RiskAquaSoil

Atlantic Risk Management Plan in Water and Soil

Newsletter 3
September, 2019

Editorial

The European Atlantic area is affected by soil erosion at various scales

It is concerning to note that erosion, which occurs during climatic extremes, is reinforced by climate change, which is illustrated by more frequent extremes events. The first type of extreme event is drought which, by reducing plant activity, removes or damages the vegetation layer that gives structure to the surface soil, making it more vulnerable to wind erosion (In extreme cases, drought is the cause of forest fires, forests which then become vulnerable to erosion). It is estimated that about 1 mm of soil dust, or 10 m3 of fertile soil per hectare, is lost every year to the wind. In the face of this hazard, it is essential to preserve the networks of shelterbelts or green screens surrounding plots of about 6 Ha whilst still allowing a profitable mechanized work. In the sixties and seventies, France carried out consolidation work which amplified this phenomenon of erosion by removing many hedges surrounding narrow fields. Today, actions are being implemented, such as with the Landscape Network of New Aquitaine, to replant resistant local species.

The second climate extreme is the abundance and intensity of convective rains that occur a few days a year. If during these intense rains the soils are bare and/or recently worked (as during sowing), inclined plots will see large gullies furrowing these slopes. In addition, these run off events carry pesticides and weed-killer residue to streams along with fertile soil elements and nutrients, negatively affecting water quality and the biological life that depends on it.

In response to this type of risk, Risk-Aquasoil has developed two methods to map plots at risk of erosion from visible satellite images (Spain & UK) and also radar (France) when cloud cover is present. At the same time, local measurements in several watersheds are carried out to characterize the impact of heavy rainfall on the erosion of vine soil (Galicia), burnt forests (Portugal), agricultural plots (France and UK). New less expensive sensors are tested to monitor in real time the result in the rivers of these erosion streams (UK and France with water level, conductivity, pH, temperature).

All these risk monitoring tools make it possible to identify priority areas for action in order to propose solutions, such as intermediate crops, grassy and sometimes shrub buffer zones or simply proposing a rotation of different crops (France).

It still remains necessary to find and activate local levers to call farmers to action to replant hedges shelterbelt and better management of agriculture, soil conservation and water quality of the streams. These levers are not only financial but often linked to the awareness of the long-term impact of a silent phenomenon that is not very visible to rural actors in the midst of change and uncertainty. Sociological and economic analysis (Ireland, Portugal and France) helps us to identify the obstacles to adaptation to this risk of erosion and to find the necessary link between these local actors and regional and higher levels.

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https://www.riskaquasoil.eu/

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Estimation of soil loss rates at Dean Burn/Mardle catchment using the RUSLE equation versus the use of SCIMAP

Estimating erosion risk and soil loss is of particular value to organisations trying to limit the loss of soil to the river system. Computer modelling can help assess this issue by making assumptions about how inherent physical environmental conditions (e.g. slope gradient and length, soil erodibility and rainfall) interact with land management practices (e.g. exposed soils or natural habitat). This can generate risk maps showing areas of potential soil loss as well as give estimates of total annual soil loss. Below two methods are compared using the same base catchment in the South West of England (Dean Burn/Mardle); the Revised Universal Soil Loss Equation (RUSLE) and SCIMAP[1] and reviewed the actual areas of soil loss.

RUSLE

For the estimation of soil loss rates, the RUSLE equation was used:

$$A = R * K * LS * C * P$$

where A is the annual soil loss due to erosion [t ha^{-1} year^{-1}]; R the rainfall erosivity factor; K the soil erodibility factor; LS the topographic factor derived from slope length and slope gradient; C the cover and management factor; and P the erosion control practice factor. Since remote sensing images have been used, specifically for determining the vegetated fraction cover required for C computation, three cloudless images distributed throughout the year for covering the entire range of surface conditions were selected. The satellite used was Sentinel 2A and the dates selected were September 27 (2018) and July 4 (2019).

