Spanish aquatic ecosystem monitoring programs: possibilities to comply with requirements of NEC Directive and ICP Waters / Integrated Monitoring

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Outline:

1. Introduction to Spanish Institutions involved in this tasks
2. Ecological characterization of Spanish rivers and lakes
3. Spanish Freshwater ecosystems monitoring networks
4. Possibilities to comply with NECD & ICPs requirements

1. Introduction to Spanish Institutions involved in this tasks

GOBIERNO DE ESPAÑA | MINISTERIO DE FOMENTO | MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE | CEDEX CENTRO DE ESTUDIOS Y EXPERIMENTACIÓN DE OBRAS PÚBLICAS

Ministry of Public Works

Ministry of Agriculture and Fisheries, Food and Environment

Center for Studies and Experimentation of Public Works (CEDEX) (6 Centers)

Directorate General for Water

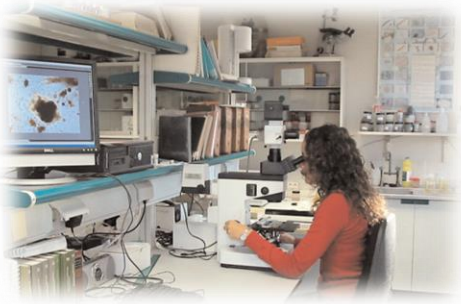
Center for Hydrographic Studies

national competences in the subject of environment and water resources

research, experimentation and technical assistance related to water resources

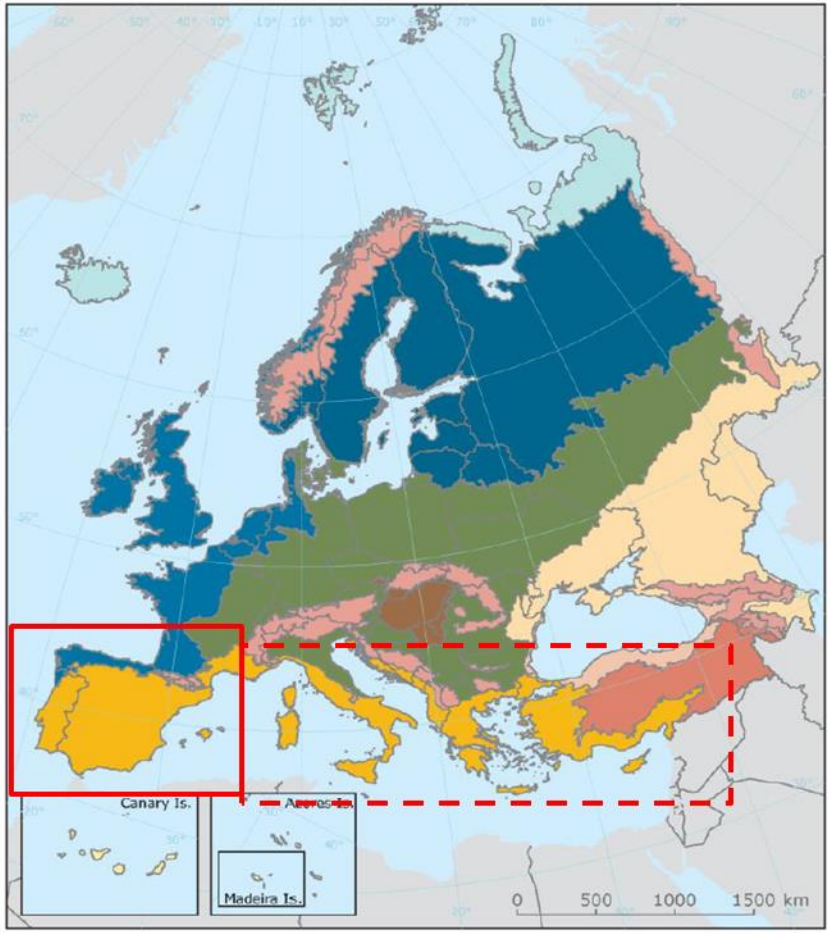
Department of Water Environment (Centre for Hydrographic Studies)

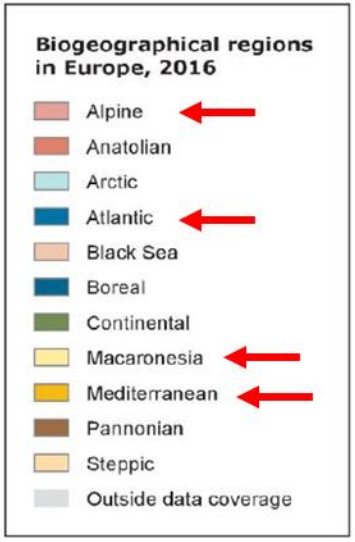
- **National and European regulations**
  - European Directives: 2000/60/CE, 92/43/CEE
  - Technical instructions, protocols, assessment of ecological status, ecological indicators,…
- **Limnological studies**
  - Effects of pressures on aquatic ecosystems: (contaminants, eutrophication, toxicity, regulation,...)
  - Ecological characterization / biodiversity
  - Instrumentation and monitoring of water bodies
  - Exotic aquatic species
- **Climate change effects on aquatic ecosystems**
  - National Plan of adaptation to climate change
  - Environmental changes reconstruction / paleolimnology
- **Laboratory for chemical analyses**
  - Surface and groundwater, sediment analyses
  - Contaminants and emerging substances
  - Toxicity - bioassays

