Trace metal accumulation and bioavailability in the Ulla basin (NW Spain): Evaluation of the potential effects on the *Margaritifera margaritifera* (L.) population

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LIFE MARGAL-ULLA

(Period 2010-2015)

- ***"Recovery of populations of Margaritifera margaritifera (Linneo, 1758), and Galemys pyrenaicus (Geoffroy, 1811), in the Ulla river basin"***

- *Rural Ministry in the Galician Regional Governmentl (Xunta de Galicia)*

- *University of Santiago de Compostela*

- *Aguas de Galicia*

- ***http://margalulla.xunta.es***

LIFE MARGAL-ULLA
(Period 2010-2015)

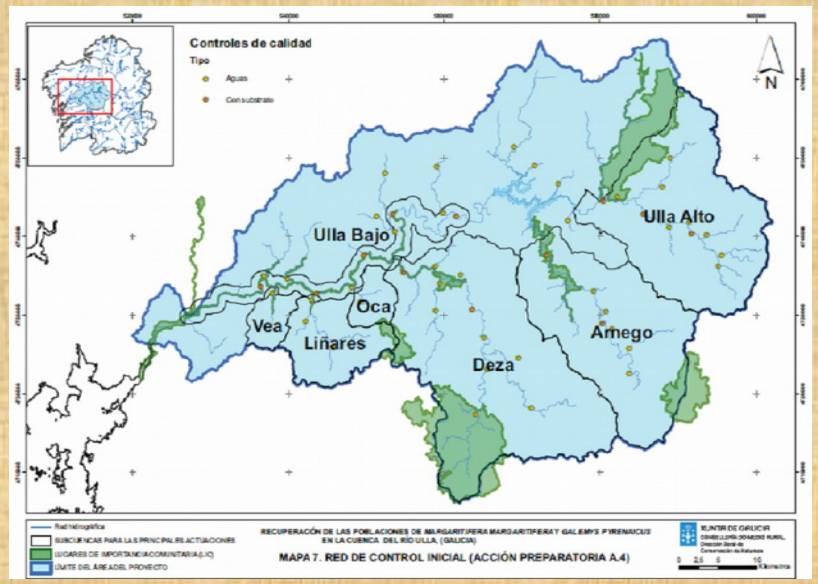
- *Conservation plan of Gallemys Pirennaicus (*also known as *Iberian Desman)*
- *Recovery plan of Margaritifera Margaritifera (freshwater pearl mussel)*
- *Improve conservation status of the species, reinforce the existine and establish suitable conditions for recovery*
- ***Water quality analysis***
- ***Sediment quality - presence of trace metals***

Margaritifera Margaritifera (freshwater pearl mussel) – Critical endangered species with different impacts considered trigger of this decline.

- *Climatic changes*
- *Introduction of invasive species*
- *Eutrophication*
- *Decline of salmonid host populations*
- *Decrease on habitat quality*
- ***Exposure to toxic elements?***
- ***Basal-content of trace metals?***

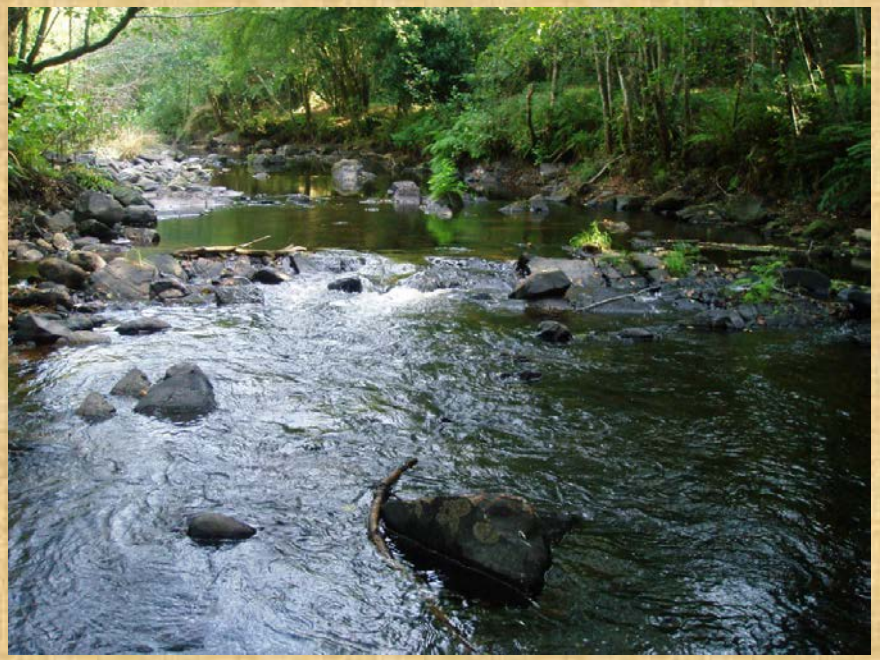
Ulla River (NW Spain)
Natura 2000 network

