatial information
- Several studies have been developed to assess soil erosion and to estimate groundwater vulnerability through **GIS proprietary software**, using RUSLE method and DRASTIC method, respectively
- There isn't a tool adapted to anymodel which can be **modified** and **freely** used

Objective of DRASTIC Model



Objective of RUSLE Model



Methodology

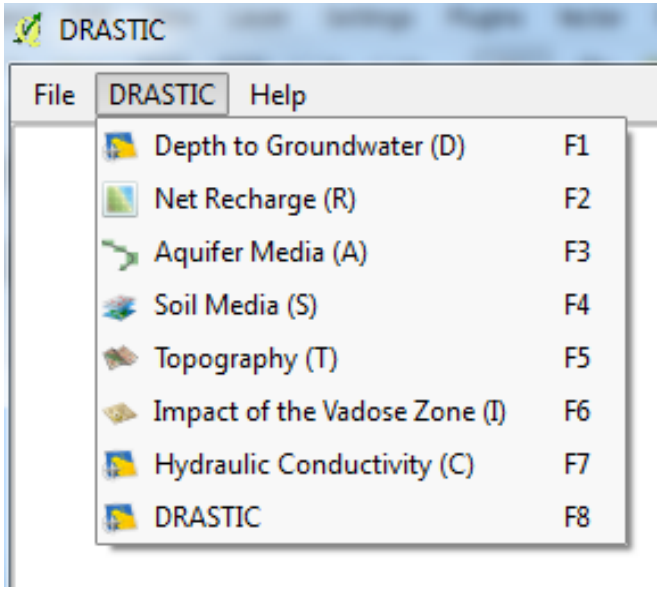
- Software **QGIS**
- APIs (*Aplication Programming Interface*): Numpy, SAGA, QGIS API, Gdal/OGR API, PyQt4 API
- **Processing Toolbox** algorithms (QGIS): *ordinarykrigingglobal*, *clipgridwithpolygon*, *cubicsplineapproximation*, *r.mapcalculator*, *v.surf.idw* e *v.surf.rst*
- ***Python*** programming language
- *Framework **Django** (RUSLE WEB version)*

