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European Regional Development Fund
EUROPEAN UNION
Aguamod

Development of a water resource management platform during low water periods in the SUDOE region

Analysis of factors affecting sediment yield in catchments draining to the Cantabrian Sea (West Europe)

Juan Luis Lechuga-Crespo, Maite Meaurio, Mélanie Raimonet, Roxelane Cakir, Iñaki Antigüedad, Estilita Ruiz-Romera, José Miguel Sánchez-Pérez, Sabine Sauvage

Presenter: **Juan Luis Lechuga-Crespo**

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Universidad del País Vasco Euskal Herriko Unibertsitatea · CSIC Consejo Superior de Investigaciones Científicas · irstea · iniav Instituto Nacional de Investigação Agrária e Veterinária, I.P. · Técnico Lisboa · UCLM Universidad de Castilla-La Mancha · UCA Universidad de Cádiz · Universitat Politècnica de València

Background

Global warming → Vigorous hydrological cycle → Ecosystem changes → **↑Soil erosion (Nearing et al., 2004)**

↑Intensity
↑Rainfall rate
↑Rain frequency

Changes in Land use, Crop Yield, Evapotranspiration rates…

More info at 12h in José Sánchez presentation, session I1

Major threat

Information and tools are needed for stakeholders

European scale
(Panagos et al., 2015)

Regional scale

Local scale

"Development of a water resource management platform during low water periods in the SUDOE region"

Aguamod

Nearing, M. A., Pruski, F. F., & O'neal, M. R. (2004). Expected climate change impacts on soil erosion rates: a review. *Journal of soil and water conservation*, *59*(1), 43-50.

Panagos, P., Borrelli, P., Poesen, J., Ballabio, C., Lugato, E., Meusburger, K., ... & Alewell, C. (2015). The new assessment of soil loss by water erosion in Europe. *Environmental science & policy*, *54*, 438-447.

Study area

Area covered by **AGUAMOD project**

Area covered by AGUAMOD Project
Highlighted = Area considered in this study:

- North part of Portugal
- North part of Spain
- South-west part of France

Basins considered for this analysis

Eo
Nalón
Sella
Deva
Pas
Bidasoa
Nervión-Ibaizabal
Miño-Sil

Hypothesis and objectives

Hypothesis:

H1. The slope is expected to be the most relevant factor to take in consideration when considering soil erosion in this area.

H2. Forest and range land cover should be helpful in settling the soil particles and, though, diminishing soil erosion.

H3. Synergies and antagonisms should be presented with the combination of this parameters when talking about soil erosion.

Objectives:

O1. Obtain a database with spatial definition of soil erosion and hydrological variables for analysis.

O2. Identify the factors, or combination of factors, which show the strongest effect on soil erosion.

Methodology

T1. Assemble the data and calibrate the models	T2. Summarise the data results	T3. Analyse and identify the dominant factors.
DEM (90x90m, NASA)	Slopes, path lengths,…	Physical
Land Use (CLC project, 2012)	Covertures (forest, range,…)	Land cover
Soil types (FAO, HWSD v2.1)	Distribution (cambisols,…)	Soil classes
Climatology (SAFRAN, grid 5km)	Precipitation and temperature	Climatological
Observed Q (ROEA)	Water Yield, runoff,…	Hydrological
Observed SPM (Stakeholders)	Sediment Yield	

Sub-basin division according to official records

Time scales:

- **Warm-up period**: 5 years (January 1980, December 1984)
- **Calibration period**: 20 years (January 1985, December 2004)
- **Validation period**: 9 years (January 2005, December 2013)