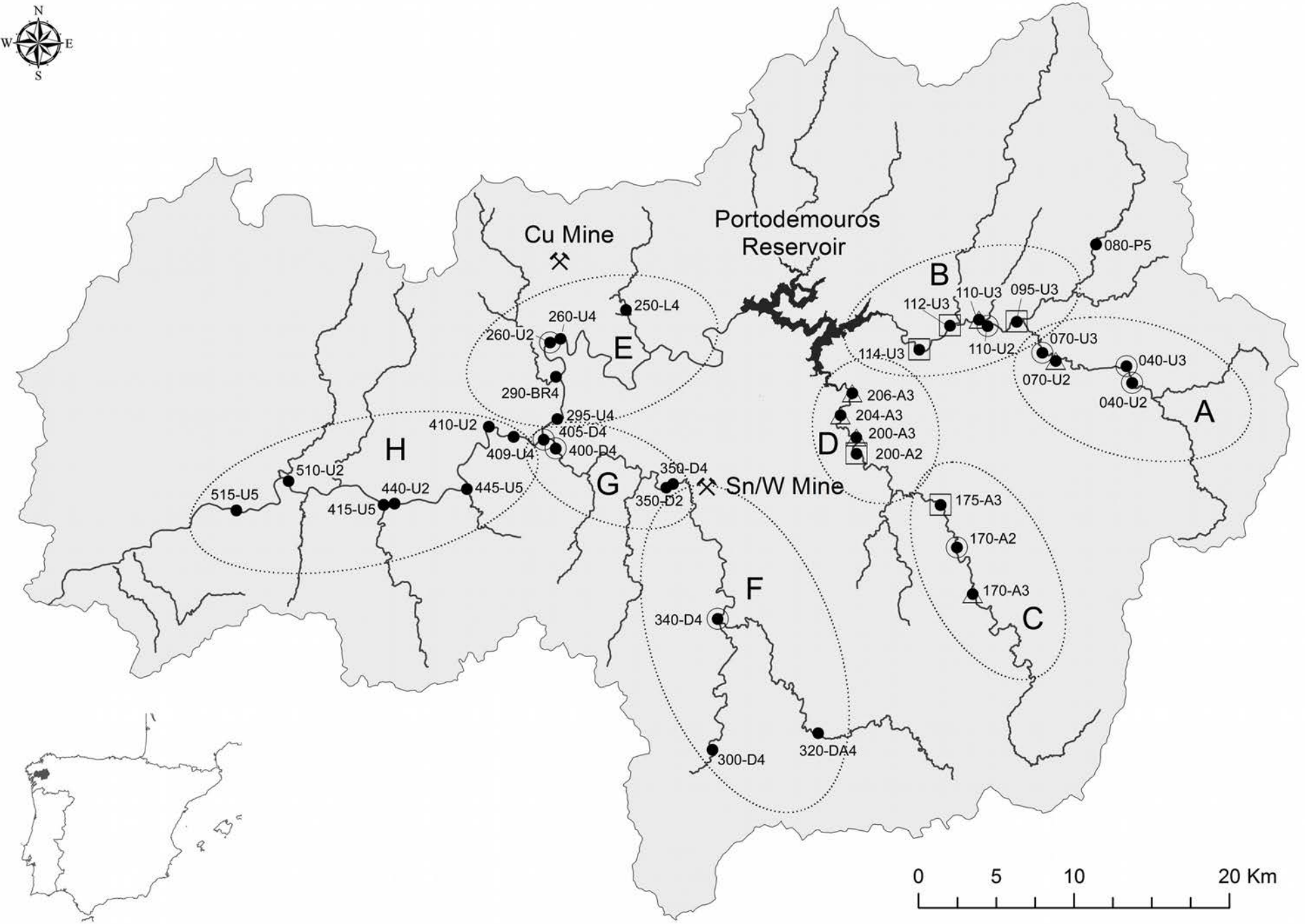
- *Total extension of 2,764 km² (2nd basin of Galicia)*
- *Atlantic weather. Average temperature, 11-15 ºC. Average rainfall, 1500-2000 mm*
- ***Presence of Margaritifera margaritifera: estimated population > 10,000. Densities ranging from 8.90 to 0.01 individual/m²***
- ***Antrophogenic pollution: agricultural and farming activities. Mining areas***
- ***Copper, tungsten and tin mines. Presence of trace metal-bearing minerals.***



