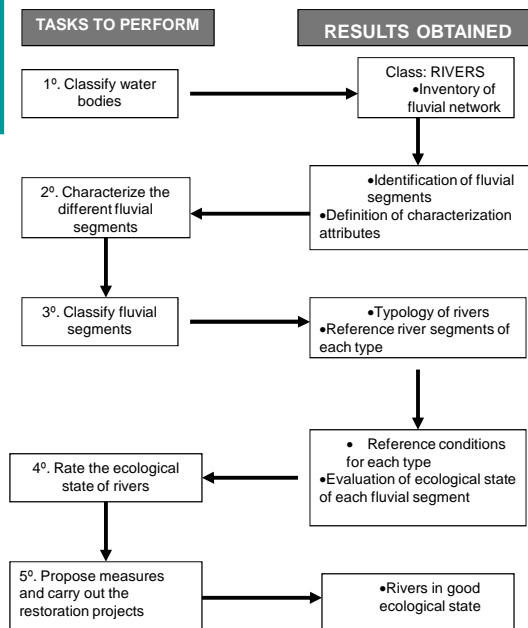


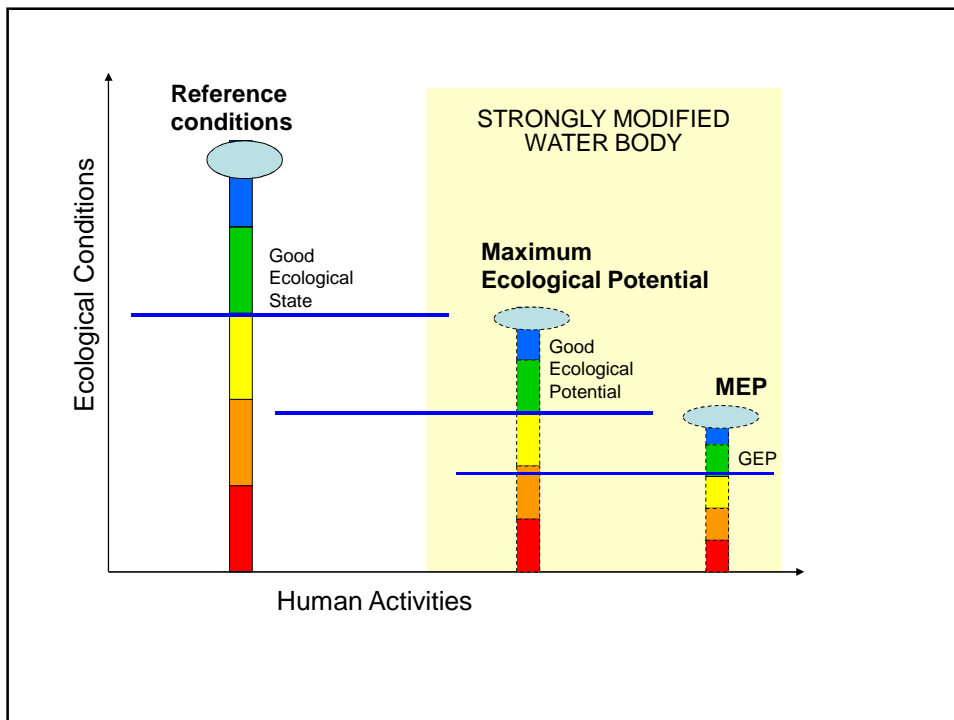
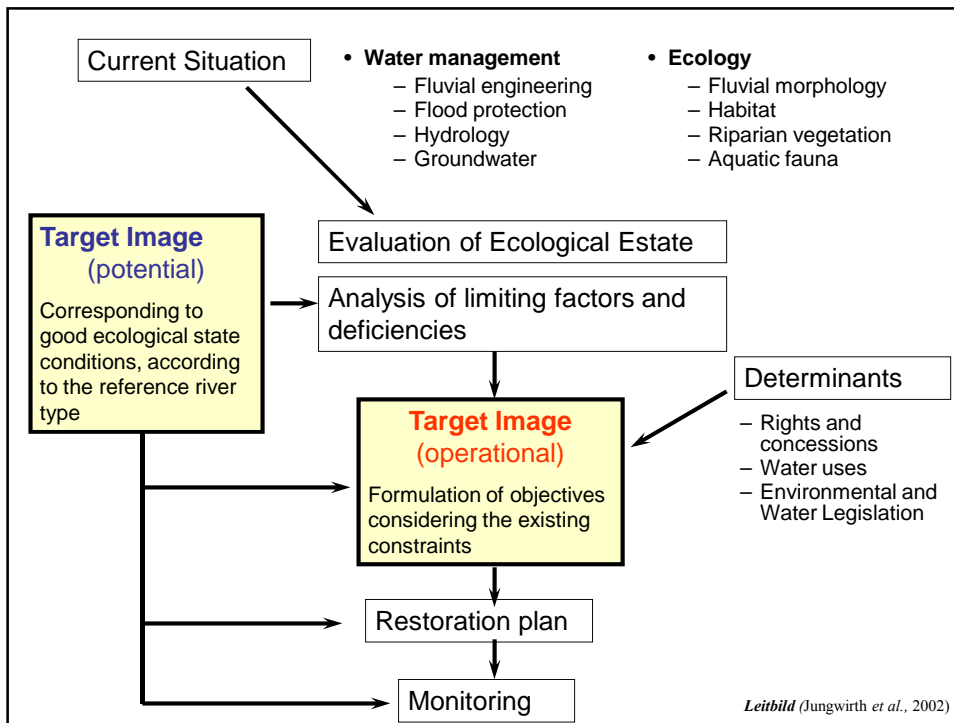
River typology: characterization and classification

Diego García de Jalón
Marta González Tánago

The Restoration in DMA (DQA)