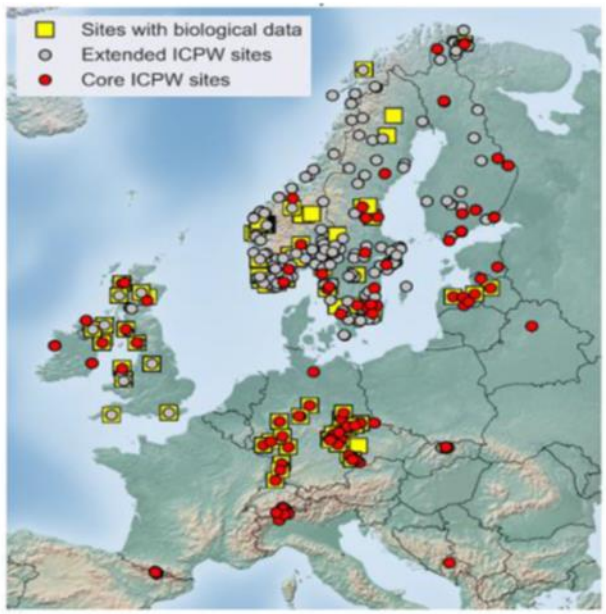


2. *Ecological characterization of Spanish rivers and lakes shows a high environmental diversity*

Aim ICP-W: Assess the degree and geographic extent of the impact of atmospheric pollution on Surface waters







ICP Waters Monitoring Network

ICP Integrated Monitoring Network (primarily forest-based)

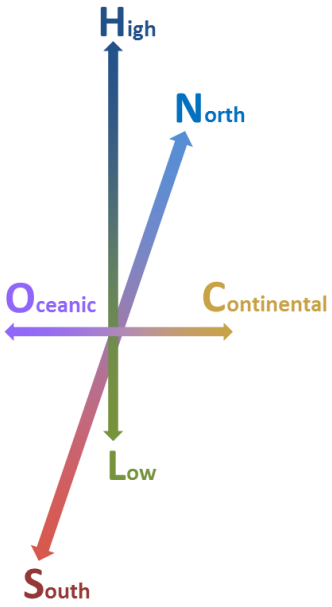
"Med-water" is missing

https://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3

The three large biogeografical regions in Iberian Peninsula include several very different bioclimatic regions…

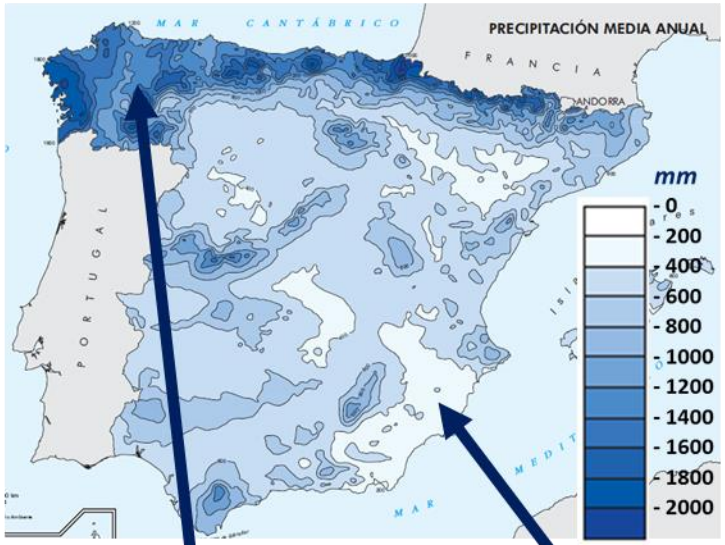
https://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3

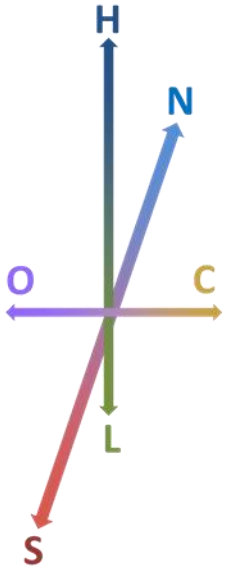
There are 9 bioclimatic regions in Spain (Iberian Peninsula) determined mainly by two factors: Geography + Atmosphere.
They respond to three different gradients:

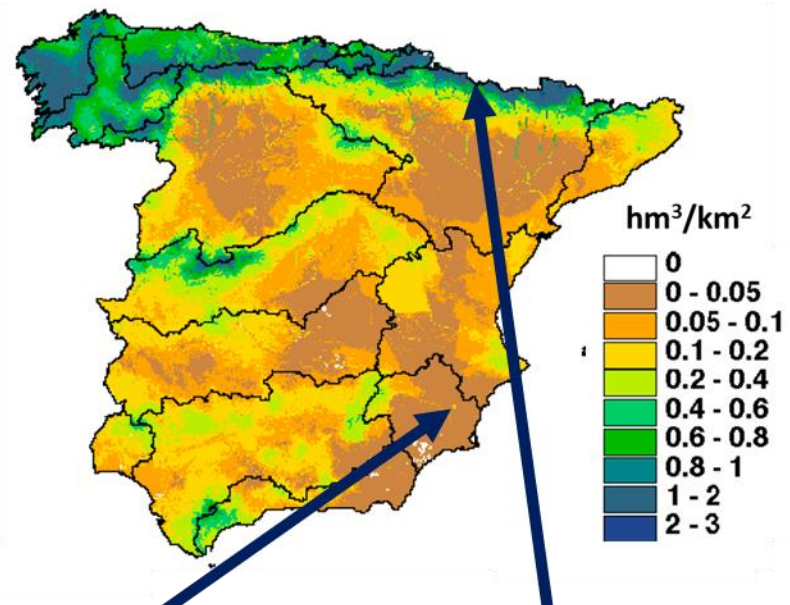


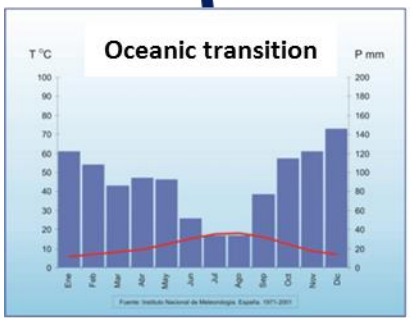
https://www.ign.es/espmap/clima_bach.htm

