Instituto de Ingeniería del Agua y Medio Ambiente

UNIVERSIDAD POLITECNICA DE VALENCIA

Riparian vegetation dynamic modelling using the succession-retrogression concept: the RIPFLOW project

By: F. Francés (1), G. Egger (2), T. Ferreira (3), K. Angermann (2), F. Martínez-Capel (1) and E. Politti (2)

(1) Technical University of Valencia, Spain

(2) Environmental Consulting-Klagenfurt, Austria

(3) Technical University of Lisbon, Portugal

Regional and national research programmes network on iwrm-net Integrated Water Resource Management

Ripflow project background

- Riparian ecosystems are important by their self and for their ecological services

- They are connected with rivers ➔ be taken into account in the rivers ecological status evaluation, in a wide sense or from the WFD point of view

- To accomplish this evaluation in the long-term, it is necessary to have a tool capable to predict the riparian vegetation response to its driving forces, as far as these drivers will or can change in the future

Ripflow project objectives

- Scientific objective: to develop a flexible dynamic model of riparian habitats and vegetation
- Merging two models:
  - CASIMIR, from Umweltbüro Klagenfurt (Austria)
  - RibAv, from IIAMA (Spain)

Ripflow project objectives

- Scientific objective: to develop a flexible dynamic model of riparian habitats and vegetation

- Application to some case studies of the countries involved in this project (Austria, Portugal and Spain):
  - Validate the model (present conditions)
  - Practical objective: assess the impact of future scenarios:
    - Climate change
    - Water management decisions: reservoirs regulation, environmental flows and restoration

See poster A 388

RIPFLOW model definition

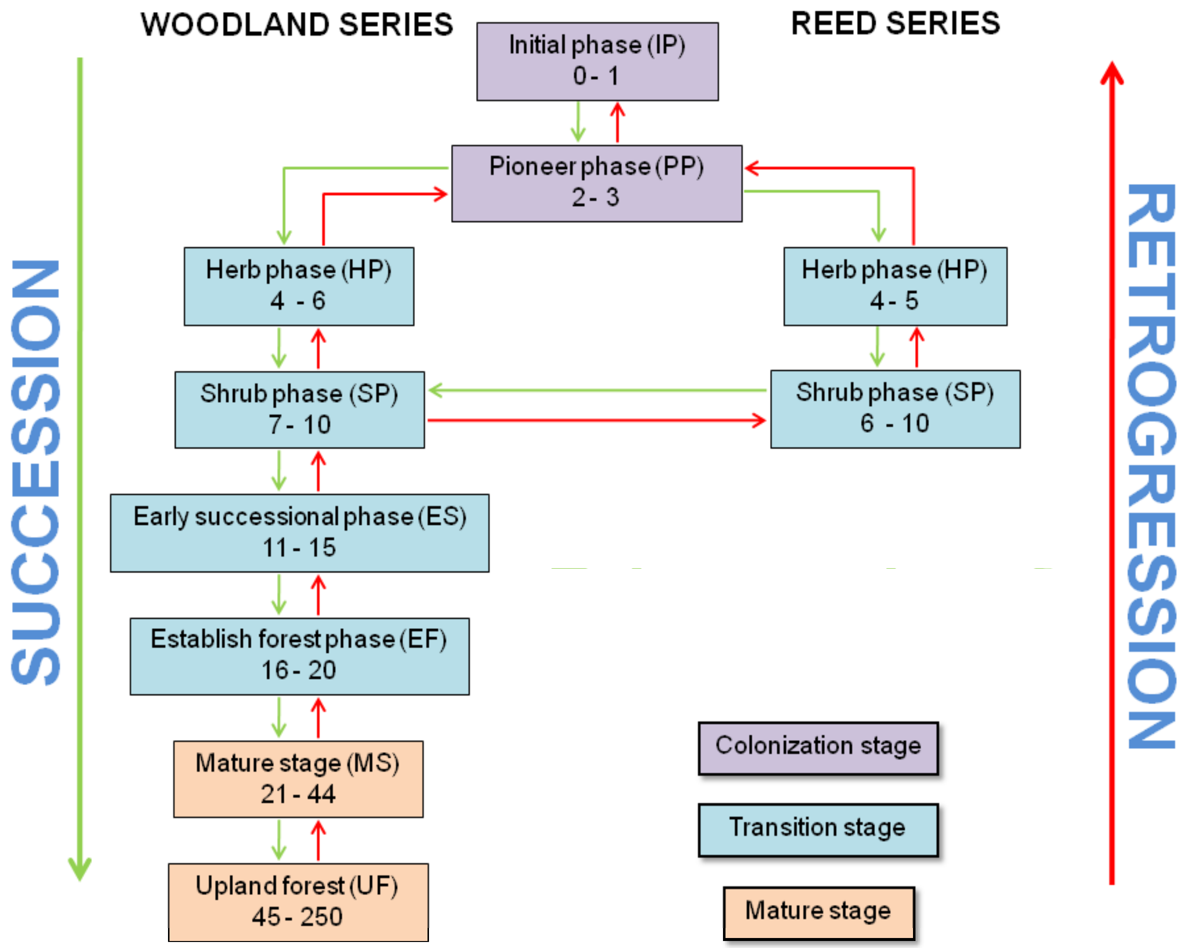
- Distributed in cells, small size (1-5m) due to height influence
- Annual time discretization (soil moisture daily)
- Main state variable: vegetation **succession phase**