- Achieve 'Good Ecological State'
- 'Reference conditions' by 'Type of River'
- Classification based on 'Hydromorphological' characteristics



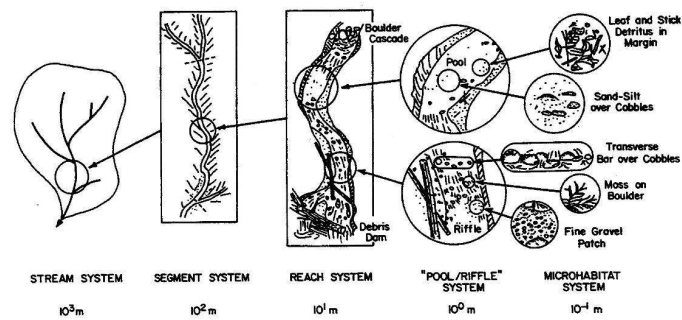


Geomorphological Classifications

Channel type		Bed load	Mixed load	Suspended load
A Morphology	Single channels			
	Channel shape width/depth ratio	60	25	8
	Channel pattern sinuosity	1.0 1.1	1.4 1.7	2.5
Multiple channels	Patterns	alluvial fan		alluvial plain anastomosing

Types of rivers proposed by Schumm (1968), according to shapes and transport of solid flow processes

Classification according to habitats

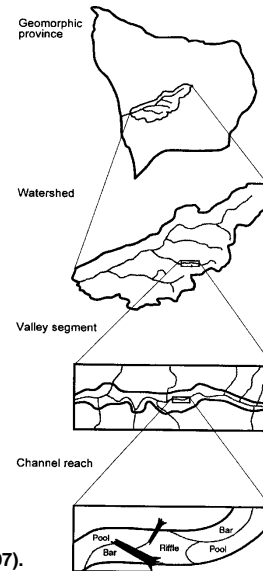


Hierarchical organization of fluvial system, integrating fluvial habitats in the river network and its watershed (Frissell *et al.*, 1986).

- Hierarchical
- Spatial scales

Classification according to habitats

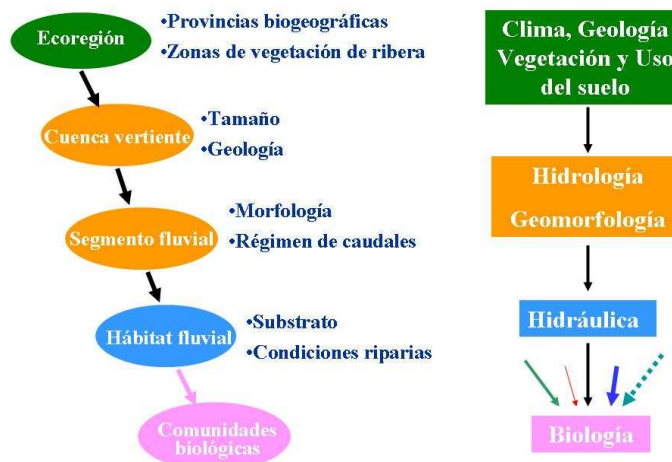
Classification level	Spatial scale
Geomorphological province	1.000 km ²
Watershed	50 – 500 km ²
Valley segment	100 – 10.000 m
River reach	10 – 1000 m
Channel unit	1 – 10 m



(Montgomery y Buffington, 1997).

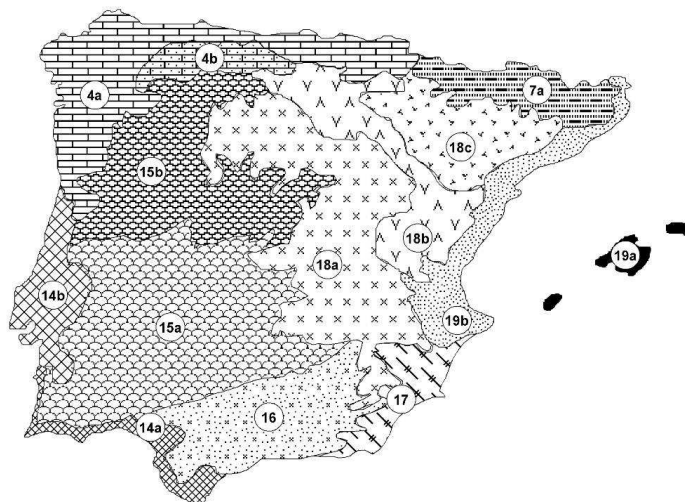
Proposal of hierarchical characterization of Iberian rivers