Fig. 1 shows the soil erosion rate for each date considered. Specifically, the average soil erosion rates for the study area were 0.37 and 0.31 t ha^{-1} yr^{-1} for September 27 (2018) and July 4 (2019), respectively.

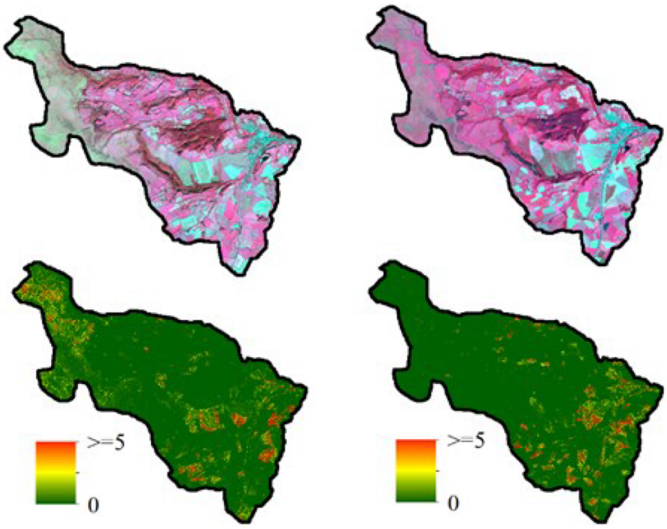
Averaging these values to obtain an annual value, the mean soil loss rate in the area was 0.34 t ha^{-1} yr^{-1}. Knowing that the area of Dean Burn/Mardle catchment is 2,940 ha, the total amount of soil lost by erosion is 1,000 t yr^{-1}.

SCIMAP

For the risk mapping of soil loss rates, the SCIMAP programme was used. The SCIMAP model is a framework for the analysis of relative risk of different locations within the catchment (in relation to their land use, land management etc.) in relation to different environmental requirements within receiving water bodies (e.g. fish habitat). The basis of the analysis is the joint consideration of the probability of a unit of land producing a particular environmental risk and then of that produced risk actually reaching the drainage network. Hydrologically well-connected and risky land uses should be the prime focus of management activities, and hence the result is a method for determining where efforts should be concentrated in order to achieve environmental protection.

SCIMAP uses the Digital Elevation Model (DEM) and Rainfall data to calculate Slope, Upslope Area and Stream Power and ultimately generate a Surface Flow Index (SFI) that estimates the flow of water through any point on a map. Alongside this it uses Land Cover to assess erodibility (based on local weightings of practices) and then combines this with SFI to create an Erosion Risk map. Figure 2 shows the SCIMAP Erosion Risk map for the Dean Burn/Mardle.

Fig. 1 - Instantaneous soil loss rates (t ha^{-1} yr^{-1})
Sep 27 (2018) Jul 4 (2019)



[1] http://www.scimap.org.uk/

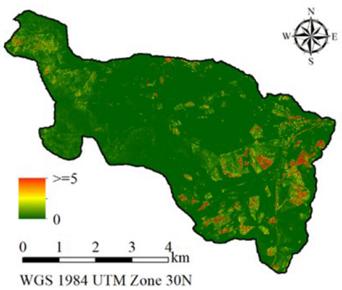


Fig. 1 - Average soil loss rate (t ha^{-1})