Succession phases

- IP: initial phase
- PP: pioneer phase
- HP: herb phase
- SH: shrub phase
- ES: early successional woodland
- EF: establish forest
- MS: mature stage
- UF: upland forest

- Succession series
  - WD: woodland series
  - RE: reed series
  - WE: wetland series

Succession and retrogression

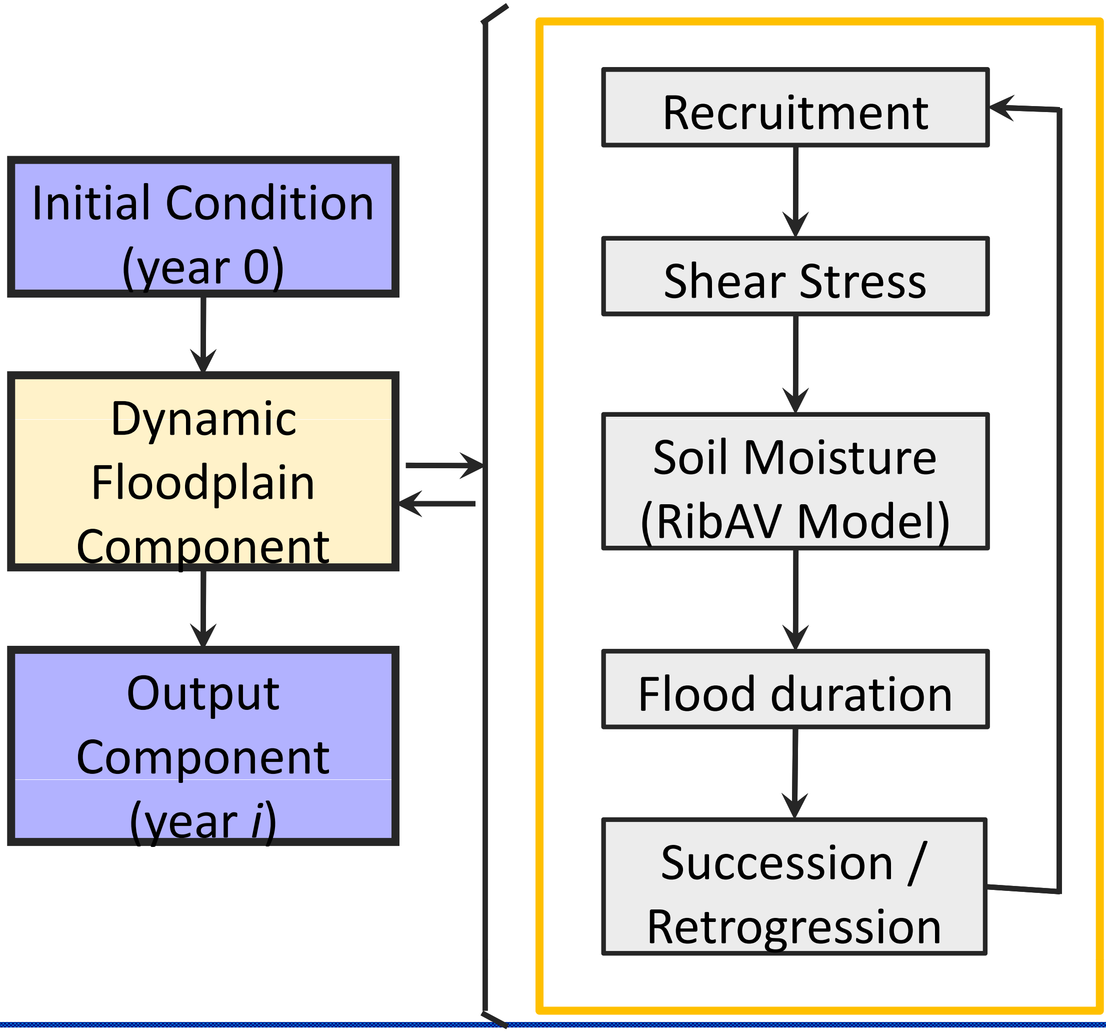


Mijares River at Terde reach, Spain

RIPFLOW model definition

- Distributed in cells
- Annual time discretization
- Main state variable: vegetation succession phase
- Main driving forces (and processes):
  - Maximum shear stress <= flood destruction
  - Flood duration <= submersion extinction
  - Base flow or spring flow <= recruitment and seedling conditions
  - Annual transpiration <= water stress
- Retrogression parameters basically are **thresholds**