CARACTERIZACIÓN JERÁRQUICA DE LOS RÍOS



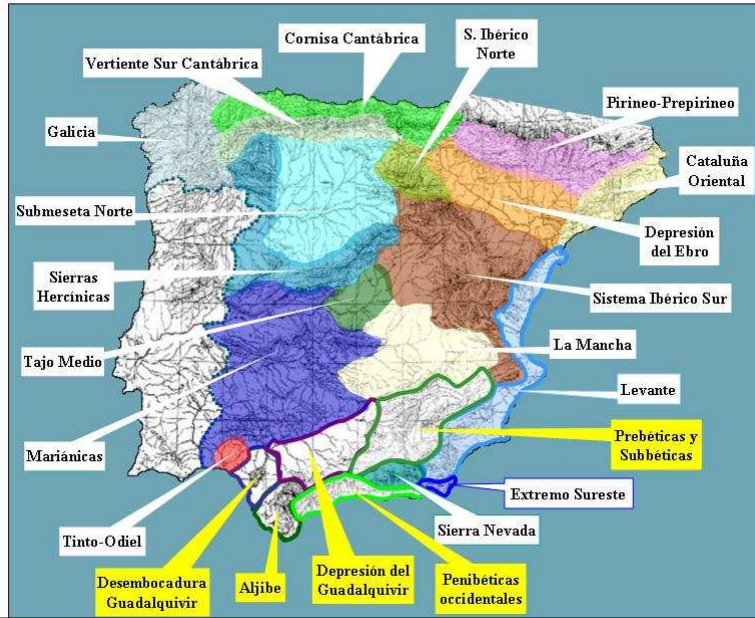
Factors to consider in fluvial typology

1. Biogeographic Region
 - Provinces and sub-provinces (Rivas Martínez et al, 2002)
 - Riparian areas (Garilleti et al, 2004)
2. Watershed
 1. Lithology
 - Siliceous
 - Chalk
 - Clayey
 2. Size
 1. Small (<100 km²)
 2. Medium (100-1000 km²)
 3. Large (1000-10000 km²)
 4. Very large(10000-25000 km²)
 5. Major river artery (>25000 km²)
3. Fluvial Segment
4. Fluvial Habitat



Biogeographic provinces recognized in the Iberian Peninsula by Rivas Martínez *et al.* (2002). 4: European Atlantic Province. 4a: Cantabrian-Atlantic Sub-province; 4b: Orocantabrian Sub-province. 7: Cevenense-Pyrenean Province. 7a: Pyrenean Sub-province. 14: Lusitano-Andalusian-Litoral Province. 14a Gaditano-Algarviense Sub-province. 15: Occidental Iberian Mediterranean Province. 15a Luso-Extremadurensis Sub-province; 15b Carpetano-Leonese Sub-province. 16: Bética Province. 17: Murciano-Almeriense Province. 18: Central Iberian Mediterranean Province. 18a Castellana Sub-province. 18b Oroiberian Sub-province; 18c: Low Aragonese Sub-province. 19: Catalanian-Provenzal-Balear Province. 19a Balear Sub-province; 19b: Catalanian-Valencian Sub-province

**SECTORIZACIÓN DE LA LA ESPAÑA PENINSULAR
EN FUNCIÓN DE LA VEGETACIÓN RIPARIA**



Tributary of Silo River (Huelva)
Province: Occidental Iberian Mediterranean,
Subprovince: Luso-Extremadurensis



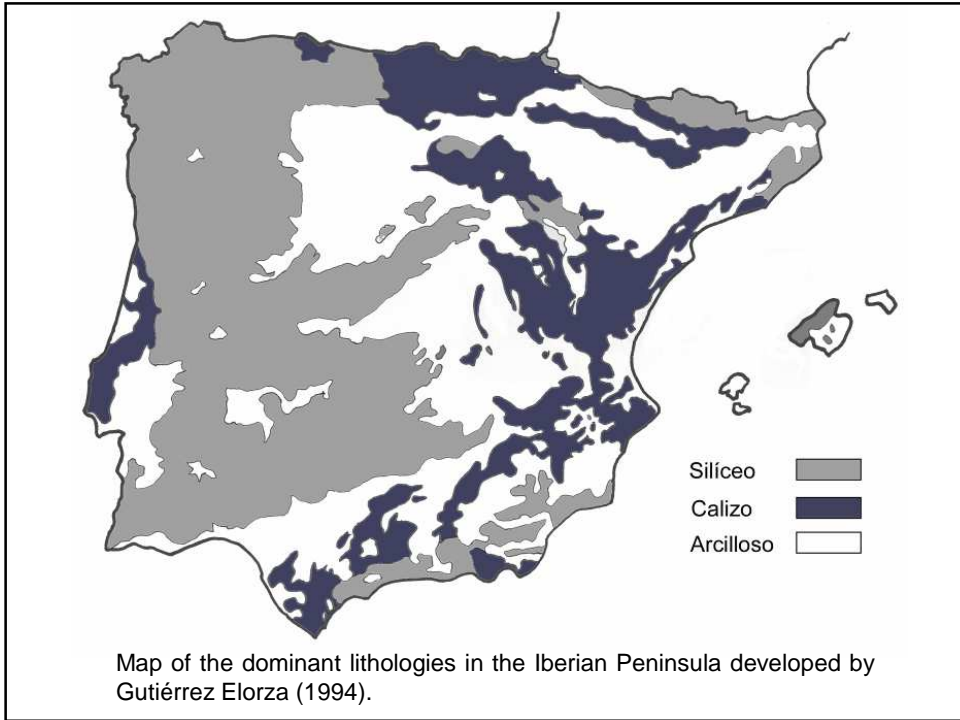
Esera River (Huesca)
Province: Cevenense-Pyrenean



The Judío Torrential River (Murcia)
Province: Murciano-Almeriense



Areta River (Navarra)
Province: Central Iberian Mediterranean
Subprovince: Low Aragonese