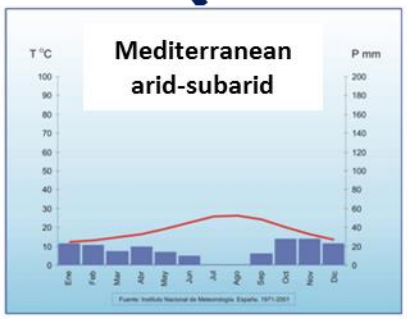
Mean annual precipitation in Spain* → Specified annual drainage in Spain**

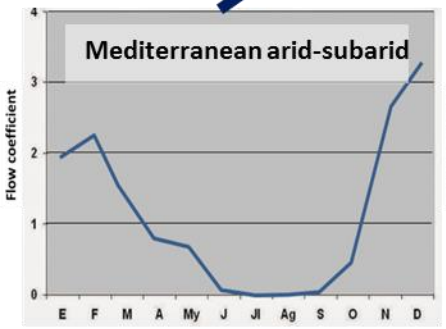


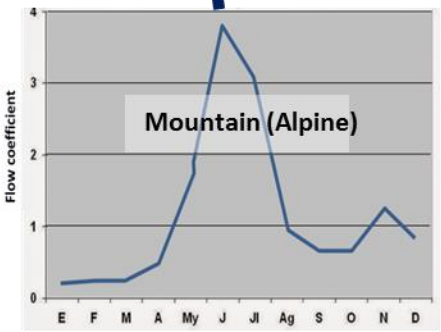












** https://www.ign.es/espmap/clima_bach.htm*

*** CEDEX. 2005. Characterization of rivers and lakes typologies for Directive 2000/60/CE*

Characterization of rivers and lakes in accordance with WFD (system B) reflect the high environmental diversity

RIVERS

Variables (GIS analyses)

- Altitude (m.a.s.l.)
- Air temperature range (ºC)
- Watershed area (km^2)
- Annual mean flow (m^3/s)
- Specific annual drainage (hm^3/km^2)
- Geology/Estimated conductivity (µS/cm)
- Latitude (UTM 30)
- Longitude (UTM 30)
- River order (Stralher)
- Catchment slope (%)
- Months with river flow = 0 (%)
- Mean air temperature (ºC)

LAKES

Variables (ranges and thresholds)

- Humide index (prec./ETP): >2, < 2
- Altitude: 0-15, 15- 1500, > 1500
- Origen: karstic, not karstic
- Thermal regime (hot momomictic, cold monomictic, dimictic, polymictic)
- Drainage inflow regimen
- Hydroperiod: temporal, permanent
- Max depth: < 3 m, 3 – 15 m, > 15 m
- Salinity: Hammer criterium (anual salinity evolution)
- Alkalinity: > 1 meq/l , < 1 meq/l

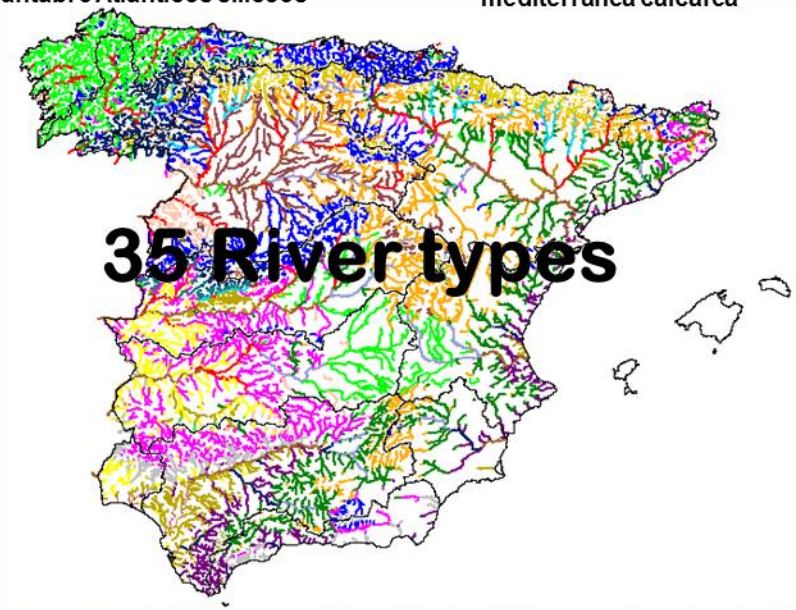
Tipo 21. Ríos Cántabro Atlánticos silíceos