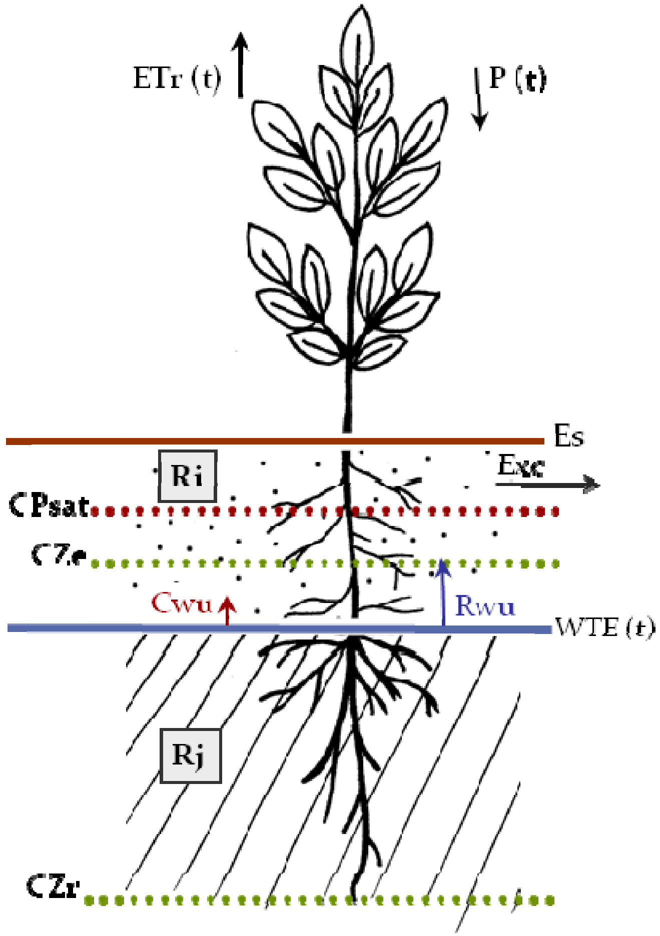
General structure



Soil moisture module

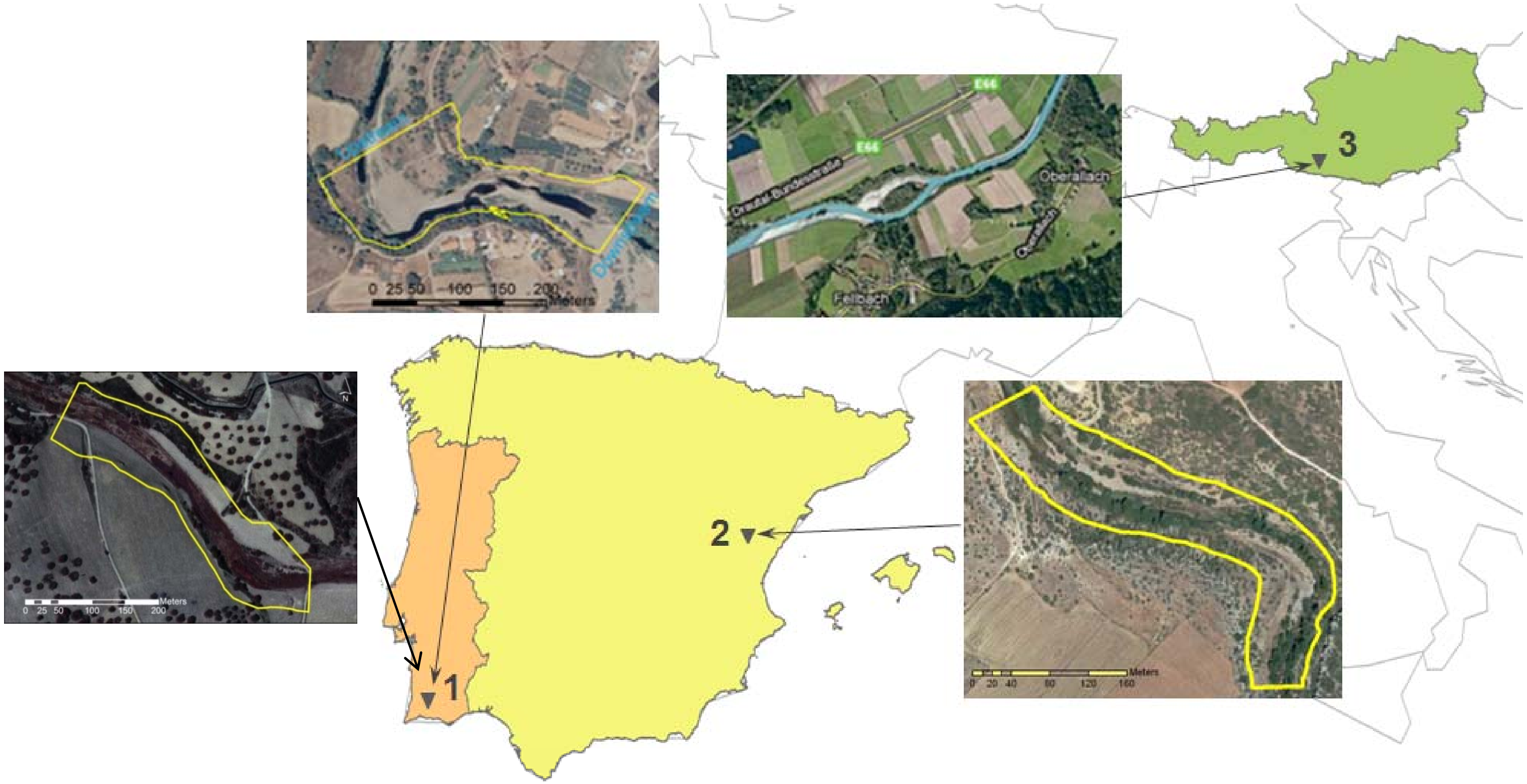
- Plant Functional Types:
  - BS: bare soil
  - RH: riparian herbs
  - RJ: riparian juveniles and small s...
  - R... nd big shrubs
  - TV: terrestrial vegetation