Castril River (Granada), limy nature



Head of the Arlanzón River (Burgos), siliceous nature



Arga River (Navarra), large size



Aigualluts River (Huesca), medium-sized basin

Factors to consider in fluvial typology

3. Fluvial Segment

Type of Flow Regime

1. Permanent

1. Rainfalls

- Nival
- Pluvial

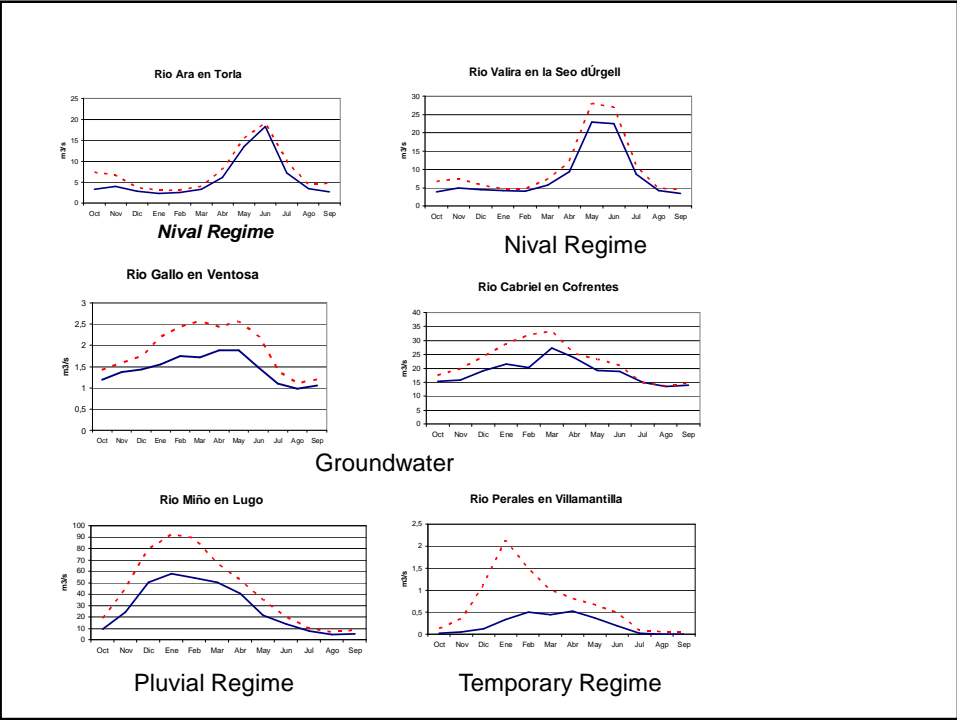
2. Groundwater

2. Not permanent

1. Ephemeral

2. Temporary

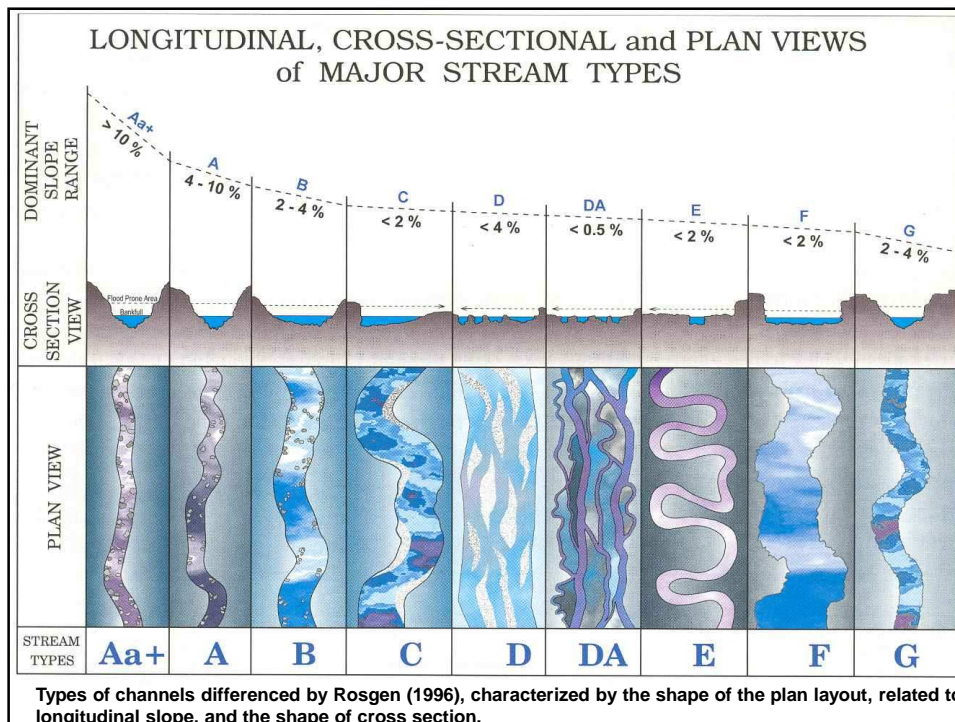
- Exhaustion
- Seepage



Factors to consider in fluvial typology

3. Fluvial Segment

1. Flow Regime
2. Geomorphology (Rosgen, 1996)
 - Mountain Torrents (A)
 - Mountain Rivers (B)
 - Piedmont Rivers (C)
 - Braided Rivers (D)
 - Meandering Rivers (E)
 - Canyons (F)



Types of Valley, in Iberian Peninsula (modified of Rosgen, 1996)

- **Valley Type 1.**- Located in upper reaches, headstreams or high mountain, which we may in turn divide into the following subtypes:
 - **1-A:** Narrow valley, in V, fluvial origin, with inclination of hillslopes equal or higher than 45°.
 - **1-B:** Relatively wide Valley, in U, glacial origin, with inclination of hillslopes equal or more than 45 °.
 - **1-C:** Relatively narrow and confined valley, U form, formed by rocky canyons or with strong inclination and height. In general stable, often with rocky controls and covered by vegetation.
- **Valley Type 2.**- Located in upper reaches in low mountains, or medium reaches. Relatively open valley, with inclination of hillslopes less than 45°, often crossed by a tributary network, but not yet configuring a floodplain in the principal channel.
- **Valley Type 3.**- Located in medium or low reaches of the rivers. Very open valley and of considerable width, with the floodplain well defined and confined by fluvial terraces.
- **Valley Type 4.** – Located in flat relief areas, on ancient deposits (eg. La Mancha).