Tipo 31. Pequeños ejes fluviales Cántabro Atlánticos silíceos

Tipo 12. Ríos de montaña mediterránea calcárea

Tipo 27. Ríos de Alta montaña

Tipo 3. Ríos de las Penillanuras silíceas de la Meseta Norte



Tipo 5. Ríos Manchegos

Tipo 24. Gargantas de Gredos - Béjar

Tipo 18. Ríos costeros mediterráneos

Tipo 17. Grandes ejes fluviales en ambiente mediterráneo

Tipo 9. Ríos mineralizados de Baja montaña mediterránea

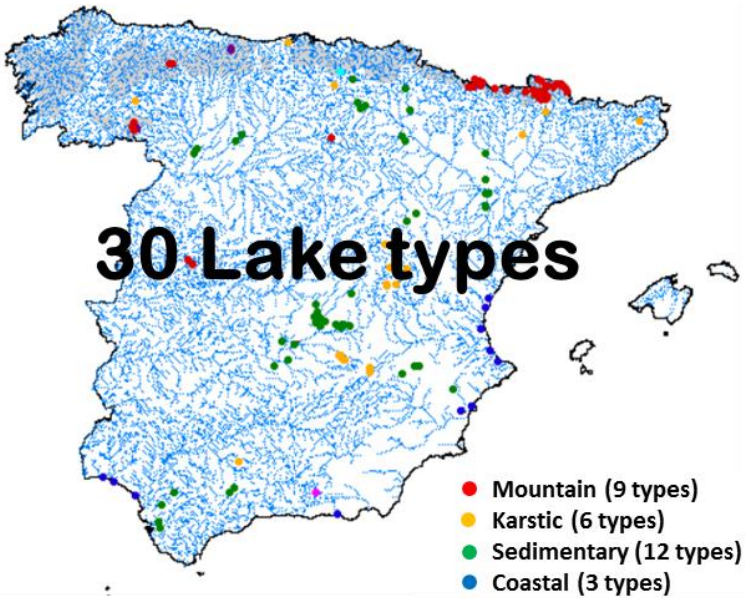
Tipo 10.

Tipo 12.

Tipo 14.

Tipo 6.

Tipo 21.



Tipo 23.

Tipo 2.

Tipo 10.

Tipo 23.

Tipo 1.

3. Current monitoring networks in freshwater ecosystems in Spain

At national-level, there are two main monitoring networks in freshwater ecosystems

Water Framework Directive	NATURA 2000
2000/60/CE	92/43/CEE
Water Bodies types: rivers, lakes, HMWB, artificial, transitional and coastal.	Habitats (SCI)/Species: Running and standing waters (rivers and lakes/wetlands)
Water bodies: ≈ 3800 rivers + ≈ 320 lakes	**Rivers: 2950 SCIs + Wetlands: 1400 SCIs**
Spanish Government + Regional Governments (inter-communities) (intra-communities)	*Competences*	**Regional Governments**
All river basins ≈ 10 years (some basins > 15-20 y)	*Current monitoring*	**Regional differences, and only wetlands**

Lack of correspondence between WFD and HD types

Ecological criteria for classification

Tipo 8 Ríos de baja montaña mediterránea silícea	Tipo 3220 Ríos alpinos con vegetación herbácea en sus orillas
Tipo 11 Ríos de montaña mediterránea silícea	Tipo 3230 Ríos alpinos con vegetación leñosa en sus orillas de *Myricaria germanica*
Tipo 12 Ríos de montaña mediterránea calcarea	Tipo 3240 Ríos alpinos con vegetación leñosa en sus orillas de *Salix eleagnos*
Tipo 25 Ríos de montaña húmeda silícea	
Tipo 26 Ríos de montaña húmeda calcarea	

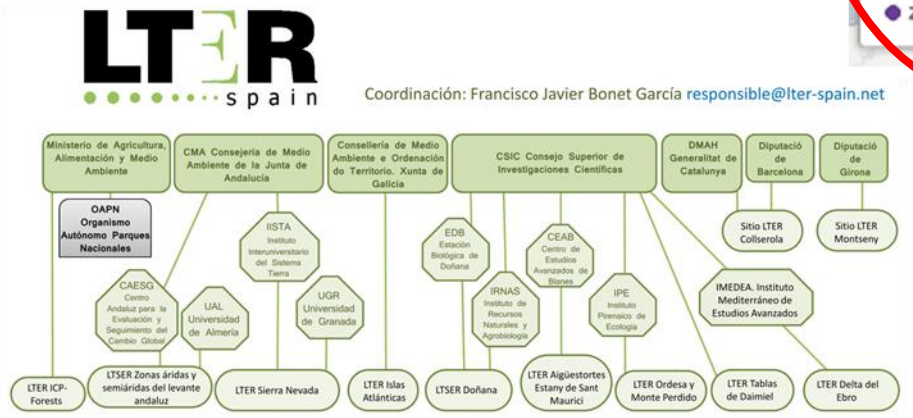
. . . / . . .

Phytosociological criteria for classification

A national working group is coordinating the optimization of both networks to comply with the requirements of both Directives in coincident sites, based on WFD monitoring network.

Also at national-level, but very limited in number of sites:

- **LTER-Spain / National Parks Network**



LTER AIGÜESTORTES

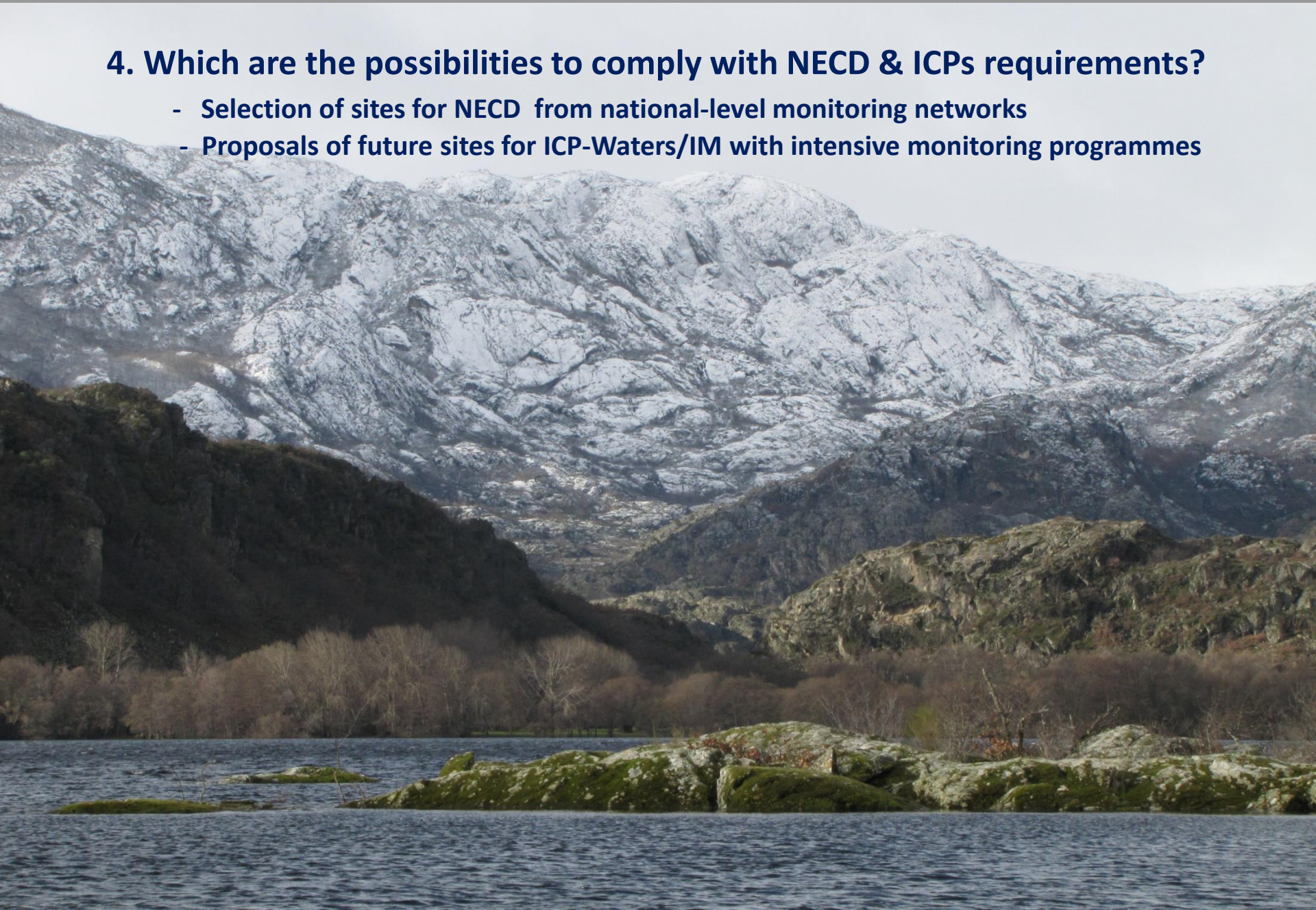
LTER-Aigüestortes was established in 2008 by 6 institutions, and covers six areas: climatology, CO_2 flows, biogeochemistry of atmospheric precipitation and surface water, reconstruction of past environmental change , populational trends and phenological changes.

http://parcsnaturals.gencat.cat/ca/aiguestortes/coneixeu-nos/ambits_o_linies_de_treball/node_lter/

Source: http://www.lter-spain.net/

4. Which are the possibilities to comply with NECD & ICPs requirements?

- Selection of sites for NECD from national-level monitoring networks
- Proposals of future sites for ICP-Waters/IM with intensive monitoring programmes