$$T_{index} = \sum \frac{Ttot_{(t)}}{ET0_{(t)} \cdot Cov}$$



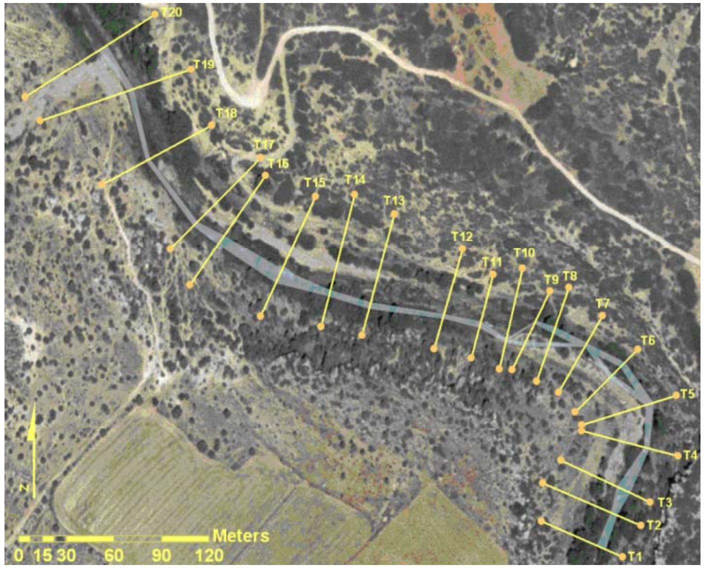
Case studies

- Odelouca and Sado, Upper Drau and Mijares



Terde reach at the Mijares River

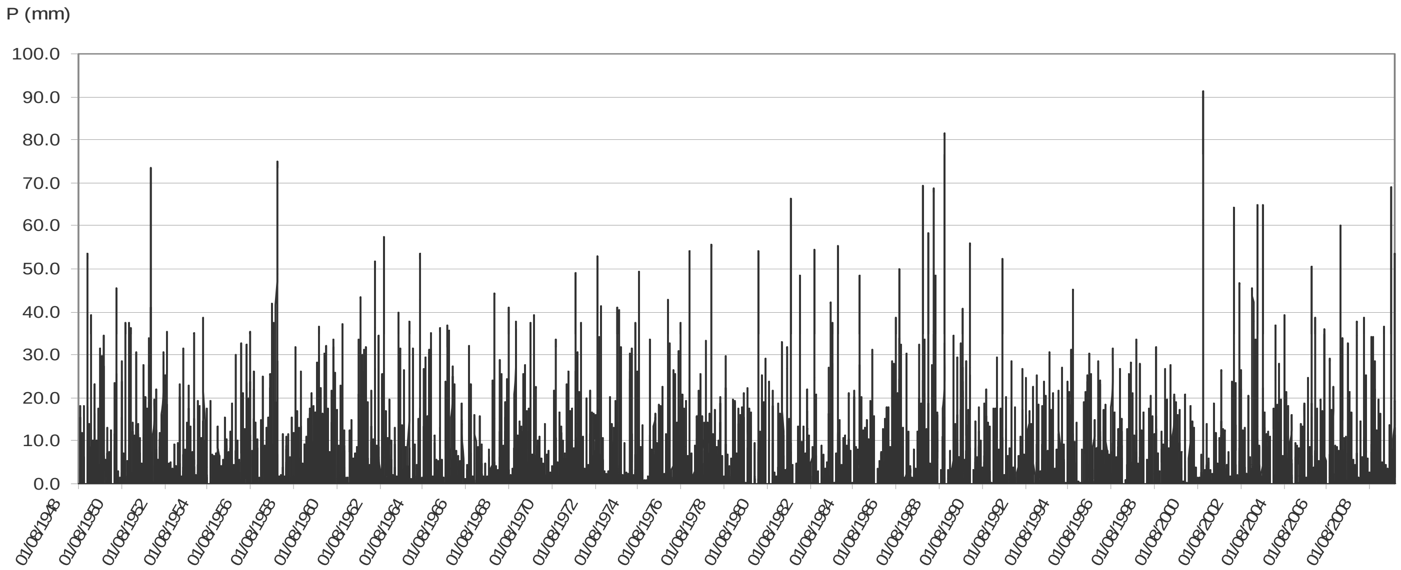
- **Permanent** flow regime
- **No flow regulation** upstream
- Near natural conditions
- Basin area: 665 km2
- Bankfull Q= 5 m3/s