DRASTIC Application

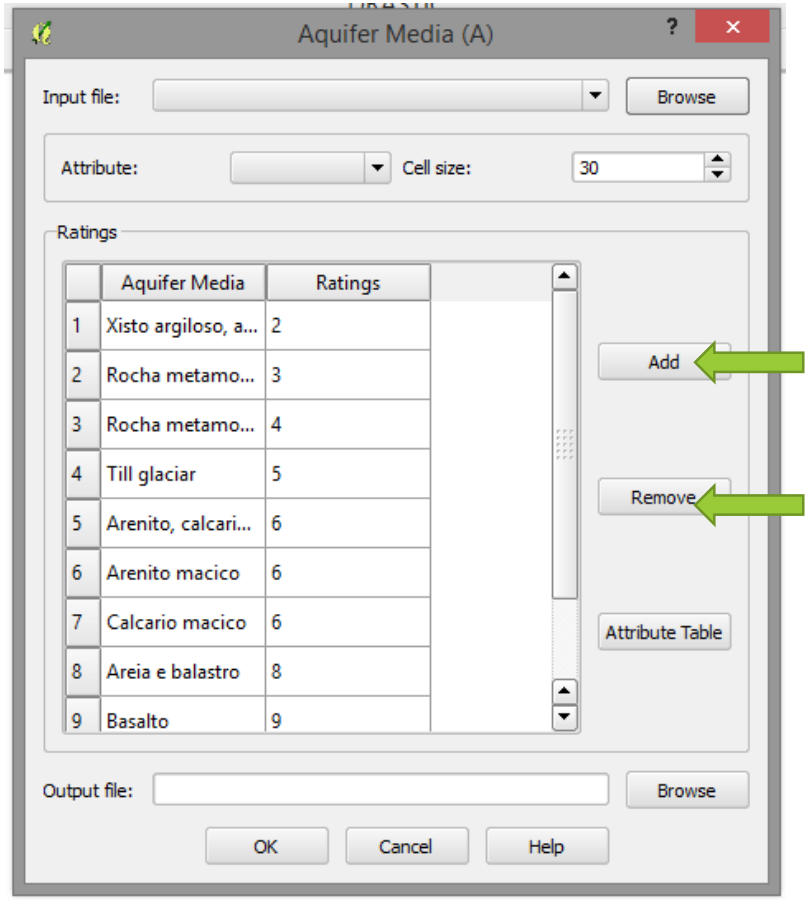
DRASTIC Window

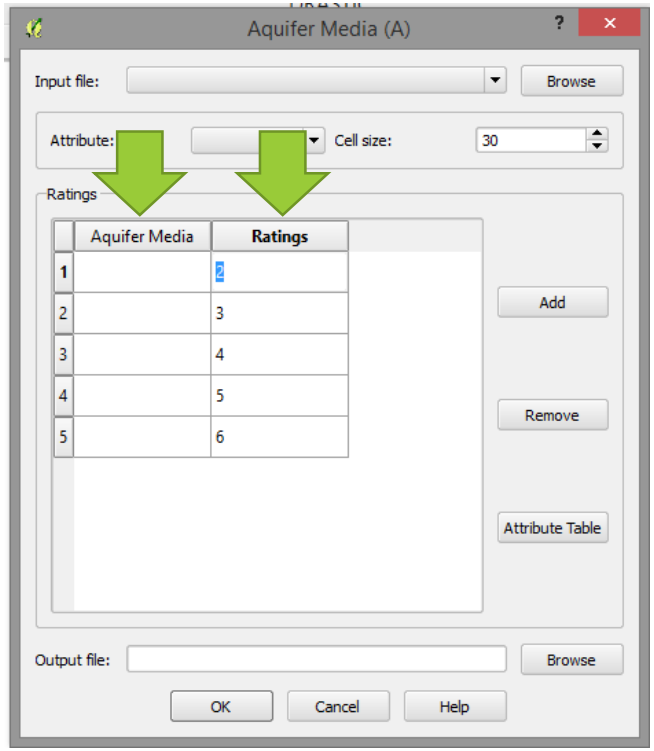
Map canvas
Menu Bar

File menu