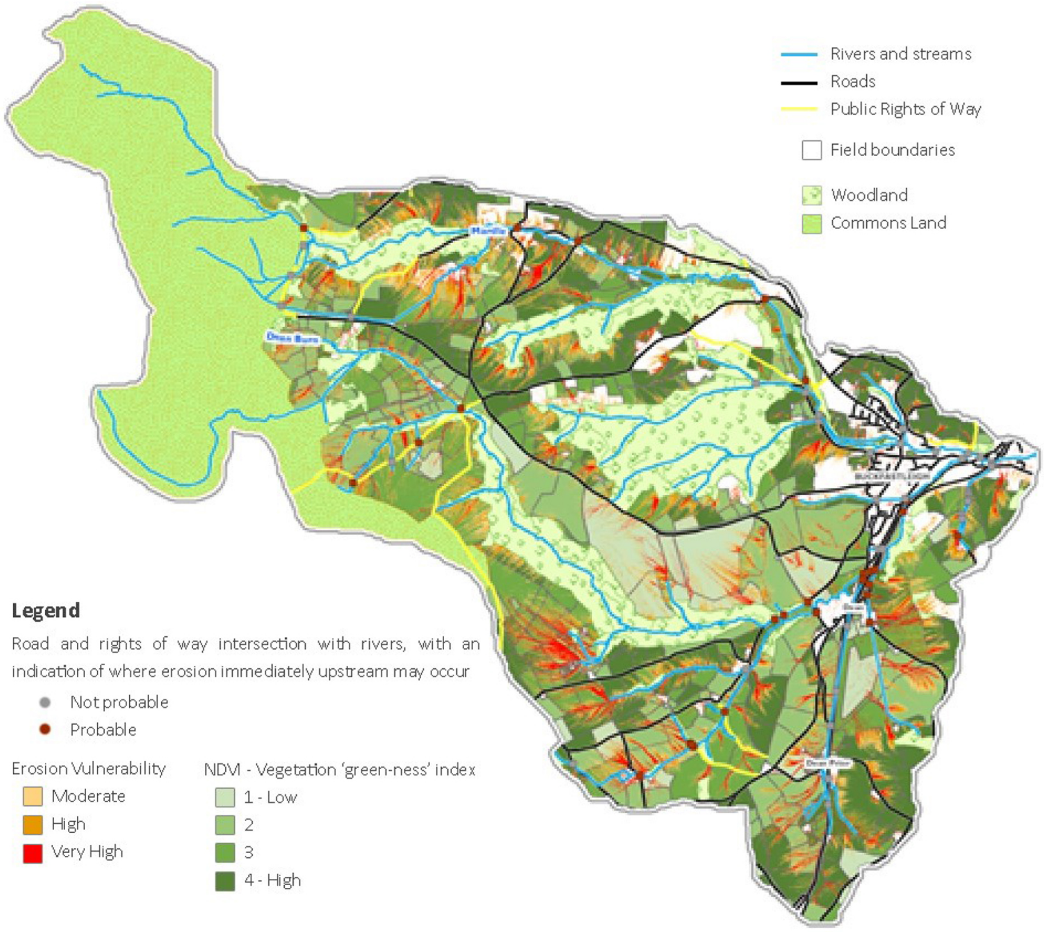


Fig. 2. - Soil Erosion Risk Map (Erosion Vulnerablity) on the Dean Burn/Mardle catchment contrast against NDVI index taken in Spring 2018 as well as publicly accessible points were soil loss could be seen.

The two models work using similar data sets and not surprisingly, where risk factors for land use are the same, they generate similar results. For the Dean Burn/Mardle the West of the catchment, which is predominantly upland is in general low risk as there is never exposed soil during the year whereas in the lower Eastern catchment, where farming practices follow more common rotations and practices the two models predict higher soil loses as steep, long slopes drain areas of exposed arable land.

Therefore, where the land use data layer identifies low NVDI scores the underlying inherent properties of topography (e.g. slope, field length, contributing drainage area) predict the same erosion risk. Typically, SCIMAP uses Land Cover Data from 2007 to generate land use data and this clearly has limitations. Natural habitat and long-term pasture do not change much over time, but arable land and short rotation leys vary on an annual basis. Using Sentinel data to assess current land use and offer a more accurate and timelier picture of erosion risk for that year.

In the UK SCIMAP has been used with Sentinel data to predict soil loss pathways in the autumn were farming practices and heavy rain fall mean soils are at their maximum risk of erosion. Alongside this it is possible to identify publicly accessible places where regulatory and/or advisory staff can assess current soil loss in the river.