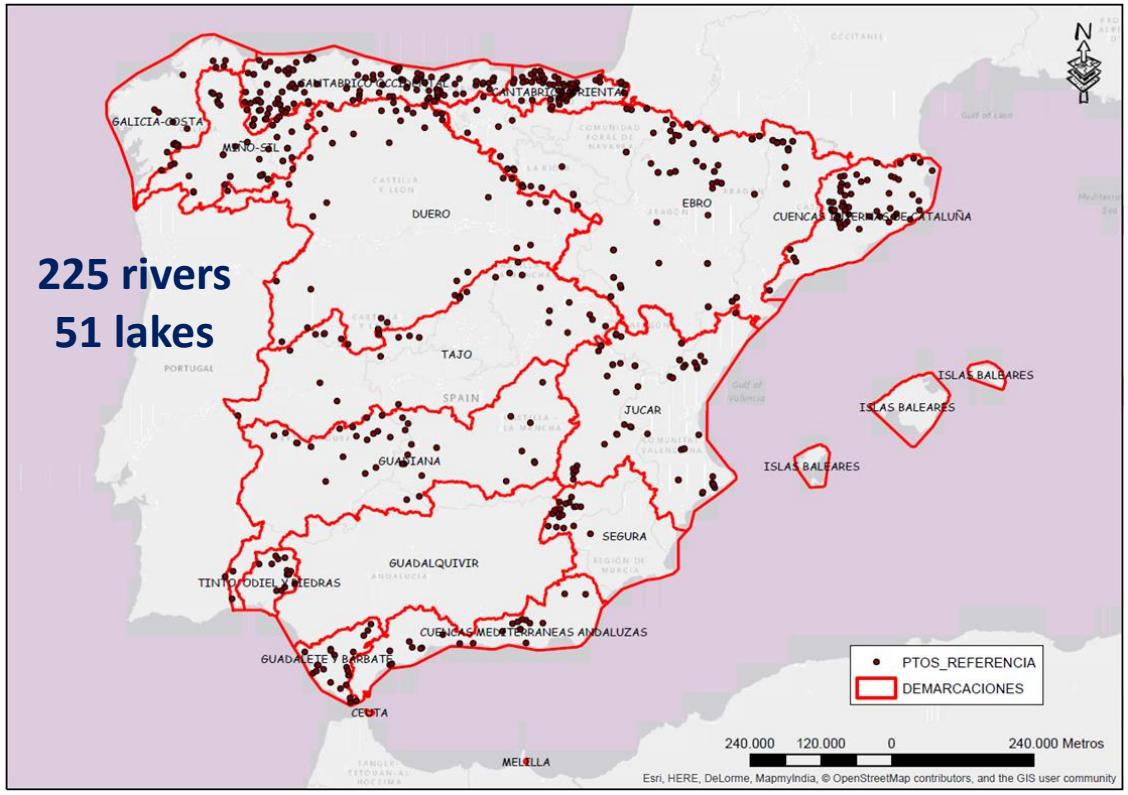


To comply with NECD requirements is necessary to look for representative sites of different habitats (environmental gradient) and without any pressures:

Starting point is the Subprogramme of selected reference sites in rivers/lakes for WFD.
The criteria used to select reference sites in rivers/lakes for WFD was the existence of:

Minor or no alterations from:

- **Land uses (%)(agric., livest., urban., indust.)**
- **Morphological alterations**
- **Hydrological alterations**
- **Exotic species**
- **Waste waters**
- **Recreational uses**
- **Groundwater connection**
- **Eutrophication**



But a selection of reference sites **without any minor pressure** is needed

Does this programme fit the NECD requirements (Annex V)?

Sub-programme of monitoring for Reference sites : indicators and frequency of sampling

BIOLOGICAL ELEMENTS
PHYTOPLANKTON
BENTHIC DIATOMS
MACROPHYTES
MACROINVERTEBRATES
FISHES

GENERAL CHEMICAL PARAMETERS
TURBIDITY
pH
ALKALINITY = ANC
DISSOLVED OXYGEN (mg/L + %sat)
Total HARDNESS
TEMPERATURE
CONDUCTIVITY
DISSOLVED SOLIDS
SUSPENDED SOLIDS
PHOSPHATE
Total PHOSPHORUS
NITRATE
NH_3
AMONIUM
NITRITE

OTHER CHEMICAL PARAMETERS
MERCURY
SILICA
Total CLORIDE
SH_2
SO_4
CHLOROPHYLL *A*
DQO
PERMANGANATE INDEX
ANIONIC TENSOACTIVES
DBO5
N Kjeldahl
N Total

- **It comply NEC Directive**
- But DOC is missing

- All protocols and methodologies were adopted according to WFD.
- Because many labs are involved in the different basins, IC is needed.

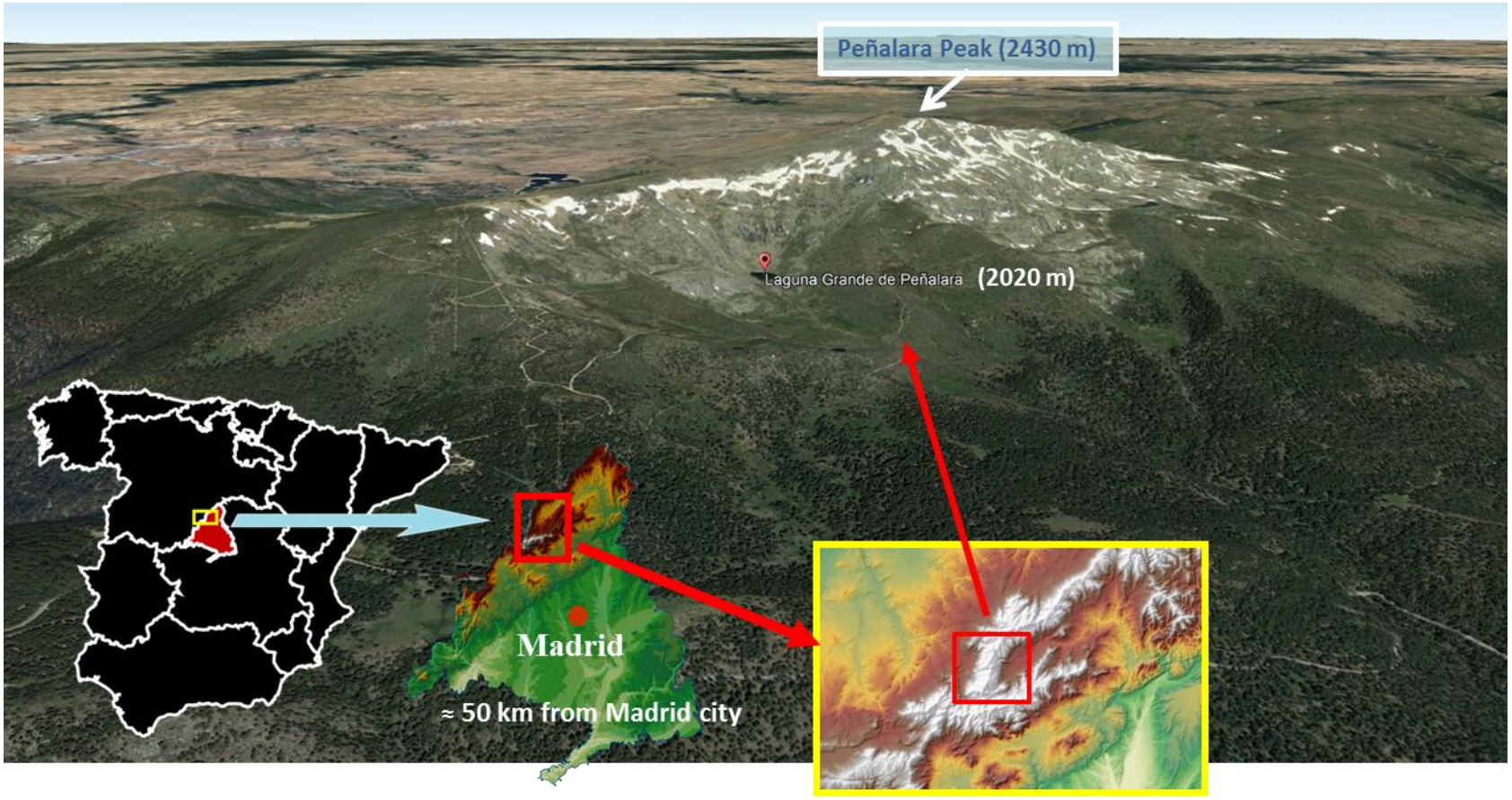
Surveillance Monitoring Frequency is according to WFD: ≥ 1 year/RBM Plan (6 y) (some basins yearly)