DRASTIC menu
Help menu

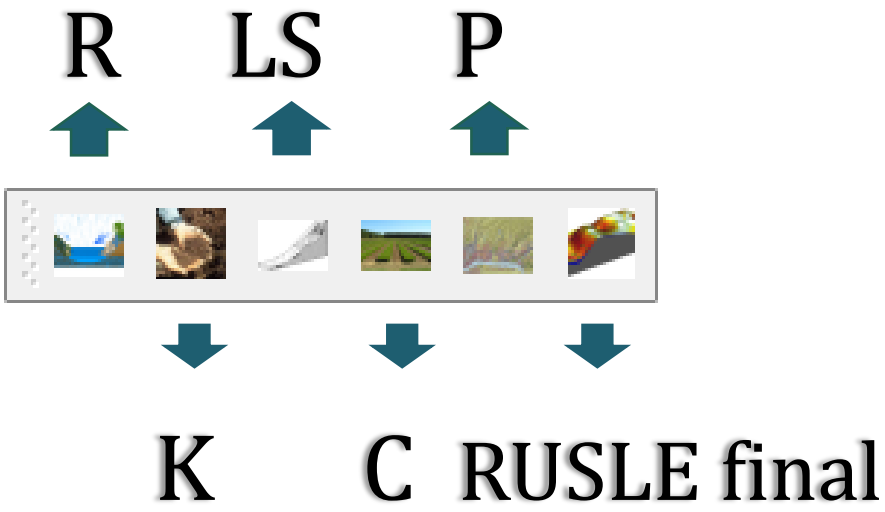


DRASTIC Application





RUSLE Desktop Version



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