Therefore, in summary both models have their benefits and when land use or NVDI is properly calibrated to the land use in the area both models highlight areas of risk. The main additional benefit RUSLE has is the ability to assess volume of soil loss but SCIMAP is more widely available for Rivers Trust so has gained traction in the UK. Together with using Sentinel data to better predict current land use SCIMAP offers a powerful open source tool.

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EROSION AFTER FOREST FIRES

On the October 15th of 2017, around 500 ignition lead to a succession of wildfires that affected the Mondego River Hydrological Basin and destroyed more than 220.00 hectares of forest and a death toll of 51. The fires have been associated to a prolonged dry period that affected the country that year associated with the Ophelia hurricane.

The removal of vegetation is commonly linked to an increase of erosion, since it reduces the interception of raindrops. A decrease rugosity of the soil, by removal of the vegetation, also allows an increase in water flow velocity, which improves the water capacity for soil's particle removal.

One month after these forest fires, the CES Risk AquaSoil team started a monitoring campaign on the water streams in areas affected by these forest fires.

The majority of the burnt area of the Mondego Drainage Basin is occupied by humic cambisols, upstream the Mondego River crosses a soil of the rankers type.

It was visible an increase of turbidity as soon as the first rains, with some areas showing also ashes present in the water. As a consequence, in early months of 2018, some municipalities cut off the water supply, and a few news outlets presented a discourse amplification about stream water quality degradation.

However, was only the rainiest months, of March and April of 2018, that considerable changes to water physical and chemical changes were noticeable. Just as turbidity, the electrical conductivity increase substantially, indicating dissolved substances in the water. The water chemical analysis to major and minor ions did reveal a considerable rise in aluminium, iron and manganese. These can be linked to the soil's erosion process, specially to clay minerals, and their transport into the water streams. These effects have attenuated in the following months, reaching normal levels in June of 2018.