Head of Guadarranque River, in Puerto de San Vicente (Cáceres), in a valley section type 1A



Estena River valley in Horcajo de Los Montes (Toledo), type 2



Zújar River in Campanario (Badajoz), running along a section of valley type 3



Guadiana River in Herencia (La Mancha, Ciudad Real), in a valley type 4

Types of River Channels, in the Iberian Peninsula (modified of Rosgen, 1996)

- **High mountain stream or torrent:** Small watercourse with high longitudinal slope (more than 10%) and more or less straight path, located in mountainous areas, in general in valleys of type I A.
- **Mountain River:** Upper reaches of rivers located in mountainous areas, with high longitudinal slope (more than 2%), of greater width and flow than reaches of previous type, with sinuous or straight paths, located in valleys type I.
- **High and piedmont reaches:** Medium and upper reaches of rivers in low mountain areas or piedmont, with longitudinal slope a little lower than previous type (<2%), with sinuous or meandering paths, generally in valleys type I or II.
- **Meandering reaches:** Medium and lower reaches of rivers in areas of low relief, with gentle longitudinal slope, in general in valleys type II, III or IV.
- **Braided reaches:** Multiple and branched channel reaches, located downstream from the high mountain reaches, with longitudinal slope relatively high and big load of coarse grain sediments, in general in valleys type I or II.
- **Anastomosed rivers:** Multiple and branched channel reaches located in areas of medium or lower reaches, with longitudinal slope relatively small, and a big load of fine grain sediments, in general in valleys type III or IV.
- **Narrow canyons:** Fluvial segments laterally confined by the presence of natural canyons, located in valleys type IC.
- **Narrowed reaches:** Fluvial segments laterally confined by a decrease of the bed level due to processes of natural or human origin narrowing, located in valleys type II, III and IV.



Upper reach in Lozoya River, with a straight path



Meandering reach in Aragón River Suborder (Huesca)



Braided reach in Oja River (La Rioja)



Narrowed reach in Lumbier Canyon (Navarra)

Factors to consider in fluvial typology

4. Fluvial Habitat

1. Type of Substrate

1. Granulometry

1. Cohesive rivers

Rock

Clay

2. Non-cohesive rivers

Gravel

Sands

Fines

2. Bed Forms

Cascades, waterfalls and pools

Continuous rapid, rapids and backwaters

Dunes and ripples



Medium reach of Pas River (Cantabria), with a cohesive substrate of chalk rock



Upper reach of Esera River (Huesca), with a substrate of blocks and rolling stones



Lower reach of Bañuelo River (Ciudad Real), with gravel substrate



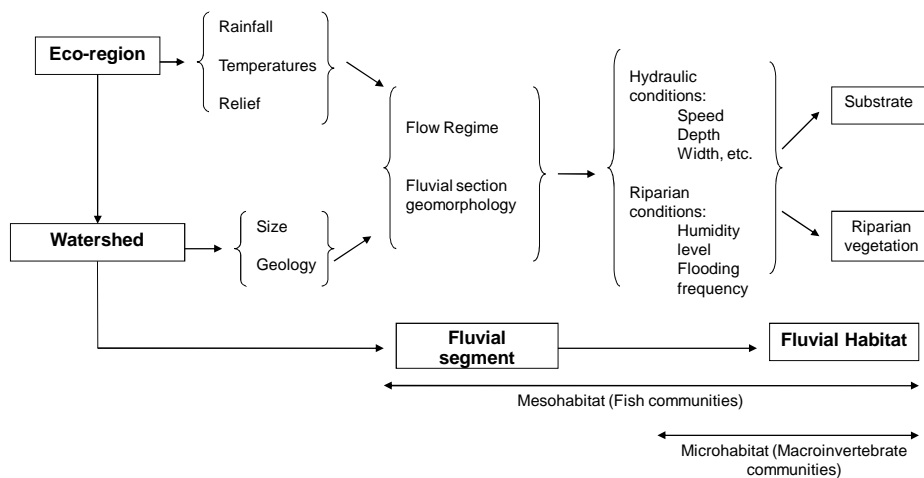
Perales River (Madrid), with sandy substrate

Factors to consider in fluvial typology

4. Fluvial Habitat

1. Type of Substrate
2. Vegetation
 - Woody communities
 - Emergent macrophytes
 - Submerged vegetation
3. Other peculiarities
 - Travertine
 - Saline
 - Gypsum
 - etc.

RELATION between VARIABLES for CHARACTERIZING RIVERS and its APPLICATION to RESTORATION