Ulla River (NW Spain)
Natura 2000 network
Antrophogenic impacts

- *"Distribution of trace metals inthe riverine basin. Analysis of the relationship between trace metal content on river sediments and the abundance of freshwater pearl mussel populations"*
- *Assessment of the accumulation and mobility of trace metals. Metal speciation*
- *Population distribution (abundance and density)*
- *Statistical analysis*




N
W
E
S
Cu Mine
Portodemouros
Reservoir
Sn/W Mine
A
B
C
D
E
F
G
H
080-P5
110-U3
095-U3
112-U3
110-U2
114-U3
070-U3
070-U2
040-U3
040-U2
206-A3
204-A3
200-A3
200-A2
175-A3
170-A2
170-A3
250-L4
260-U4
260-U2
290-BR4
295-U4
405-D4
400-D4
410-U2
409-U4
350-D4
350-D2
340-D4
300-D4
320-DA4
510-U2
515-U5
440-U2
415-U5
445-U5
0
5
10
20 Km

IAP 2014

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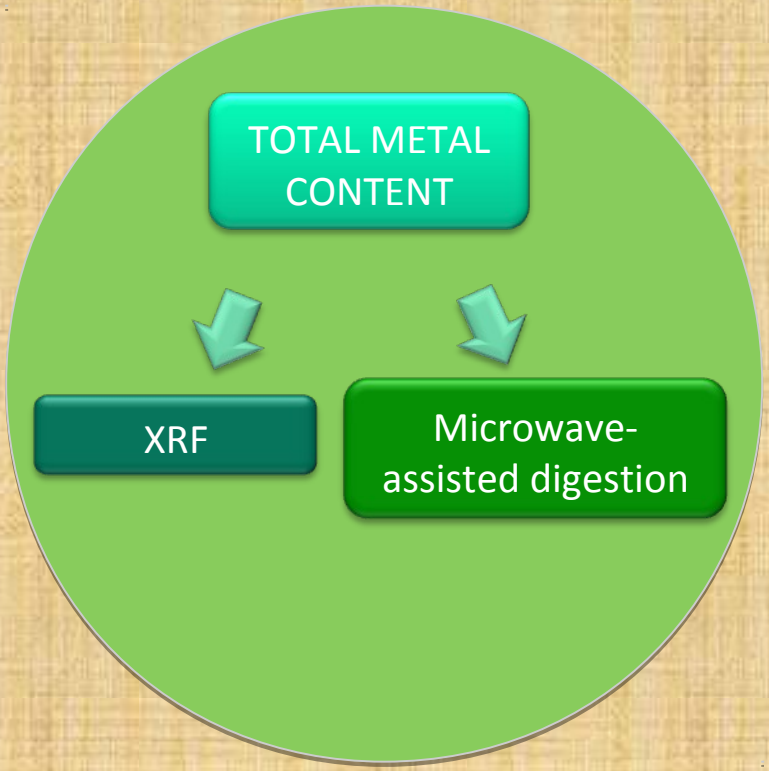
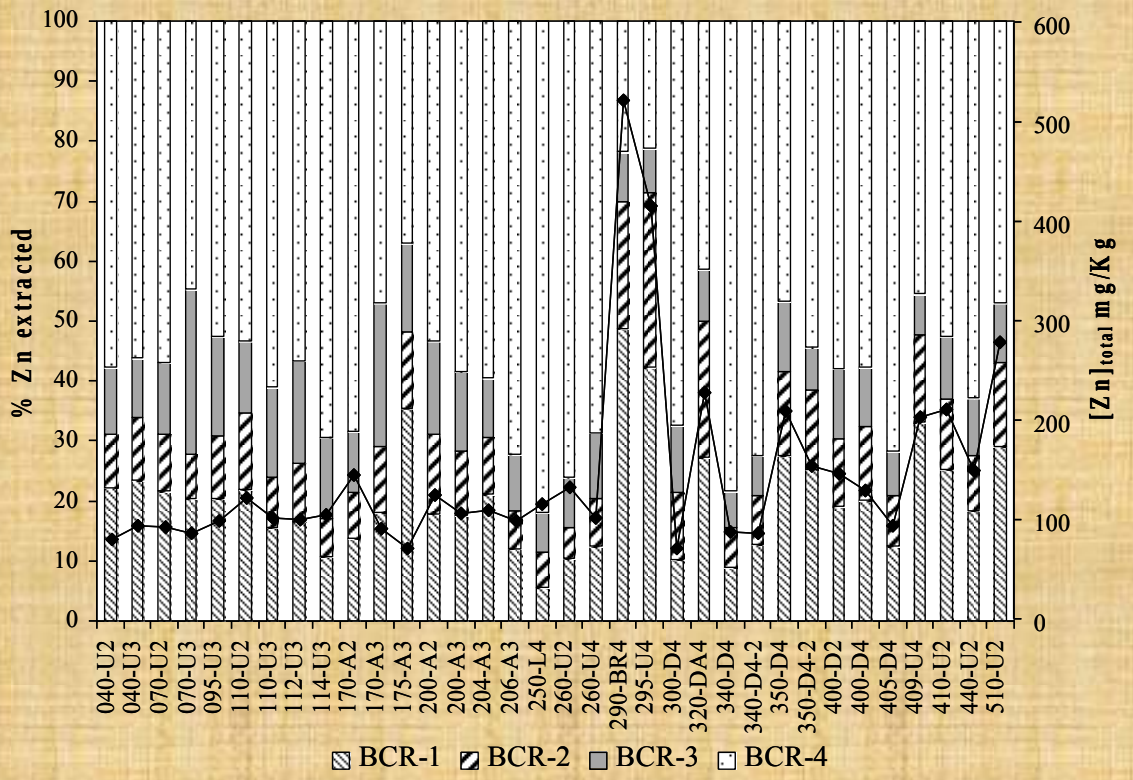
Sediment samples collected from sites affected by acid mine drainage (AMD) (Old copper mine, 1974-1988 Rio Tinto Group)