Time step results: **monthly**

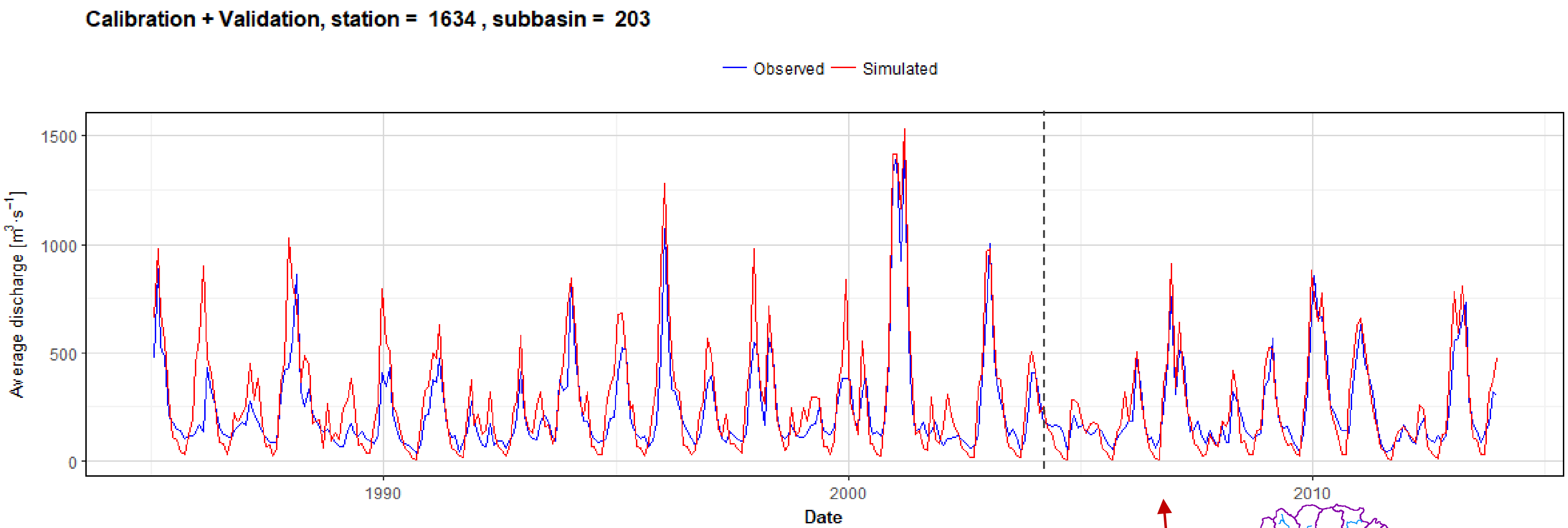
Model evaluation:

- Coefficient of determination (R^2)
- Nash Sutcliffe Efficiency (NS)

Results

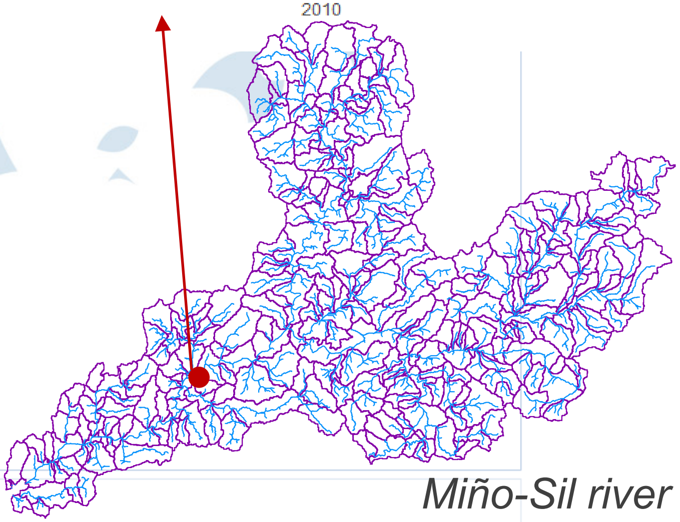
T1. Assemble the data and calibrate the models

DISCHARGE, Q



Evaluation of model performance

Period	r^2	NS
Calibration	0.81	0.62
Validation	0.87	0.80



Miño-Sil river

Results

T1. Assemble the data and calibrate the models

DISCHARGE, Q

		Calibration		Validation	
River	**Subbasin**	**r^2**	**NS**	**r^2**	**NS**
Miño-Sil	32	0.75	0.74	0.80	0.74
Miño-Sil	100	0.78	0.78	0.70	0.74
Miño-Sil	114	0.85	0.75	0.90	0.85
Miño-Sil	203	0.81	0.62	0.87	0.80
Nalón	39	0.81	0.84	0.84	0.84
Nalón	67	0.78	0.68	0.80	0.67
Sella	21	0.86	0.70	0.88	0.77
Bidasoa	3	0.75	0.77	0.89	0.88