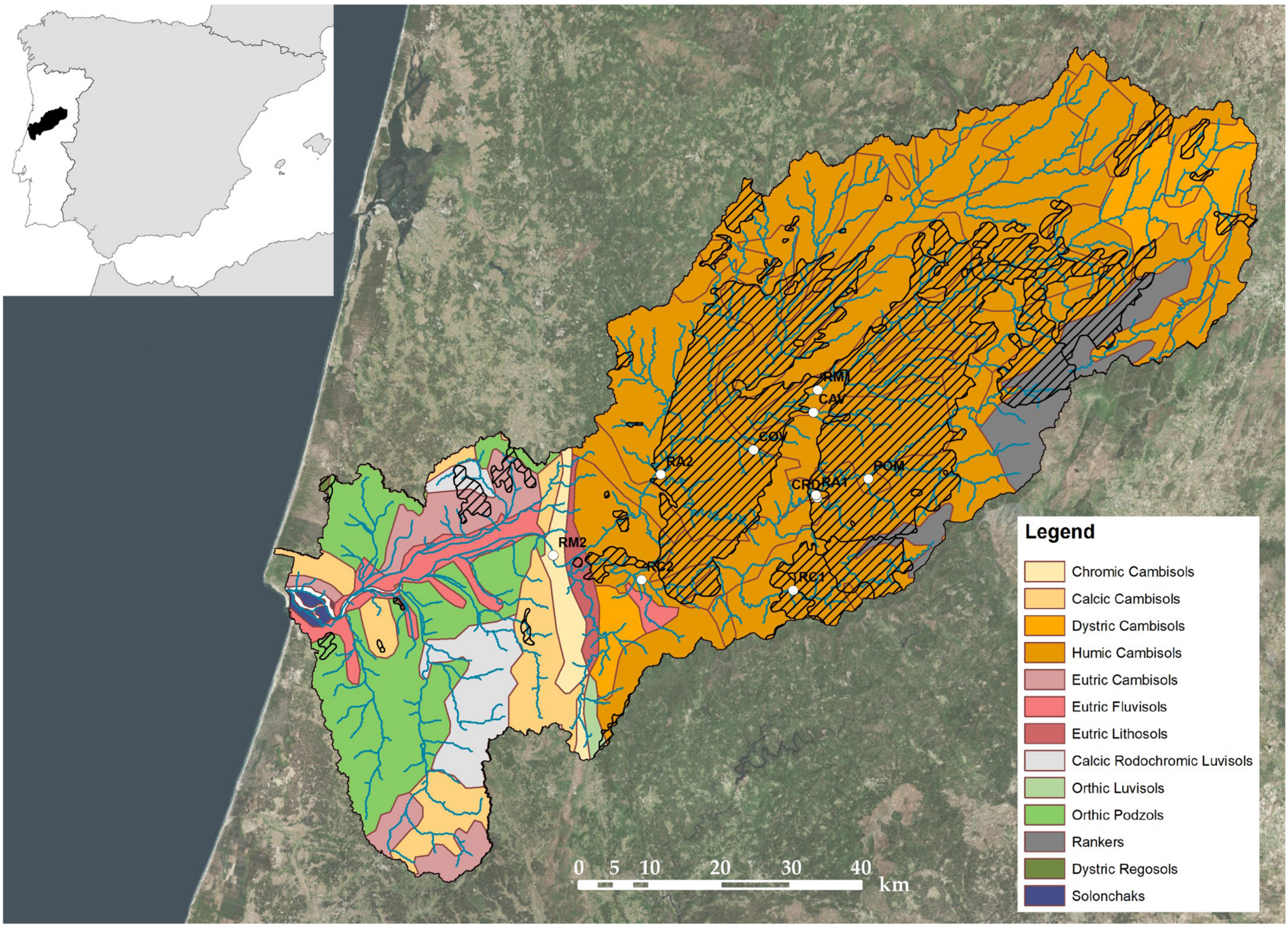


Fig. 3 - Soil map of the Mondego River Hydrological Basin with burnt area

QUANTIFYING THE EROSION RISK

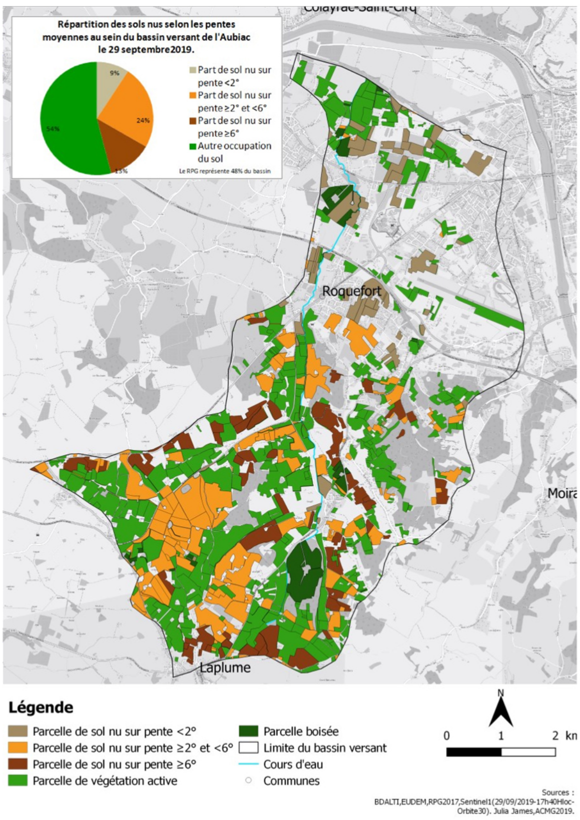
2018, ACMG implemented a method to determine the land use of agricultural fields using Sentinel 1 radar satellite imagery (VH and VV polarization). The objective was to qualify the risk of erosion over the year despite clouds. Land use is divided into four categories: 1/ active vegetation able to retain runoff flows, 2/ woods, 3/vineyards and 4/bare soils. Bare soils with a significant slope (greater than or equal to 6°) have a high potential for erosion during intense rain. Since 2018, ACMG has been producing monthly land use maps of various river basins in the Dropt valley, 3 small catchment areas around Agen, and all over the department of Lot-et-Garonne.