- Riparian vegetation: *Salix eleagnos*, *Salix purpurea* and *Populus nigra*
- Upland forest: *Pinus* and *querqus*

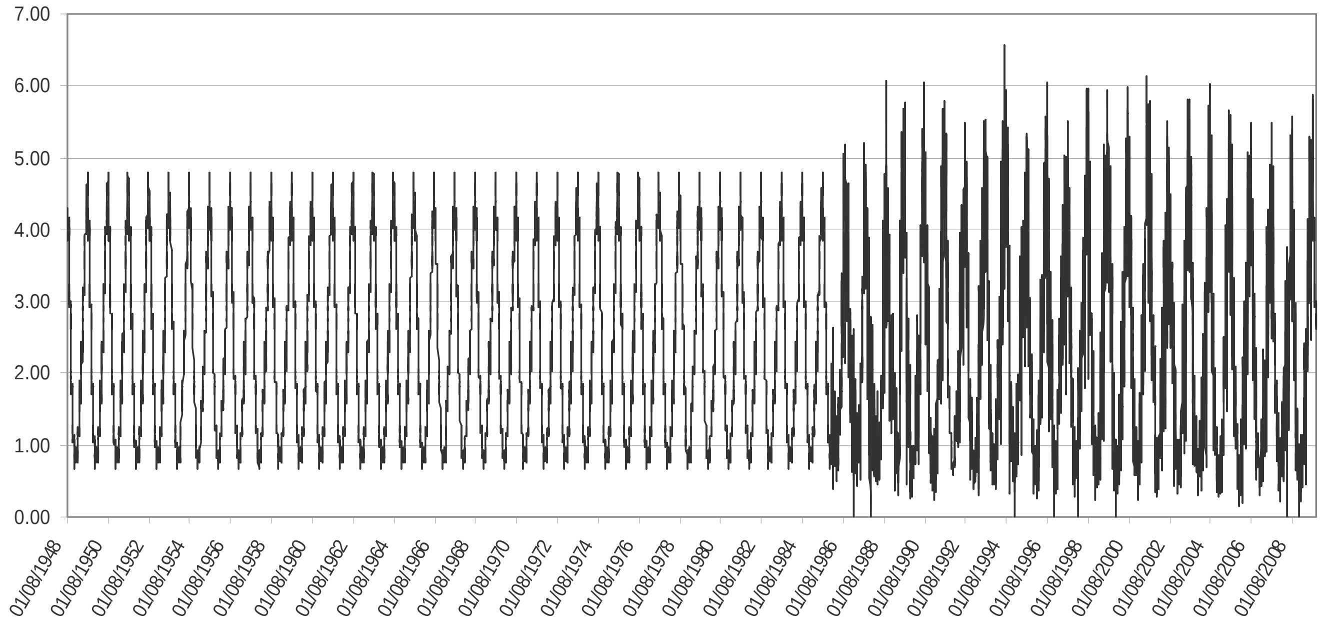
Hidrometeorological info.

- Daily precipitation (mm/day) period 1948 – 2009
  - 1988-2009: **P= 514 mm/year**