HIERARCHICAL CHARACTERIZATION AND RIVER CLASSIFICATION OF NAVARRA

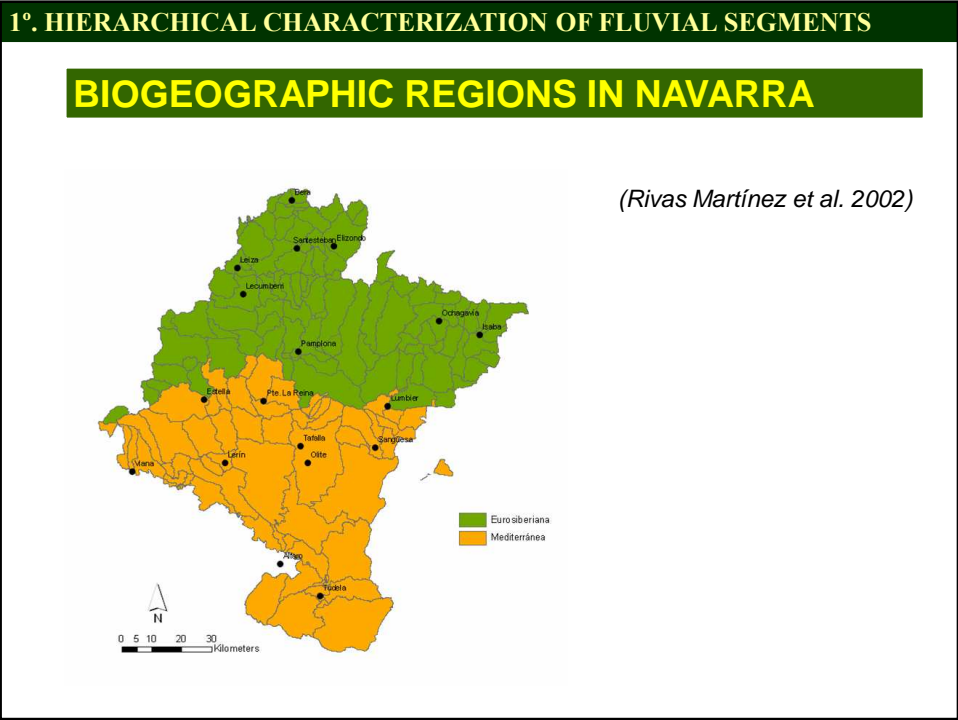
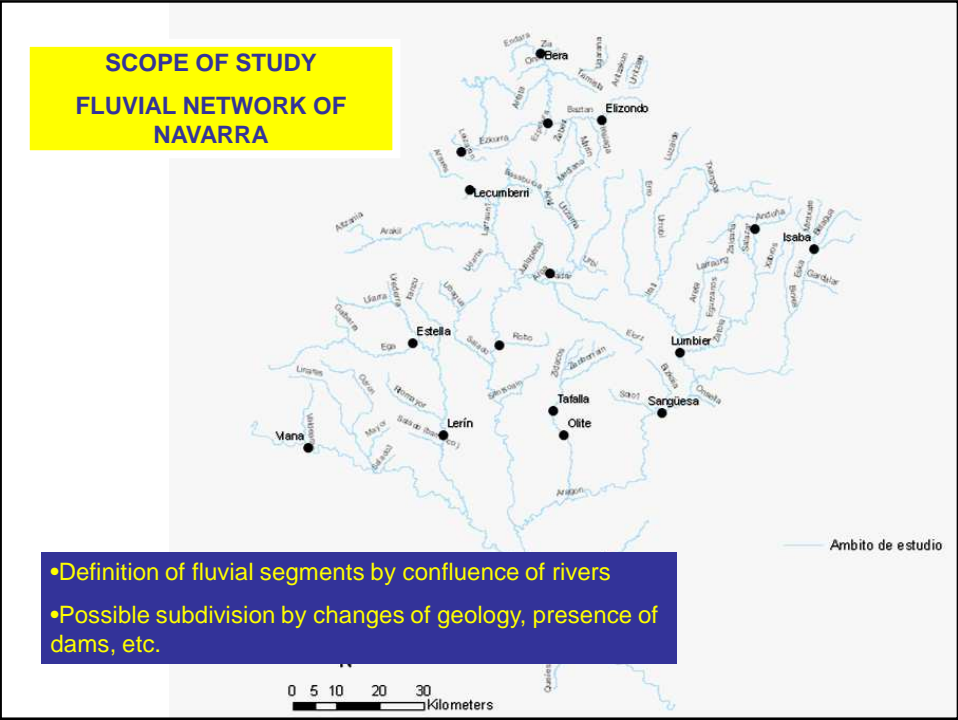
**M. González del Tánago, M. Marchamalo, C.
Alonso, D. García de Jalón, D. Baeza, P.
Vizcaíno**

*E.T.S. Ingenieros de Montes
Universidad Politécnica de Madrid*

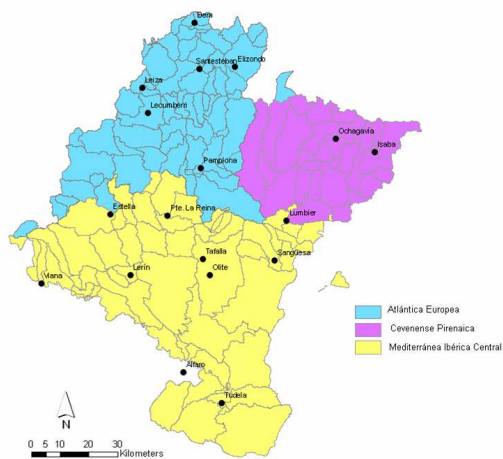
TASKS

Characterization and river Classification

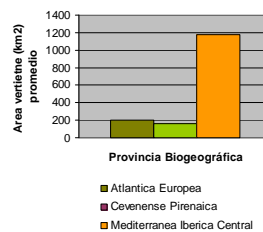
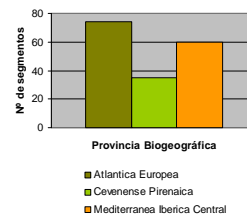
1. Identification of river segments and functional units
2. Establishment of watersheds: Areas accumulated at lower end of each fluvial segment or sector
3. Analysis of physical characteristics from existing cartography basin size, geological character and biogeographic regions.
4. Characterization of fluvial segments: flow regimes and geomorphological characteristics (longitudinal slopes and sinuosity).
5. Field verification of fluvial segments (types of valleys and channels). Hydromorphological conditions (substrate and riparian conditions).
6. Hierarchical organization
7. Classification of rivers taking into account the characterization variables: Typology of Navarre rivers and management units.
8. Development of a database including the characterization and classification of fluvial segments of Comunidad Foral de Navarra.