Used parameters:

SURLAG.bsn
ESCO.bsn
EPCO.bsn
SMTMP.bsn
SFTMP.bsn

ALPHA_BF.gw
GW_DELAY.gw
GW_REVAP.gw
REVAPMN.gw
GWQMN.gw

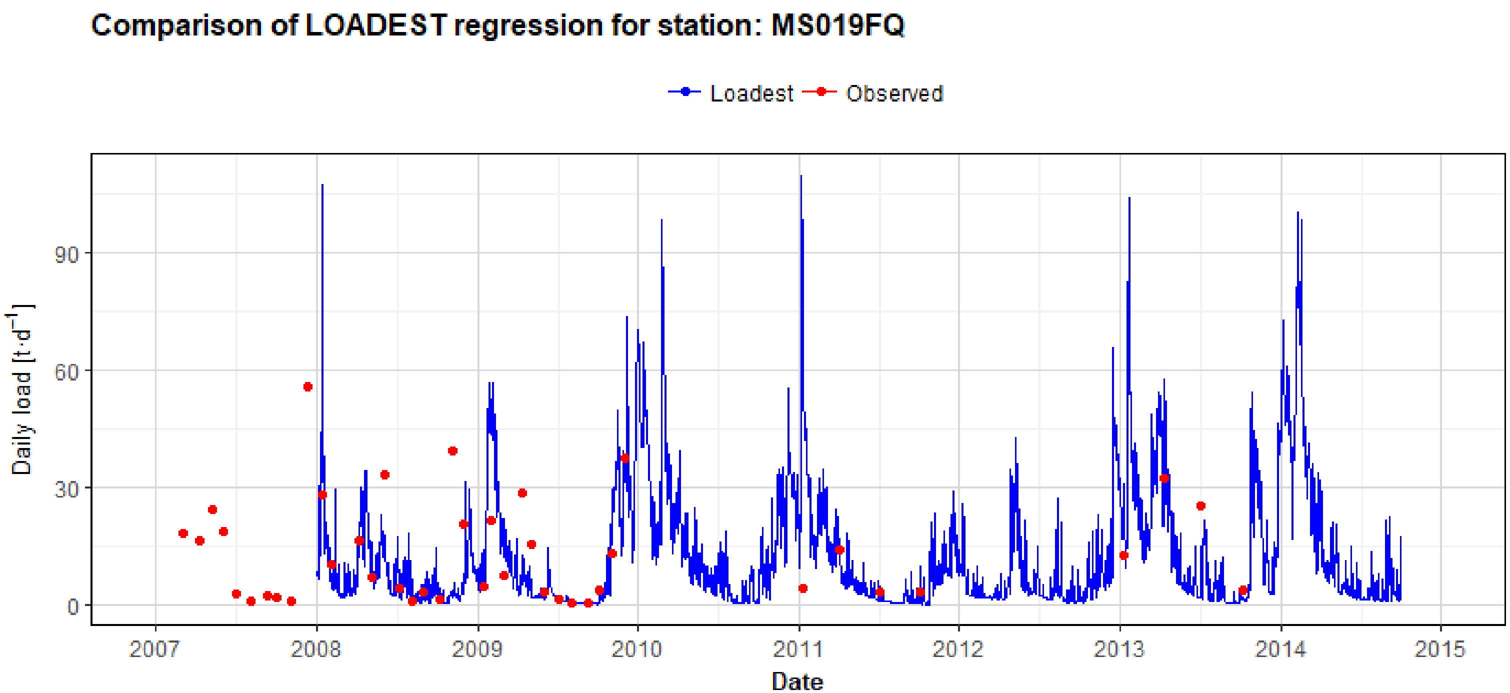
SOL_AWC(1).sol

CN2.mgt

Results

T1. Assemble the data and calibrate the models **SEDIMENTS, SPM**

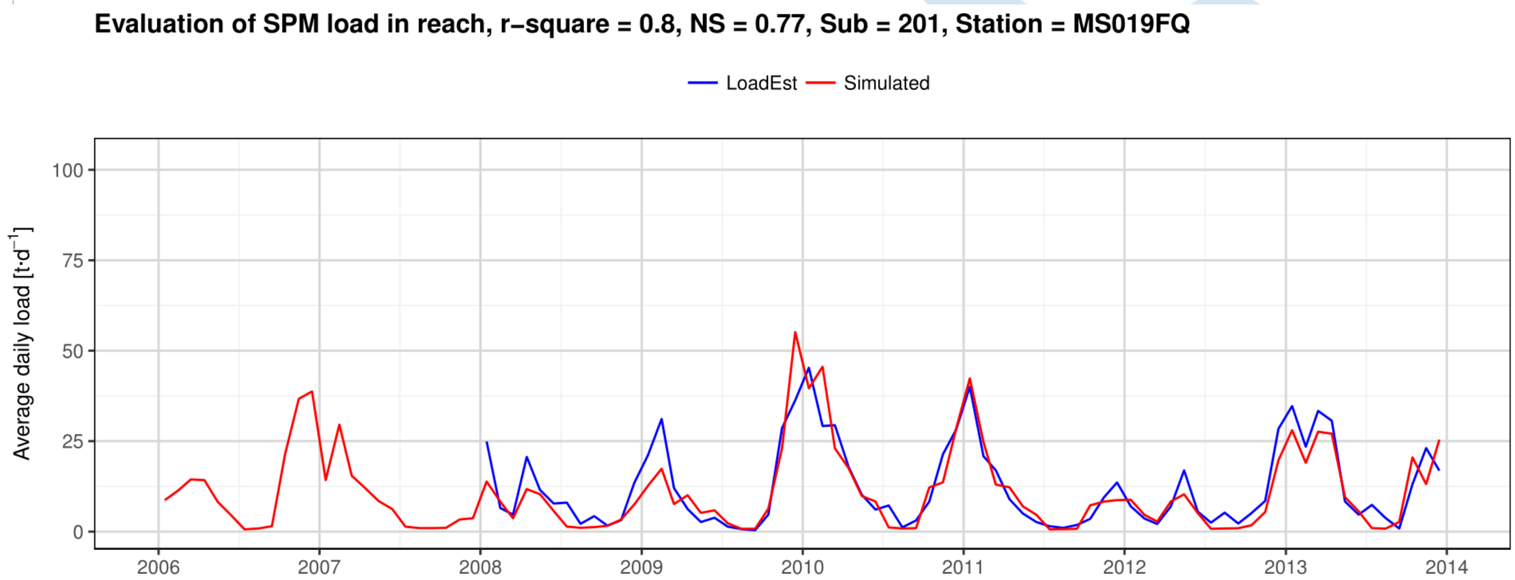