	Rivers	Lakes
Phytoplankton	- -	1/6 months
Other flora and fauna	1/3 years	1/3 years
Physico-chemical	1/3 months	1/3 months
Hydromorphology	1/3 years	1/3 years

- Frequency do not comply NEC Directive (Annex V: yearly in lakes/ monthly in rivers) in some basins and need to be increased.

To comply with ICP-Waters/IM requirements is necessary to look for appropriate sites with long-term intensive monitoring (including air-pollution).

1º Proposal: Peñalara Lake – Lozoya River basin (Sierra de Guadarrama National Park)



In April- 2018, the Regional Goverment began talks with several Research Institutions for the establishment of a monitoring programme, including the possibility of the creation of a EMEP site in the National Park, adapting the current programme GuMNet (*An atmospheric and ground observational network in the Guadarrama Mountains*)
(https://www.ucm.es/gumnet/noticias/presentation-of-the-project-gumnet)
It would include a current lake-river monitoring programme started in 1995.

Peñalara Lake – Lozoya River basin (Sierra de Guadarrama National Park) monitoring programme includes data from

Alk.: 0,05 meq/l
pH: 5,9-7,2
Conduct.: 7-17 µS/cm
Ca^{++}: < 1 mg/l

Laguna Grande de Peñalara

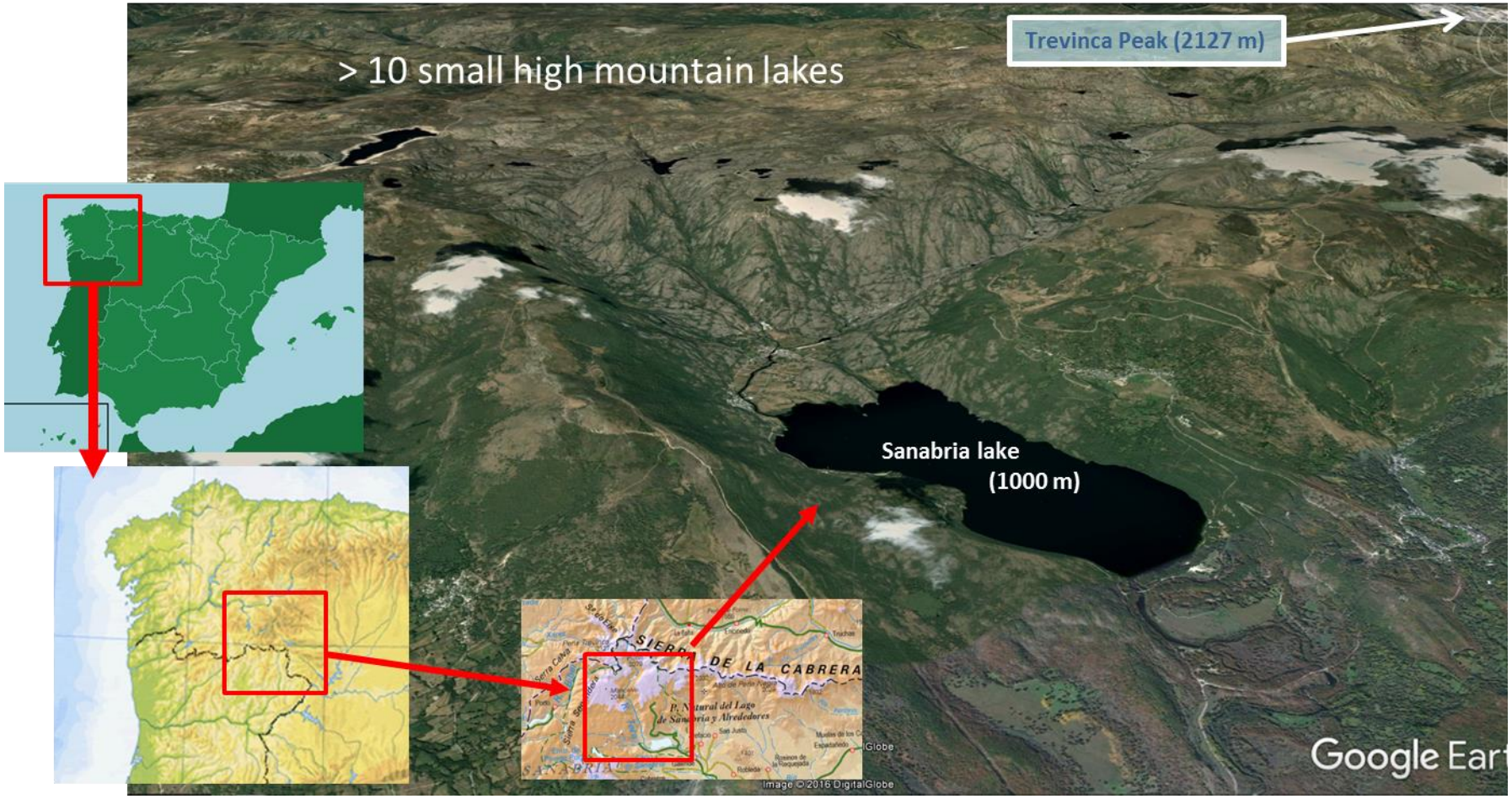
Automatic Weather Stations:
- Meteorological parameters: 1998-2018
- Air pollution (NOx, SOx, NH_3, O_3): 2005-2018