The maps produced are able to easily indentify the zones with a higher risk and when risk is likely to materialize. It represents a simple tool to communicate the message to a variety of audiences. The maps make it possible to link the sludge flow phenomena observed in municipalities with land use. Local authorities thereby are able to assess the risk and have the documents to take action. As we recall, actions must above all be based on an exchange between the actors.

These maps help to raise awareness and not just to accuse landowners. These land use maps are interesting to organizations who want to communicate about the risks and who try to improve water quality, for example. We received an order from SMEAG, a joint syndicate to monitor the Garonne basin from 2015 to 2019 during spring and fall for this purpose.

Moreover, as these maps are produced every month, it is possible to follow the watersheds over time: crop rotations, bare soil frequency, etc. A year and a half's hindsight allows us to see that some plots are frequently fields without vegetation (before, during and just after the sowing of an annual crop), which leads often to a less fertile soil. The objective was therefore to understand the views of the different groups on the territory to understand the risk management carried out, the obstacles encountered in the face of climatic hazards, and the need to adapt to reduce the harm. We now have to understand local mechanisms in order to propose sustainable and viable measures within the territories.

The last stage of work on erosion will be the automation of the classification process and inclusion into a new platform that will be built during ClimAlert, another Interreg Sudoe Project started in September 2019.



September 29th, 2019

October 17th, 2019

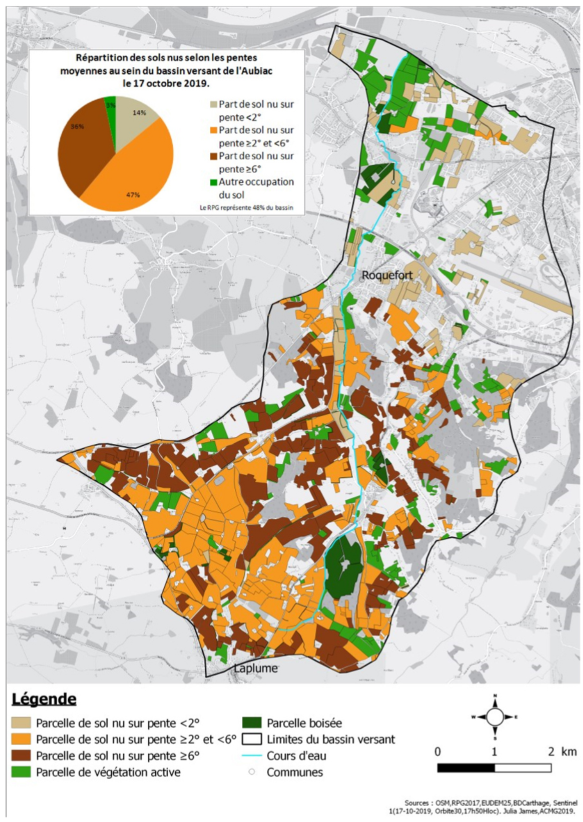


Fig. 4 - Distribution of bare soils according to average slopes within the Aubiac watershed on September 29th of 2019 and October 17th of 2019. In few days, the occupation has completely changed.

STUDY VISIT TO GALICIA

During the month of June of 2019 the members of Risk AquaSoil visited the vineyards were the partners of CSIC have been conducting their pilot actions on soil erosion management.
The dissemination of the project's activities, attended by the partners, vine producers, and the general public was organized in the Regina Viarum winery. The idea behind RiskAquaSoil and its achievements was presented, as well the results of the first year of experiments on the implementation of the RUSLE (Revised Universal Soil Loss Equation), and the use of drones and satellite imagery to determine soil characteristics of the crops and assessment of soil loss.
On the second day the partners visited the Finca Lobeira from Mar de Frades winery. The CSIC partners have been created micro plots for collecting soil losses, and experimenting treatments to reduce these same losses.