Few observations in some points → Data scarcity → LoadEst software



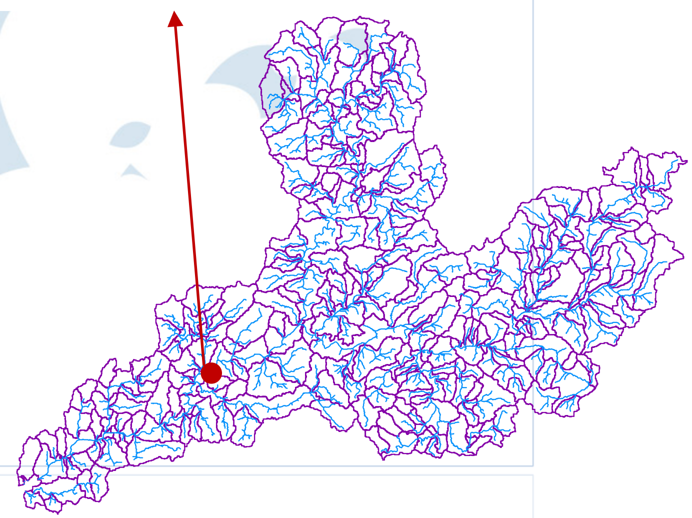
Results

T1. Assemble the data and calibrate the models

SEDIMENTS, SPM



Evaluation of model performance		
Period	r^2	NS
Calibration	0.74	0.66
Validation	0.83	0.79