Sediment samples collected in the Deza River (main tributary) – mining and industrial impacts?





Accumulation of metal downstream, with the the highest levels in the surroundings of mining areas

Variability and identification of anomalous contributions?

Total content vs chemical speciation?

Enrichment factor

Index of geo-accumulation

$$EF = (C_M/C_{Al})_m / (C_M/C_{Al})_r$$

$$Igeo = \log Cn / 1.5\ Bn$$

Allows evaluation of natural and anthropogenic contributions

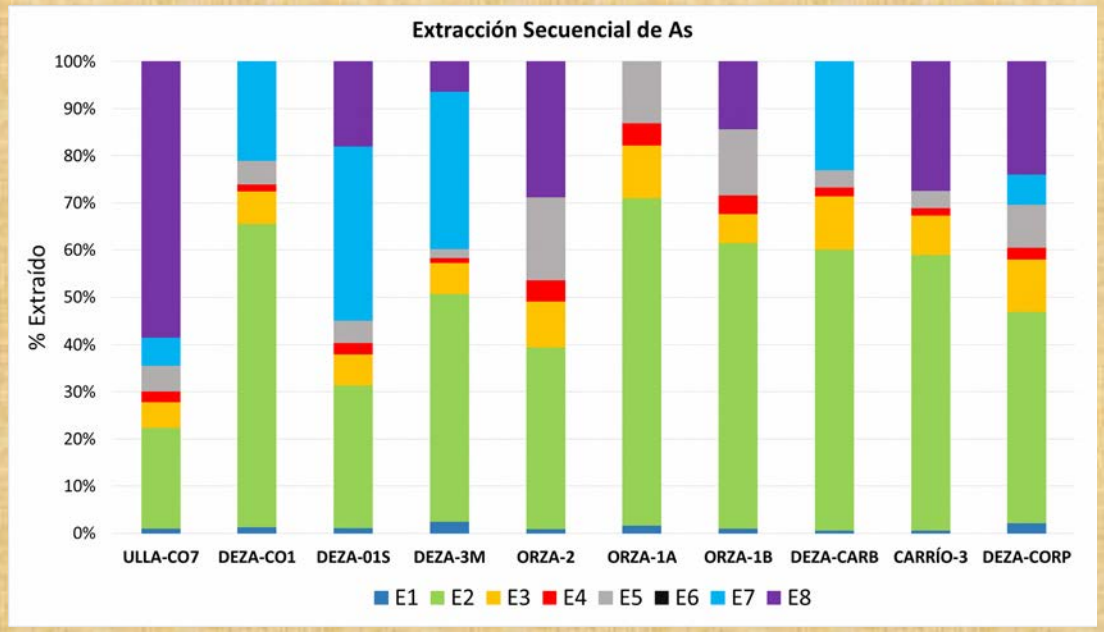
Normalization of the metal/metalloid concentration in base to the Al contents