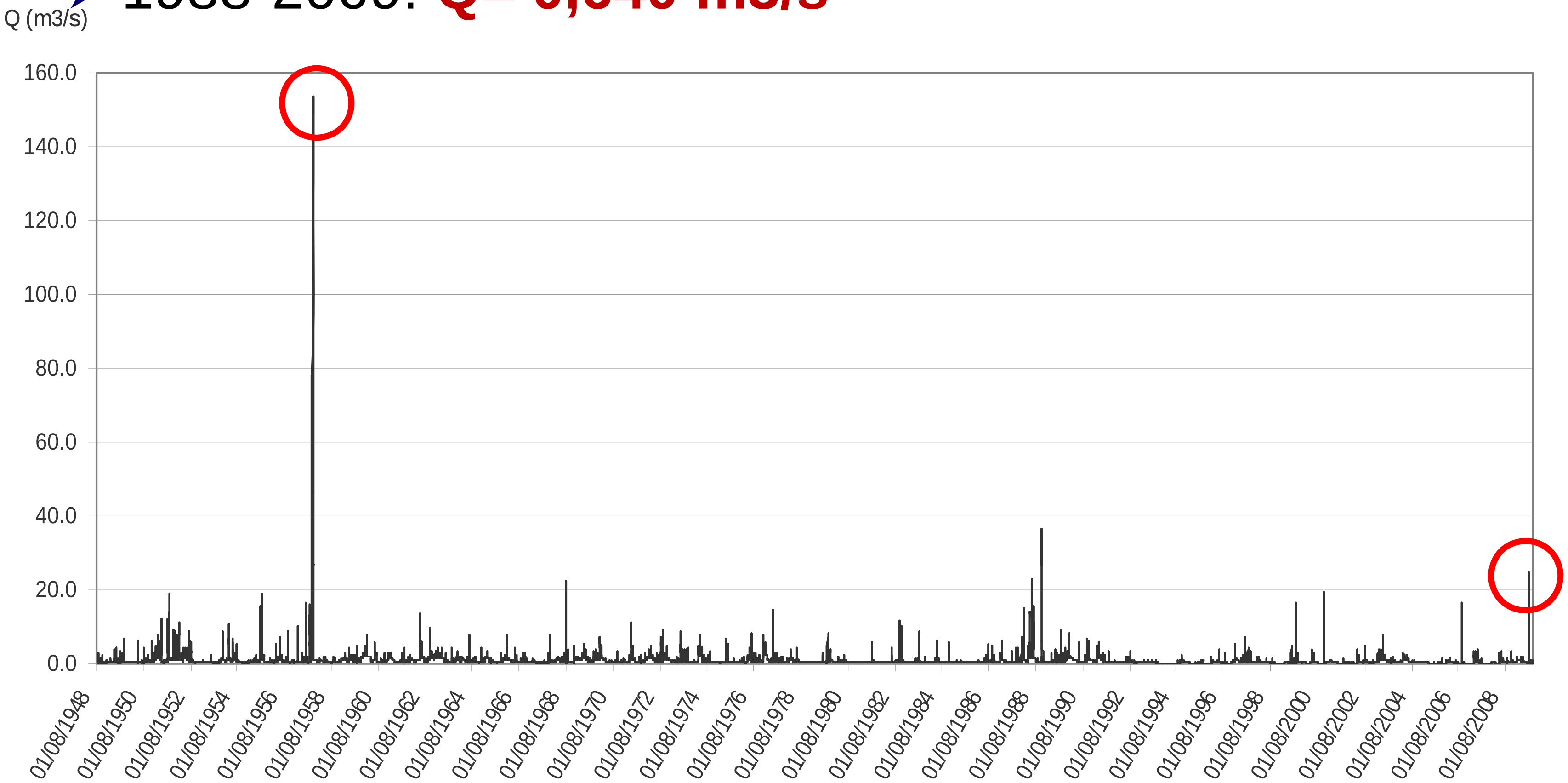
Hidrometeorological info.

- ET0 (mm/day) period 1948 – 2009
  - 1988-2009: **ET0= 860 mm/year** >P **=> semiarid**

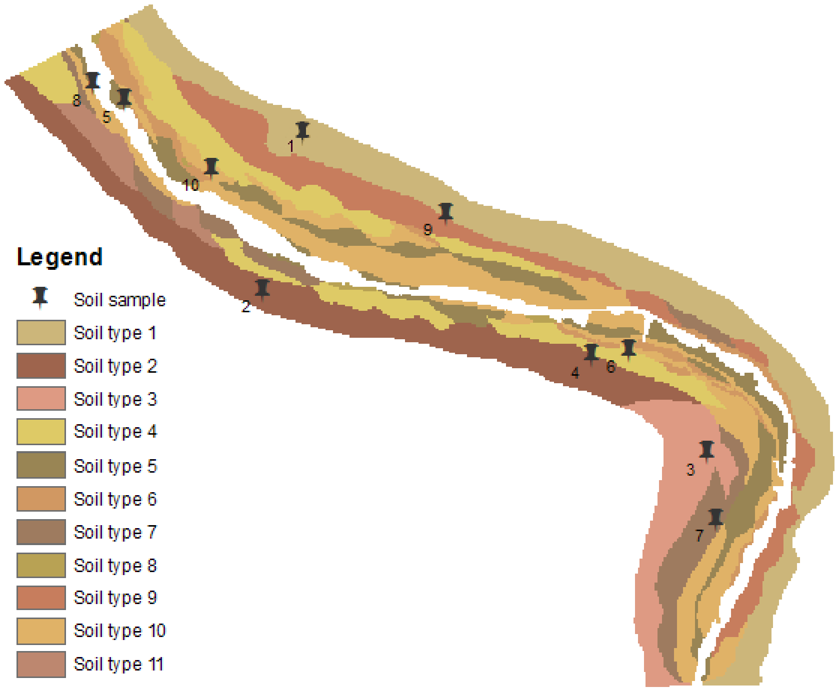


Hidrometeorological info.