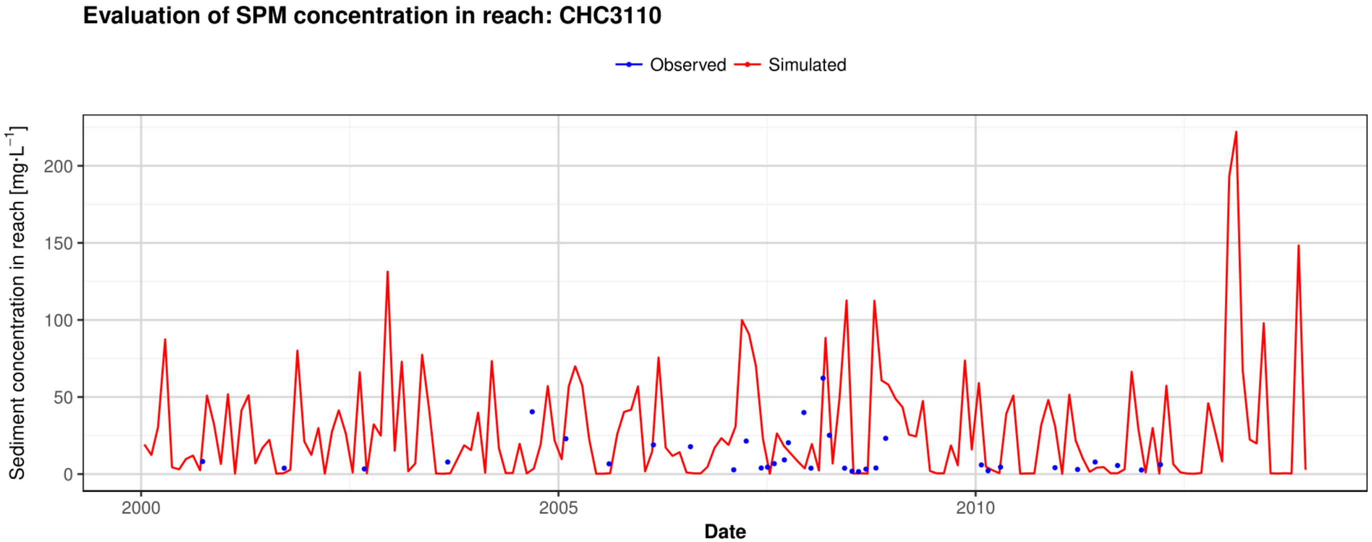
Results

T1. Assemble the data and calibrate the models

SEDIMENTS, SPM

		Calibration		Validation	
River	**Subbasin**	**r^2**	**NS**	**r^2**	**NS**
Miño-Sil	114	0.75	0.56	0.82	0.73
Miño-Sil	201	0.74	0.66	0.83	0.79
Nalón	47	0.63	0.45	0.43	0.12

No discharge data at same location than quality measurements.



Used parameters:

ADJ_PKR.bsn
PRF_BSN.bsn

CH_N1.sub

CH_N2.rte
CH_COV1.rte

HRU_SLP.hru
LAT_SED.hru
OV_N.hru

FILTERW.mgt
USLE_P.mgt

Results

T1. Assemble the data and calibrate the models

Results

T2. Summarise the data results

Mean annual sediment yield at the sub-basin scale.

Dataframe (n = 539):

- Physical (Area, Slope, Longest path length, Slope length, Tributary slope, Tributary width, Tributary depth, Elevation)
- Climatological (Precipitation, Snowmelt, Potential Evapotranspiration, Evapotranspiration)
- Hydrological (Soil Water Content, Percolation, Runoff, Water Yield)
- Land cover (Urban, Agriculture, Forest, Range, Water, Wetland)
- Soil types (Leptosols, Cambisols, Podzols, Histosols, Luvisols, Water Bodies)

Results

T3. Analyse and identify the factors

- **General approach**

Considering the variables with a very significant correlation (p<0.01) and a threshold for the coefficient of correlation $(r < -0.3 \mid r > +0.3)$.