Different levels of metal accumulation and degree of metal pollution

CHEMICAL SPECIATION

BCR Chemical sequential extraction

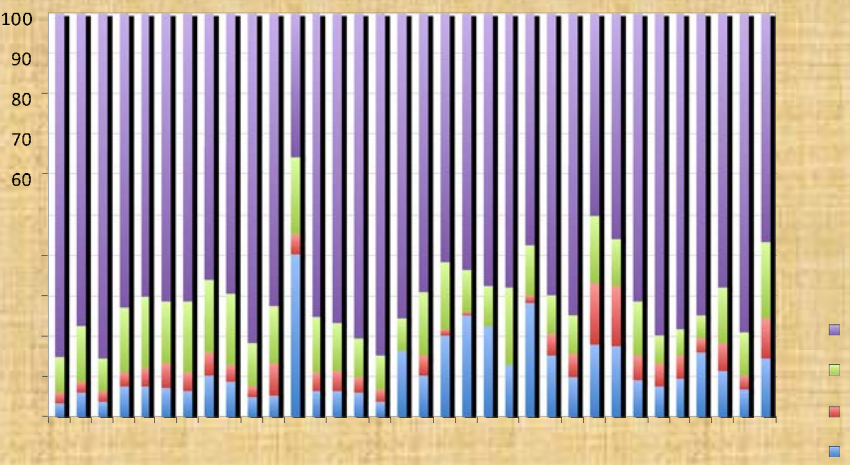
Arsenic sequential extraction

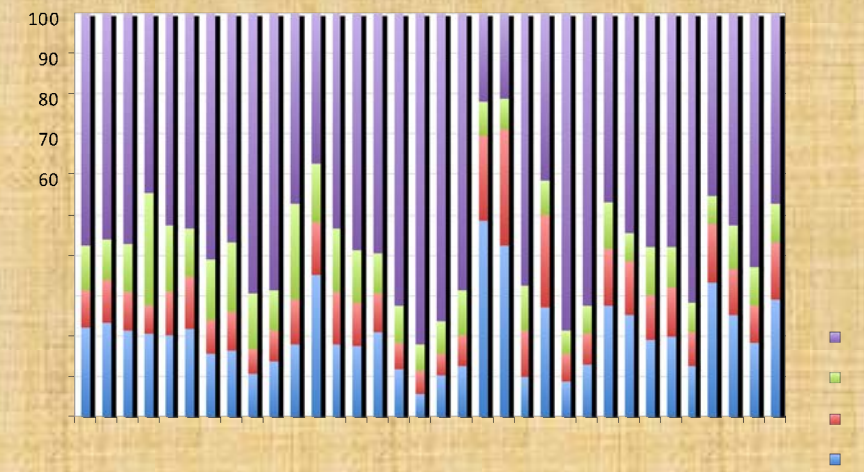


Evaluation of the mobility of the trace metals and arsenic on the sediments – *carbonates, oxides, organic matter, recalcitrant*

As-rich sediments – W/Sn mining area. Total conten > 100 mg As/kg. Minimum presece of *M. margaritifera*