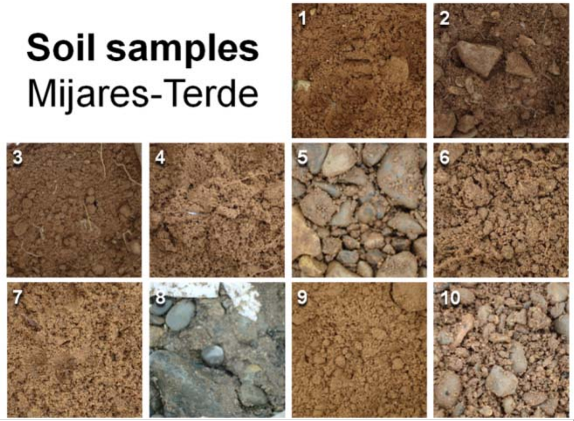
- Daily river discharge (m3/s) period 1948 - 2009
  - 1988-2009: **Q= 0,640 m3/s**

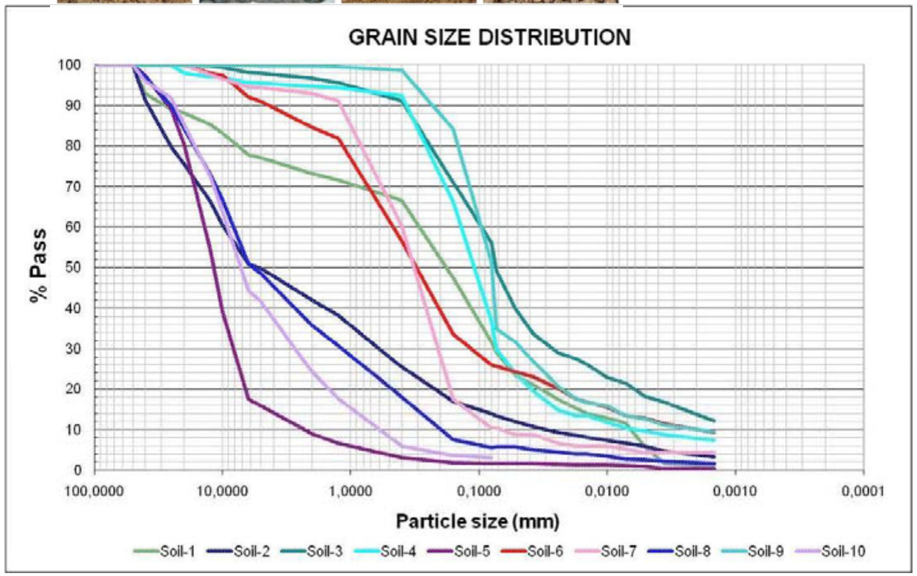


Soil survey

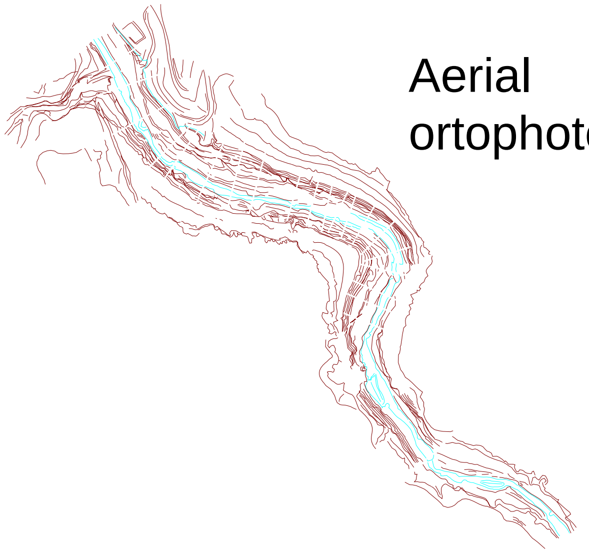


Soil samples