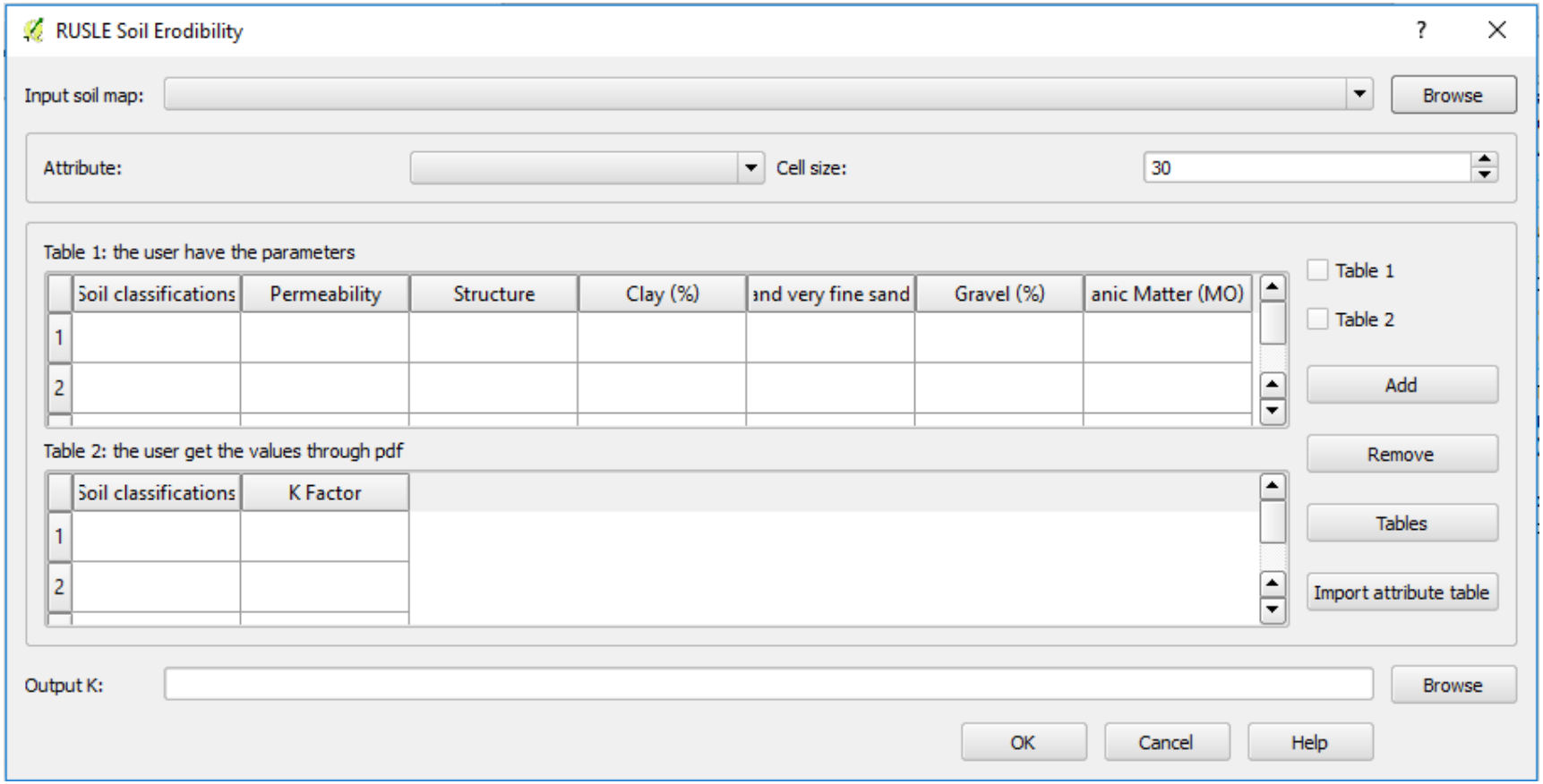
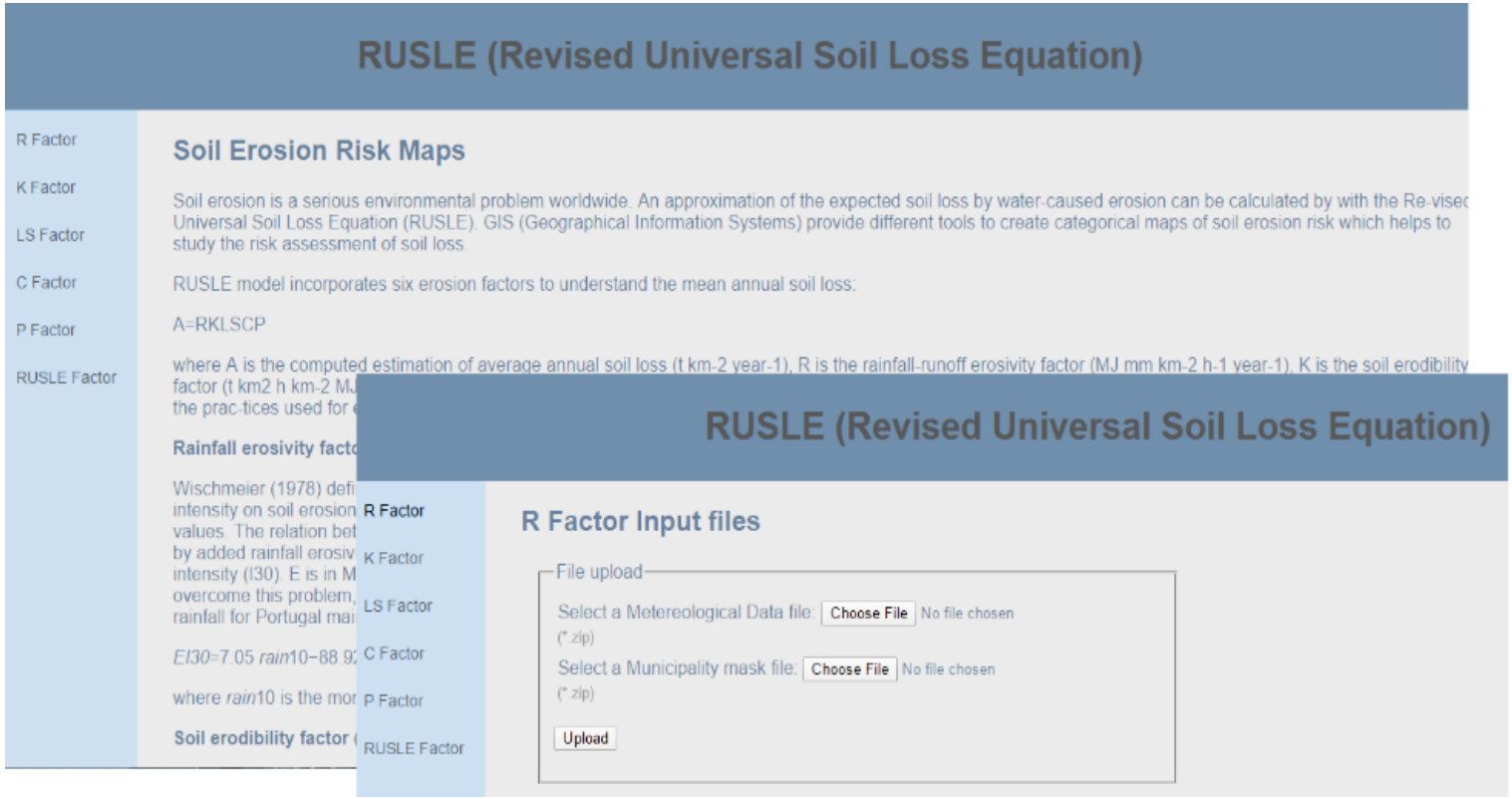
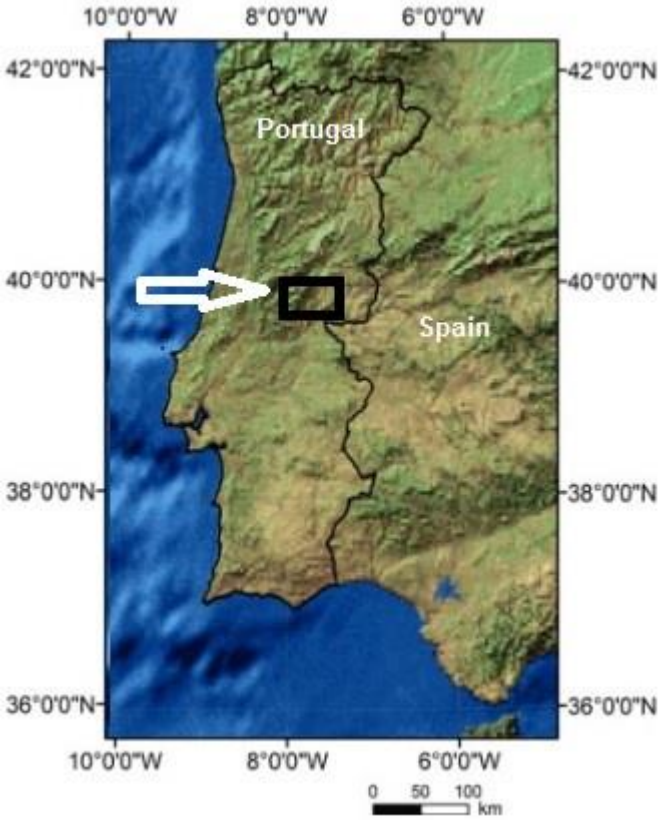