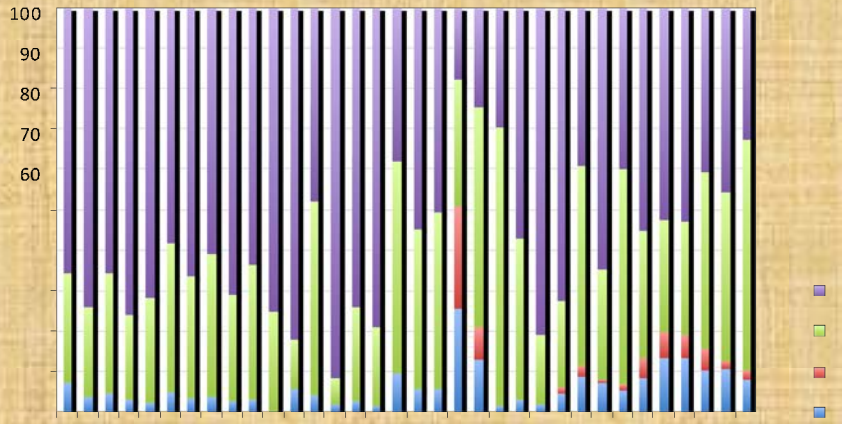
Relatively high As mobility. 30-50% easily desorbed with P





Nickel , Zinc, Copper (more movile elements)

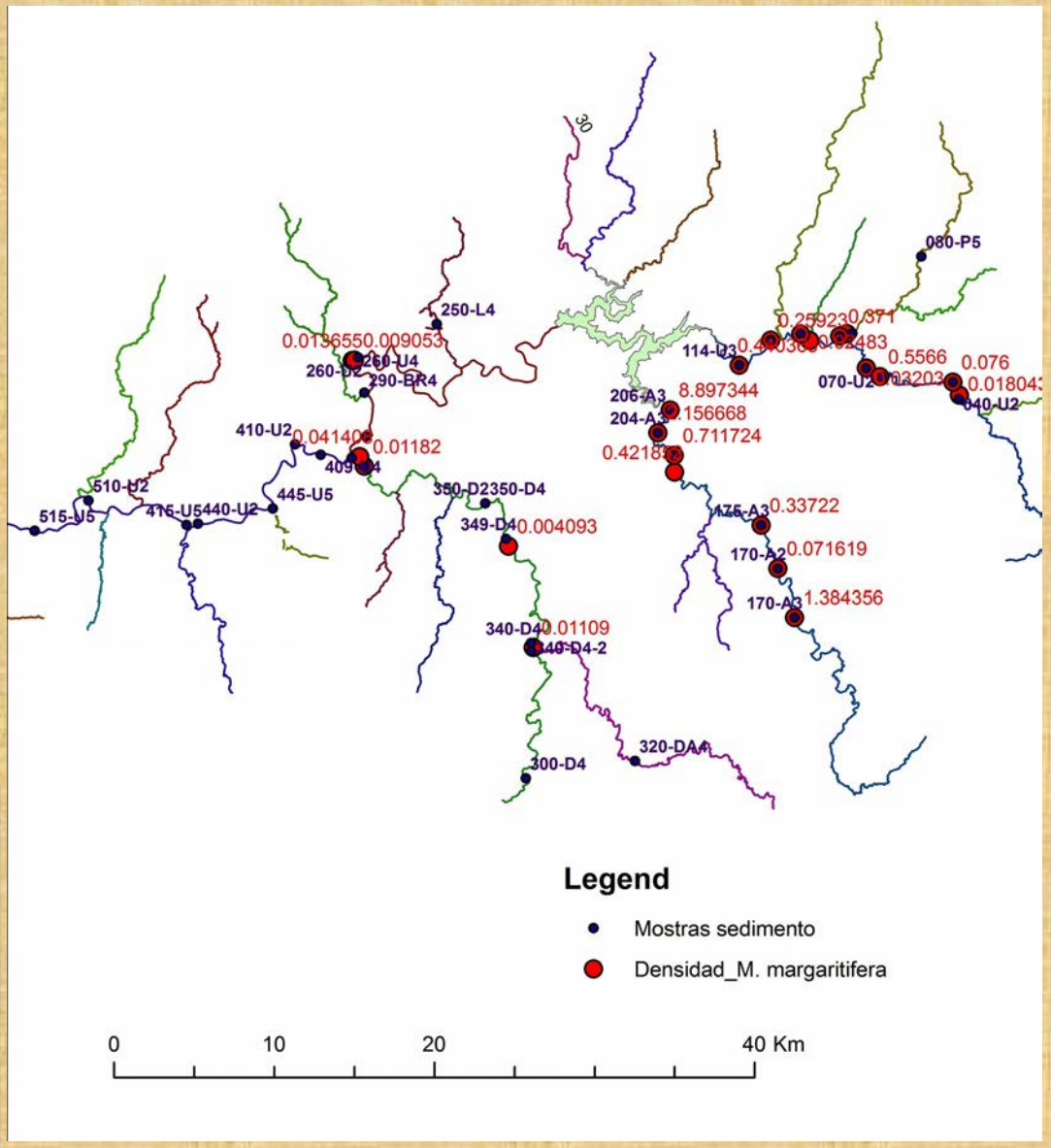
BCR1 (soluble); BCR2 (iron and manganese oxides); BCR3 (organic matter)