River monitoring (7 sites):
- Hydrochemistry (yearlly): 2007-2018
- Biological (Invertebr.) (yearlly): 2003-2018

Lake monitoring:
- Hydrochemistry (pH, Tª, Cond., Odis, P, N, Ca, Mg, Alk)(monthly): 1995-2018
- Biological (Plankt+Inv.) (monthly): 1995-2018
- Ice phenology and lake level: 1998-2018

Flow gauging monitoring:
- Continuous flow/Tª (136 ha): 2001-2018

2º Proposal: Sanabria Lake – Tera River basin (Natural Park of Sanabria)



- **Since 1987, a basic limnological lake monitoring (hydrochemistry: Tª, pH, cond., Odis, P, N, Si, Chl a, Alk) is running monthly, with several 1-2 years periods of phytoplancton surveys (monthly).**
- **An intensive monitoring (including atmospheric deposition) of the lake and its catchment carried out from 2015 to 2018 could be a starting point to establish a possible site for ICP-Waters.**
- **There are more than 10 small high mountain lakes in Sanabria Lake basin.**

Sanabria lake – Tera River monitoring programme includes data from:

Automatic Weather Stations:
- Meteorological parameters: 1983-2018
- Air pollution (NO_x, SO_x, NH_3, O_3): 2016-2018

Snow depth monitoring (5 sites):
- Telenivometer/poles: snow gauge + SWE sensing 2008-2018

Stream monitoring (11 sites):
- Hydrochemistry (P, N, SOx, Ca, Mg, Na, K, Alk, DOC) + Flow (continuous/monthly): 2015-2018

Soil water (5 sites):
- Eventually (rainfalls) (P, N): 2016-2018

Lake monitoring:
- Hydrochemistry (Tª, pH, cond, O_{dis}, P, N, Si, Chl a, Alk) (monthly): 1987-2018
- Hydrochemistry (complete) (monthly): 2015-2017
- Biological (Plankt+Invert.) (1-4 months): 2015-2017
- Lake level: 2016-2018

Flow gauging monitoring (3 sites):
- Continuous flow/Tª (11 km^2): 2015-2018

Alk.: 0,1 meq/l
pH: 5,6-7,3
Conduct.: 9-15 µS/cm
Ca^{++}: < 2 mg/l




Main Needs for the selection of sites to comply with NECD and ICP-W/ICP-IM

*About sites from national running monitoring networks (**for NECD**)*:

- **Subprogramme of Reference sites (WFD):**
  - Selection of representative sites for NECD following established criteria (**July-18**)
  - Required sampling frequency in some basins and indicators
  - Include additional parameter for water chemistry (DOC)

- **LTER-Spain sites :**
  - Selection of sites that comply with requirements for NECD **(July-18)**
  - To establish agreements with each site responsible funding/research institution.

*About proposed frequent-monitoring "pilot sites" (**for ICP-Waters/ICP-IM**)*:

- **Peñalara Lake – Lozoya River:** ***(in process)***
  - Monthly frequency for sampling in rivers is needed
  - Some additional parameters for waters, air-precipitation, and soil/water chemistry
  - Some additional parameters for vegetation/soil (if considered for IC-IM)
  - Comply with methodologies of ICP and participate in IC exercises.
- **Sanabria Lake – Tera River:** ***(in project)***
  - Institutional agreement for funding continuous monitoring is needed
  - Some additional parameters for waters, air-precipitation, and soil/water chemistry
  - All parameters for vegetation (for ICP-IM)
- **Other possible sites from LTER (eg. Aigüestortes NP)** (it needs an agreement)

Some additional ideas to be considered…

Relevance of atmospheric input of phosphorus as eutrophying substance in Iberian Peninsula (SW Europe)

African dust can be a significant source for alkalinity, base cations, nitrogen… and phosphorus:

- Avila & Alarcon_2003_Precipitation chemistry at a rural Mediterranean site. J.Geophys.Res.
- Camarero & Catalan_2012_Atmospheric phosphorus deposition may cause lakes to revert from P limitation back to N limitation. Nature Comm.
- Izquierdo_etal_2012_Atmospheric P deposition in a near-coastal rural site in NE Iberian Peninsula. Atm.Env.
- Morales-Baquero_etal_2013_Chemical signature of Saharan dust on dry-wet atmospheric deposition in the south-western Mediterranean region.TellusB
- Yu etal_2015_The fertilizing role of African dust in the Amazon rainforest_Geoph.Res.Lett.
- Jiménez etal_2018_Climate change and Saharan dust drive recent cladoceran and primary production changes in remote alpine lakes of Sierra Nevada, Spain. Glob.Chang.Biol.


Thank you!
Questions?
Lake Sanabria