RUSLE WEB Version

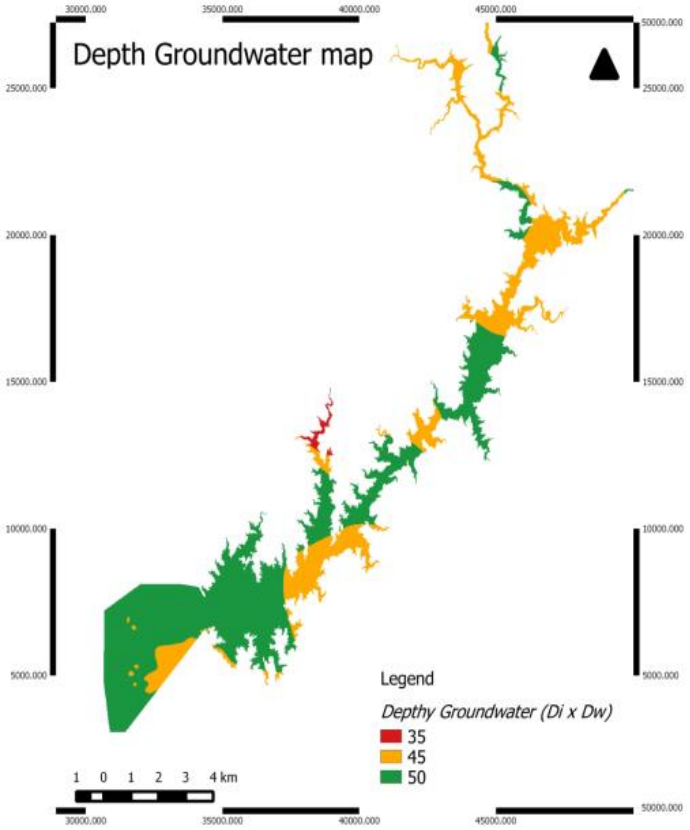


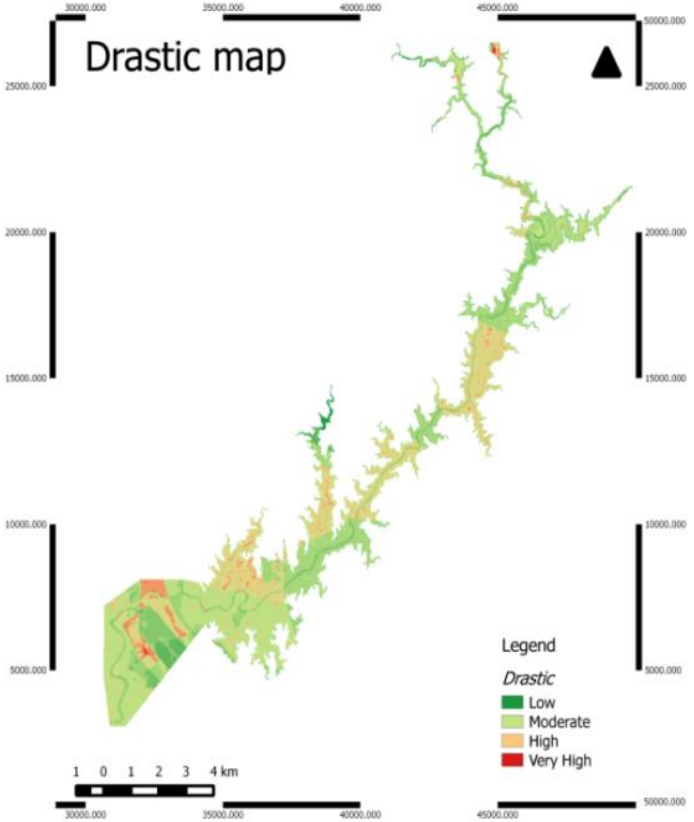
Results – DRASTIC: Case study Castelo Branco, Portugal