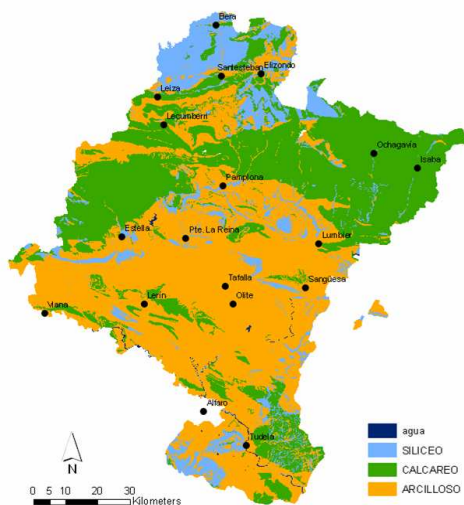
BIOGEOGRAPHIC REGIONS IN NAVARRA



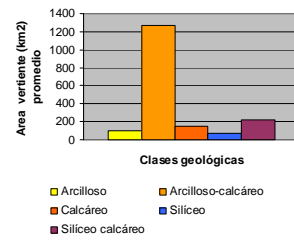
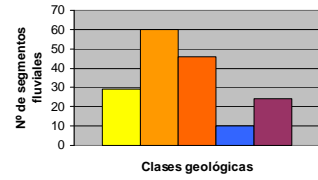
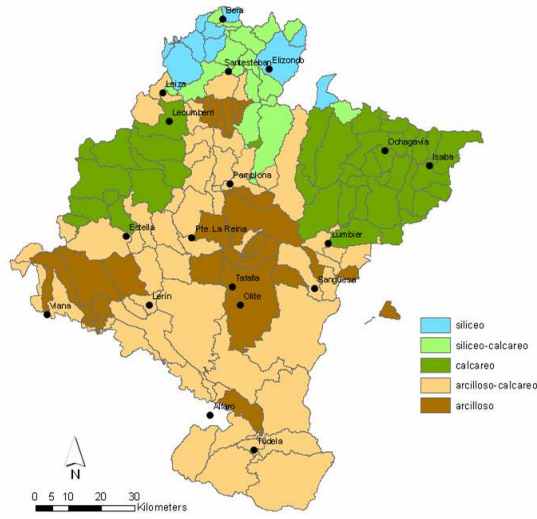
Biogeographic provinces



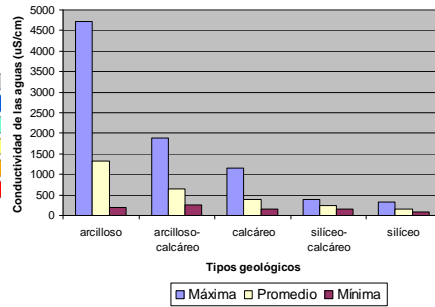
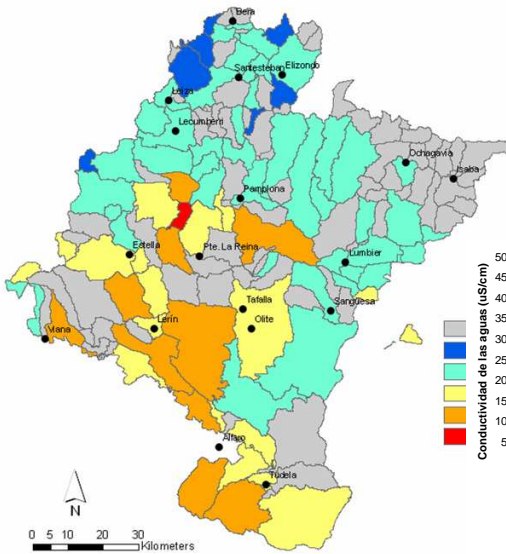
INTERPRETATION OF GEOLOGY OF NAVARRE TERRITORY



GEOLOGY OF THE BASIN CONSIDERED



CONDUCTIVITY OF WATERS



2º. ORDENATION OF FLUVIAL SEGMENTS ACCORDING TO CHARACTERISTICS

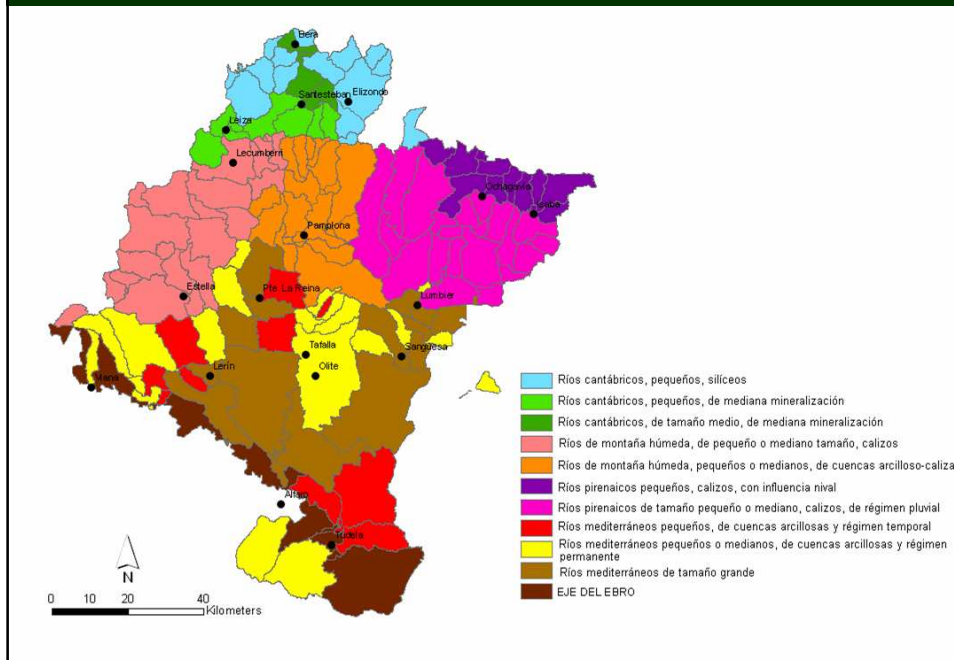
Biogeographic Region	Biogeographic Prov.	Geology	Size	Flow Regime
Euro-Siberian	Atlantic-European	Siliceous	Small	Pluvial
			Medium	Pluvial
		Siliceous-Calcareous	Small	Pluvial
			Medium	Pluvial
		Calcareous	Small	Pluvial
			Medium	Pluvial
		Clayey-Calcareous	Small	Pluvial
			Medium	Pluvial
	Cevenense-Pyreanean	Calcareous	Small	Pluvio-Nival
			Medium	Pluvial
Mediterranean	Mediterranean Central-Iberian	Clayey	Small	Temporary
				Pluvial
			Medium	Temporary
		Clayey-Calcareous	Small	Temporary
			Medium	Pluvial
			Large	Pluvial
		Very large	Pluvial	