M. margaritifera

Estimation of individuals

Density



Larger number of individuals and higher density in the upper basin (upstream – minimum impact)

Decline of the current population and ageing (absence of juveniles)

Statistical analysis
(Total metal content, metal speciation, density of *M. margaritifera*)

- *Analysis to correlate M. margaritifera with the trace metals in the sediment*

- ***Factorial analysis –*** *River basin divided in different regions to analyse the influence of anthropogenic impacts*

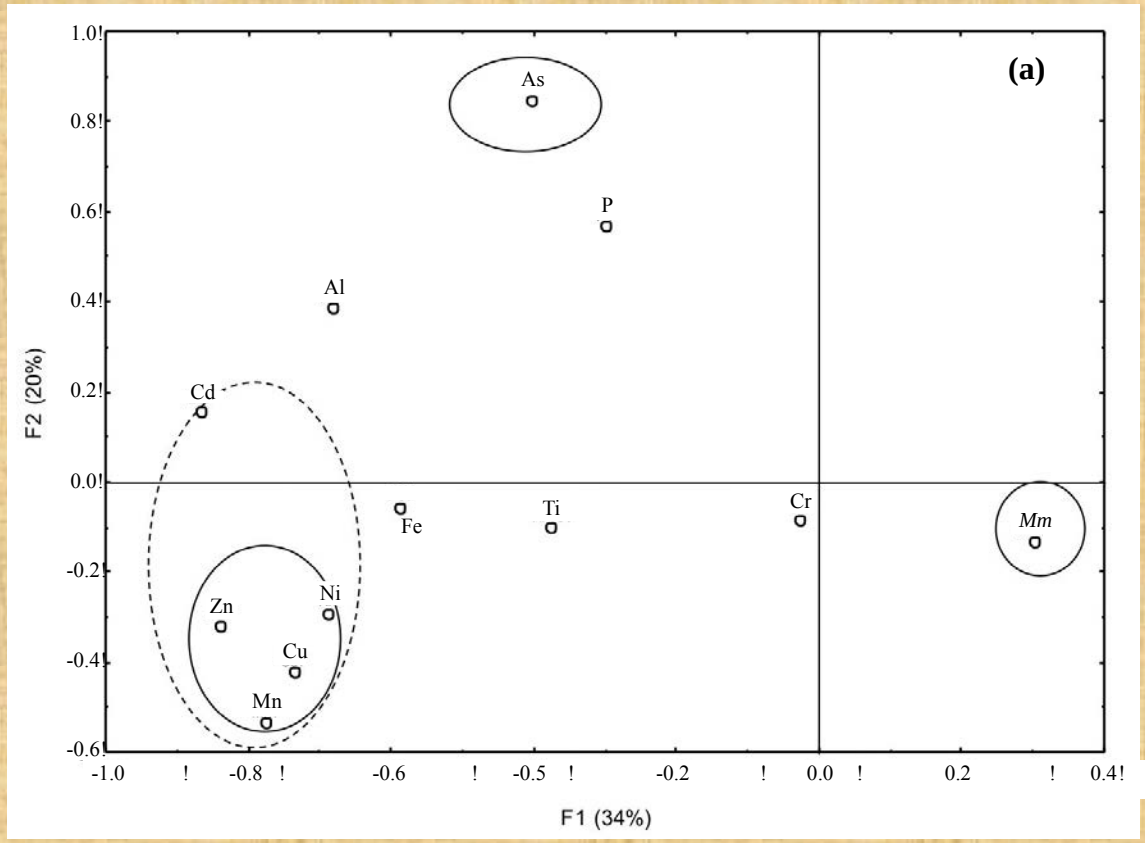
- ***Factorial analysss –*** *Cu, Ti, As, Mn, Zn, Ni, Cd, Fe, Al, P, density. No TOC or grain-size.*