- Tagus basin, near to Castelo Branco city, Portugal.
- Groundwater system covers approximately 1500 hectares with a maximum depth of 35 meters.
- Spatial resolution: 20 meters.
- ETRS89 PTTM06 coordinate system



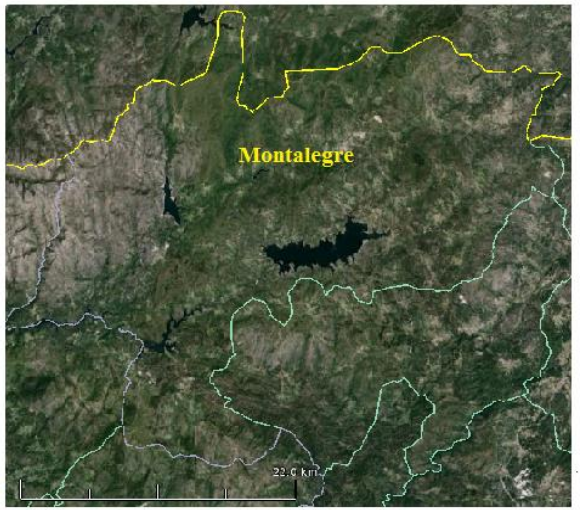
Results – DRASTIC: Case study Castelo Branco - Portugal