3º. CLASSIFICATION OF FLUVIAL SEGMENTS

Fluvial type

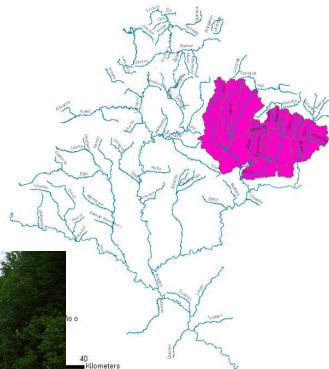
Biogeographic region	Biogeographic Prov.	Geology	Size	Flow regime
Euro-Siberian	Atlantic-European	Siliceous	Small	Pluvial
			Medium	Pluvial
		Siliceous-Calcareous	Small	Pluvial
			Medium	Pluvial
		Calcareous	Small	Pluvial
			Medium	Pluvial
		Clayey-Calcareous	Small	Pluvial
			Medium	Pluvial
	Cevenense-Pyreanean	Calcareous	Small	Pluvio-Nival
			Medium	Pluvial
Mediterranean	Mediterranean Central-Iberian	Clayey	Small	Temporal
				Pluvial
			Medium	Temporal
		Clayey-Calcareous		Pluvial
			Small	Temporal
			Medium	Pluvial
		Large	Pluvial	
		Very large	Pluvial	

FLUVIAL TYPES OF NAVARRA

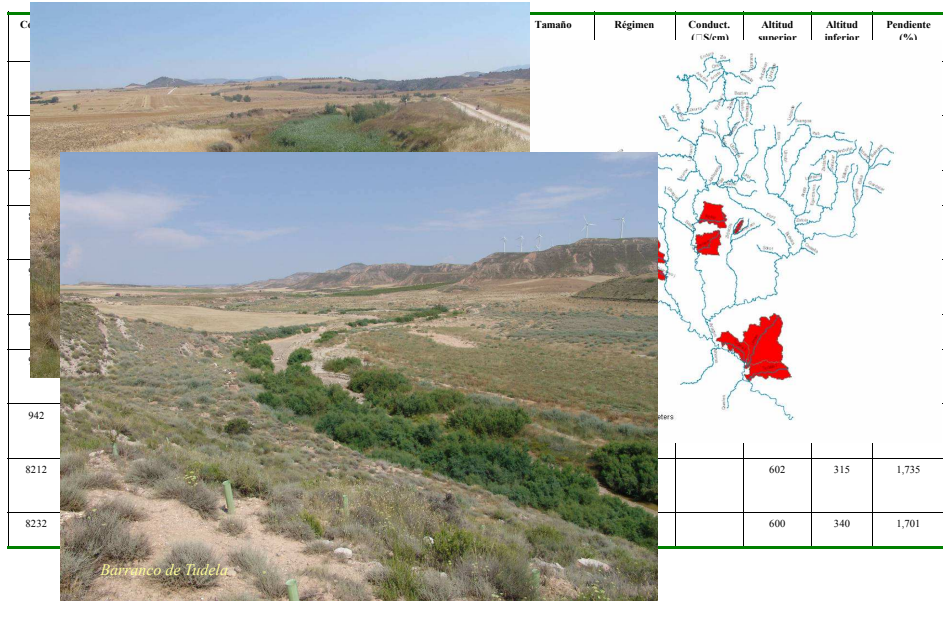


Type 7: Pyrenean rivers of small or medium size, chalk, pluvial regime

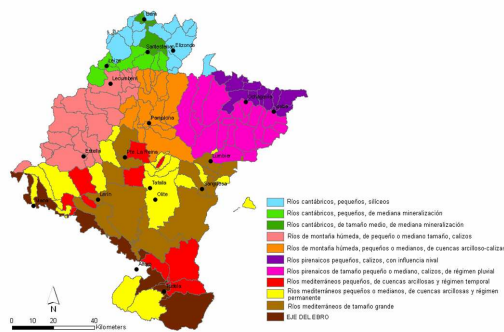
Código	Río	Segmento	Región	Provincia	Tamaño	Geología	Conduct.	Régimen	Altitud	Altitud	Pendiente	Subst
885	Eiska							fluvial	775	680	1,079	
8621	Salazar							fluvial	552	450	0,446	
8622	Eguros							fluvial	942	552	2,916	
8623	Salazar							fluvial	650	552	0,524	



Type 8: Mediterranean rivers of small or medium size, clayey basin and temporary regime.



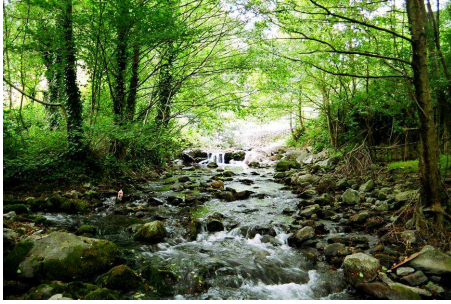
NAVARRA FLUVIAL TYPOLOGY



• **Fluvial typology** defined in the basis on main physical factors that determine the hydrological and ecological functioning of rivers.

• **Hierarchical** approach, which offers a **common and open framework**, upon which can **deepen in different spatial scales**, according to conditions that the definition of reference conditions requires.

• **Ease of application** in any spatial field, and very helpful support for the creation of a **common database** at regional, national or European scale.



THANK YOU FOR YOUR ATTENTION;