- ***ANOVA –*** *Influence of the river region, absence/presence of individual*

- **Factorial analysis –** River basin divided in different regions to analyse the influence of anthropogenic impacts

- **Negative interrelation between the *M. margaritifera* and the total trace metal content**

- *The results pointed out that the increase in the concentrations of trace metals was accompanied with an increase of the most reactive and mobile forms*



Factorial analysis

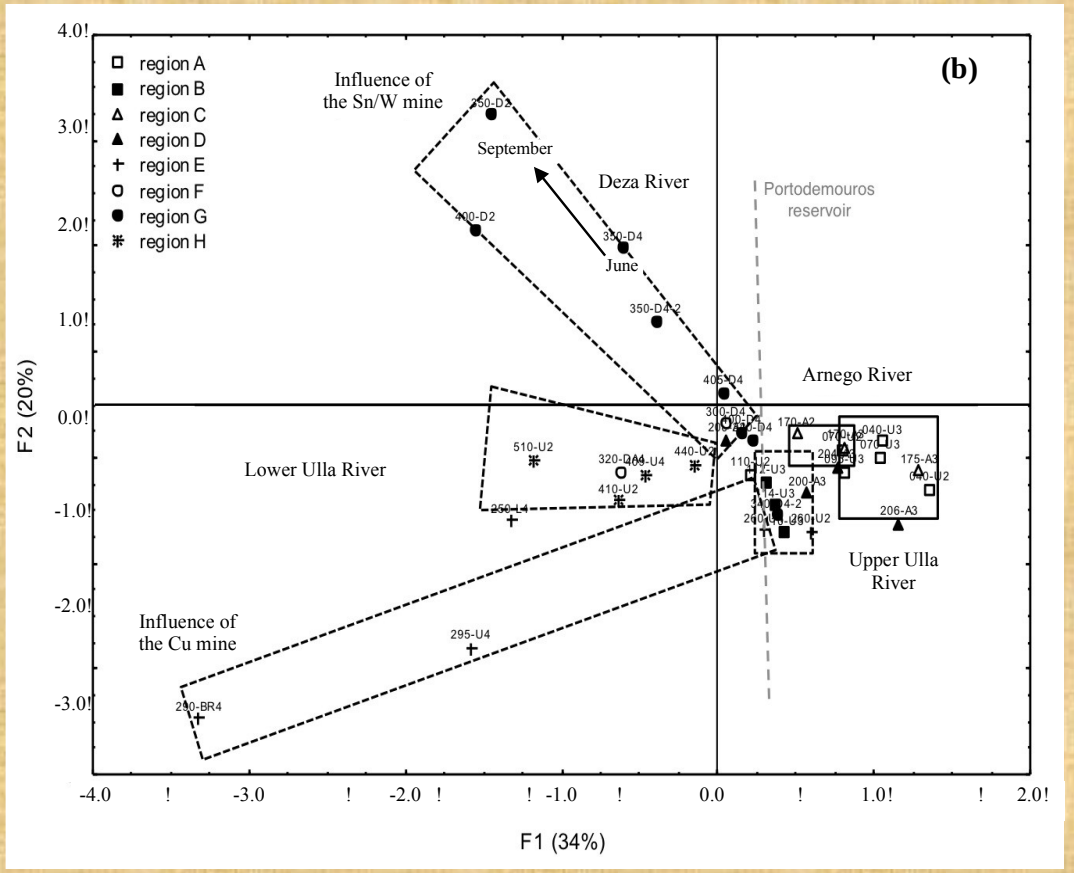
F1-F2 loadings

- **Factorial analysis** – River basin divided in different regions to analyse the influence of anthropogenic impacts

- **Samples upstream (lower pollution impact) placed on positive values.**

- **Samples downstream (larger pollution impact – mining) placed on negative values**

- The factor analysis associates the largest contents of trace metals (excluding As) to that samples affected by mining activities



Factorial analysis

F1-F2 scores (samples)

Conclusions

- Increase of trace metal concentration downstream. Decrease of number of individuals (or density) downstream

- The survival of *M. margaritifera* population is not directly affected by trace metal content in sediments but by the degree of bioavailability of these metals

- Significant differences (negatively correlated) between M. Margaritifera and trace metals and metalliods (As, Ni, Cu, Zn, and Cd) present in the sediments

- Future studies – trace metal concentration in biological tissue and shells

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Thanks for your attention

Questions?