Non correlated among them:

- Slope — Slo1
- Longest path — Len1
- Area — Area
- Range coverture — Range

			Pearson correlation	
	Unit	Factor	p	r
Slope	%	Slo1	0.00	0.46
Tributary slope	%	Csl	0.00	0.41
Area	ha	AREA_km2	0.00	0.35
Water body	%	Water Bodies	0.23	0.27
Agricultural	%	Agric	0.00	0.25
Leptosol	%	Leptosols	0.00	0.24
Urban	%	Urban	0.00	0.23
Groundwater	mm	GW_Qmm	0.00	0.20
Forestal	%	Fores	0.00	0.19
Potential Evapotranspiration	mm	PETmm	0.00	0.15
Cambisols		Cambisols	0.00	0.14
Snow melt	mm	SNOMELTmm	0.01	0.12
Percolation	mm	PERCmm	0.02	0.10
Histosols	%	Histosols	0.80	0.10
Maximum elevation	m	ElevMax	0.18	0.06
Wetlands	%	Wetla	1.00	0.00
Podzols	%	Podzols	0.99	0.00
Surface Runoff	mm	SURQmm	0.64	-0.02
Water Yield	mm	WYLDmm	0.46	-0.03
Soil Water	mm	SWmm	0.18	-0.06
Precipitation	mm	PRECIPmm	0.10	-0.07
Luvisols	%	Luvisols	0.58	-0.08
Mean elevation	m	Elev	0.00	-0.16
Width	m	Wid1	0.00	-0.17
Depth	m	Dep1	0.00	-0.18
Longest path	m	Len1	0.00	-0.22
Evapotranpiration	mm	ETmm	0.00	-0.29
Minimum elevation	m	ElevMin	0.00	-0.37
Range	%	Range	0.00	-0.42
Slope length	m	Sll	0.00	-0.47

Results

- **General approach**

Linear regression with scaled variables

$$\mathbf{SYLD} = \mathbf{80.48} \cdot \mathbf{Slo1} + (-\mathbf{31.11}) \cdot \mathbf{Len1} + \mathbf{13.47} \cdot \mathbf{Area} + (-\mathbf{75.01}) \cdot \mathbf{Range}$$

$$p < 0.01, r = 0.7 \text{ (Pearson)}$$

Slope > Range coverture > Longest path length > Area

Conclusions

H1. The slope is expected to be the most relevant factor to take in consideration when considering soil erosion in this area.

C1. Slope is, according to the strongest correlation found between this variable and the sediment yield, and the highest weight found in the linear regression, **the most important** parameter in this area.

H2. Forest and range land cover should be helpful in stabilising the soil particles and, though, diminish the soil erosion.

C2. Range cover has been presented a significative correlation with sediment yield with a negative value, though showing that it plays an **important role** in diminishing the soil erosion. Forest, on the other side, did not present this correlation, but was found to be related to range coverture in this area.

H3. Synergies and antagonisms should be presented with the combination of this parameters when talking about soil erosion.

C3. The linear regression found between the four factors shows **synergies** among the parameters, as longest length and range, which decrease erosion as their value increase.

Further work

- **Improve sediment monitoring network**, so sediment calibration and validation can be improved in modelling, leading to a lower uncertainty and better results.
- **Increase resolution for river network definition**, for this area this 90x90m cell grid is to coarse as the slopes are very pronounced, making reach definition more difficult.
- **Extrapolate this methodology to the SUDOE region or a wider area**, so catchments with a wider set of configurations can lead to clearer or stronger relations.
- **Inclusion of temporal analysis**, as the results are summarised to a yearly dataframe, an analysis of a temporal evolution may lead to correlations with other variables such as precipitation, crop yield, etc.

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Thank you! Merci! Dank je!

juanluis.lechuga@ehu.eus