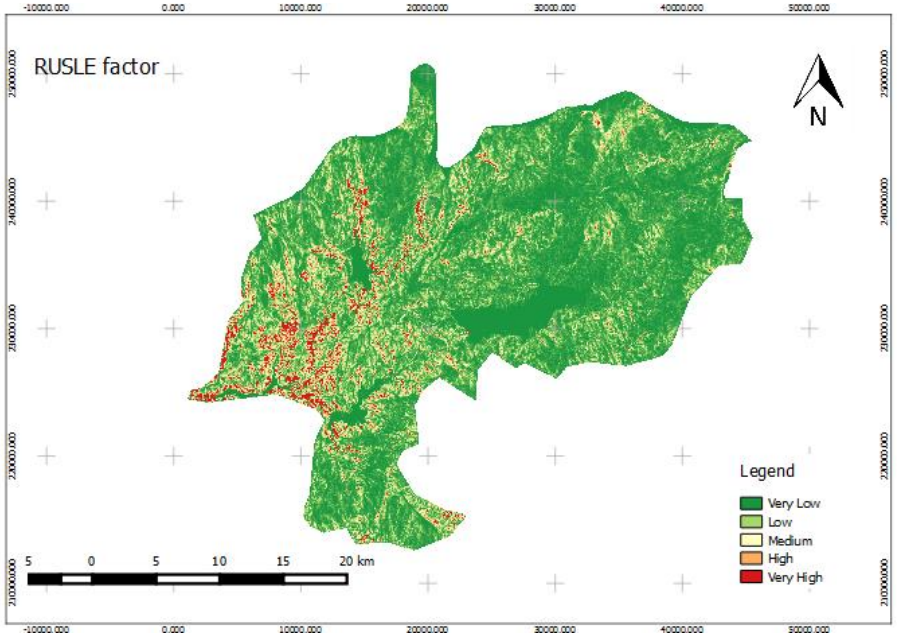


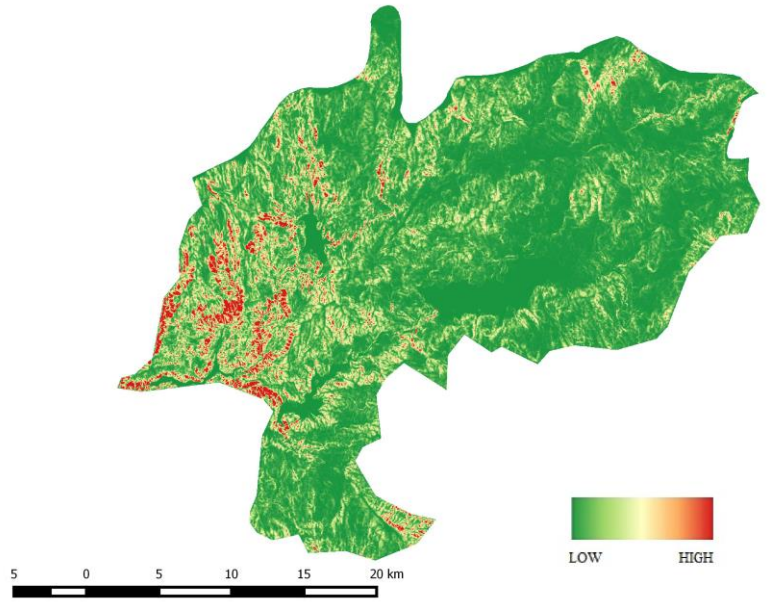
Results – RUSLE: Case study Montalegre

- Covers approximately 80,580 hectares
- Atlantic climate
- High precipitation occurrence (1531 mm/year)
- High slope carries high erosion risks when soil protection measures are not taken
- The spatial resolution of the raster files used in this study case was defined as 20 meters.
- The data were in the ETRS89 PT-TM06 coordinate reference system (EPSG:3763).



Results – RUSLE: DESKTOP and WEB RUSLE map





Discussion

DRASTIC

1. The DRASTIC index values vary between 100 and 181.
2. The available data were not enough to evaluate more precisely the groundwater vulnerability.
3. The DRASTIC index was obtained based in data available and based in Aller et al. (1987) DRASTIC model.
4. The DRASTIC index was created in the 80's of the last century. However, this index is worldwide used for the hydrologist's community.

RUSLE

1. 29 % of the area is characterized by very low soil erosion level
2. 8 % as very high to soil erosion
3. 4 % of the total area are characterized with very high slope values along with very high soil erosion level.
4. Areas with high slope values are related with high level of erosion.
5. Although a large part of the study area is classified with zones as low levels of erosion, high slope values and high values of precipitation are typical of Montalegre municipality, so it stands to reasonable values classified with very high levels of erosion.
6. The C factor is higher in zones where the soil erosion level is lower. So in these areas the soil is more protected.

Conclusions – DRASTIC Application main advantages

- Generating several procedures, giving the possibility of analyzing and change the final map.
- DRASTIC - Net Recharge presents two different methods to generate the result.
- Easiness and quickness to produce maps.
- Change the indexes and weights until get the better interpretation to his study area.
- Open source software makes it easier to obtain and use

RUSLE desktop application

Vantages

- Provides the possibility of moving the C factor map in order to evaluate if the value helps to control the erosion.
- It is flexible and allows to simulate the fact before.
- It is more detailed given several options and parameters options to the user.
- With the possibility to import the input shapefile attribute table, the user can easily adapt to other case studies.
- In some factors, such as K factor, the user can choose between two methods in order to obtain the final map. If the user has access to field observations of the soil parameters he/she can adapt the K factor map to his/her field knowledge.
- The desktop application allowed to upload different tabulated data in pdf format.

Disadvantages

- Creates the maps without the layout composer.
- Requires GIS software knowledge.

RUSLE WEB application

Vantages

- Generates the maps and incorporates a layout with a scale bar and the legend with the colours defined in high and low values.
- It is a website where any user can upload the input files necessary to calculate each RUSLE factor and to obtain the final RUSLE map in a few minutes.
- It is not necessary to have a GIS software installed and the user doesn't need to know GIS algorithms or tools.

Disadvantages

- The user must define the parameters in shapefile attribute table first.
- The maps creation depends on the internet connectivity.

Conclusions - RUSLE

- There are some differences between the two applications, although the two of them presents a very good performance in creating the maps.
- The model implemented is adapted for Portugal and uses the pdf tables defined by Pimenta (1998). However, this model can be adapted to other countries or regions if other tables were incorporated.
- The two versions developed can be very useful to create the maps necessary to evaluate soil erosion in certain zones.
- The two versions are freely available.

Thanks for your attention!

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