Mijares-Terde

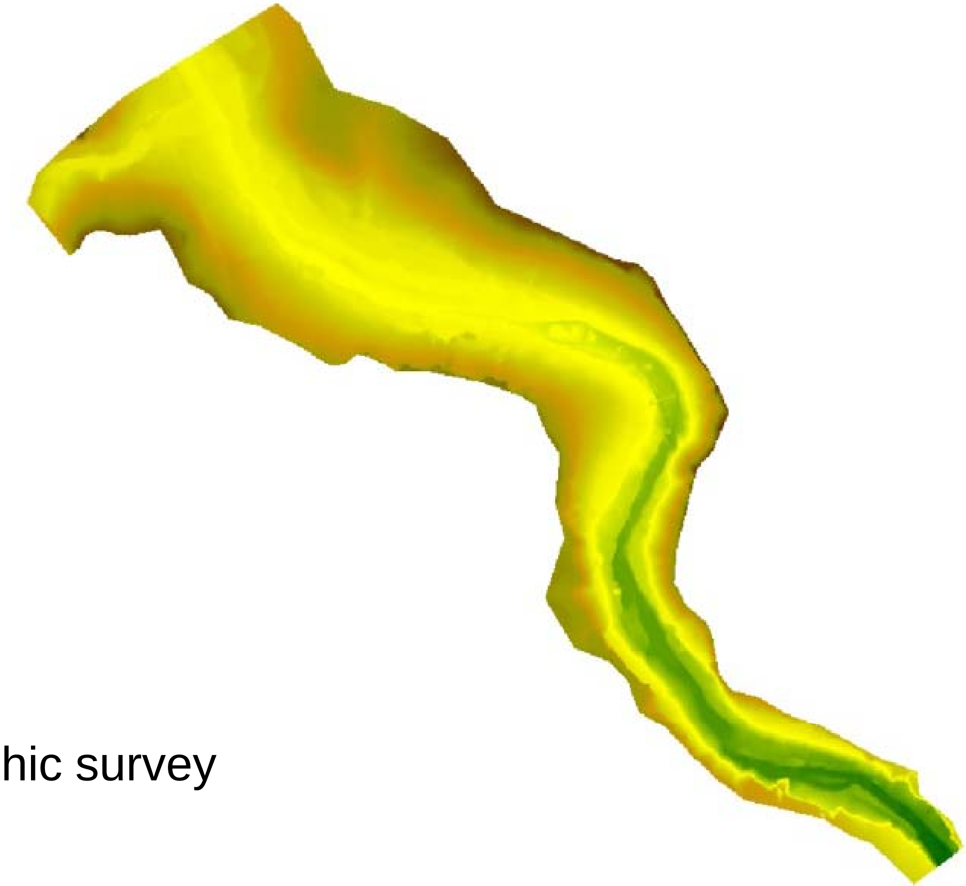


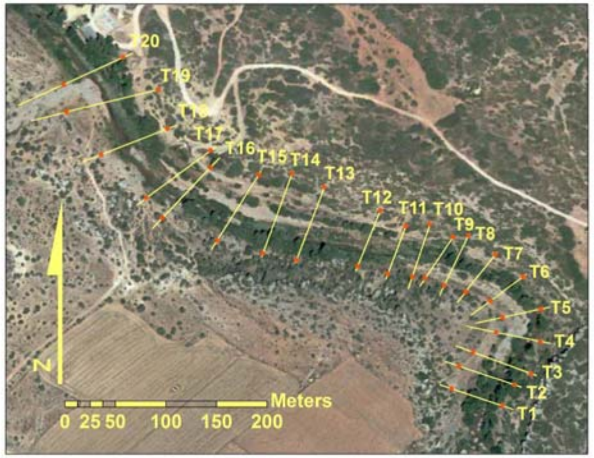


1x1m DEM



Aerial
ortophotography



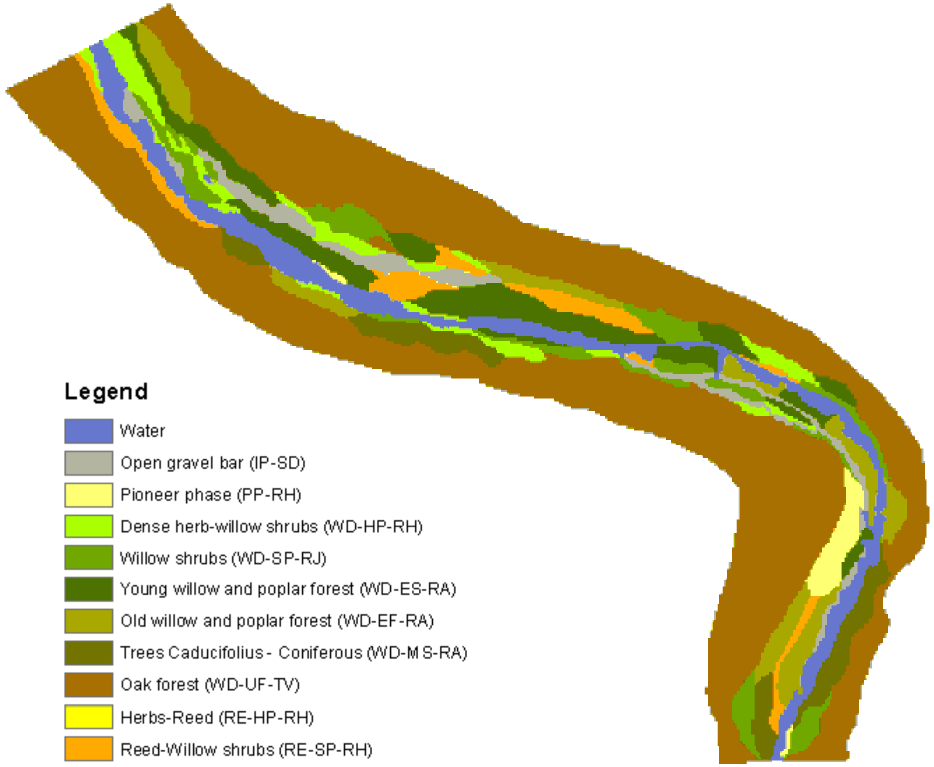


Ground
topographic survey

Vegetation survey inputs to ripflow

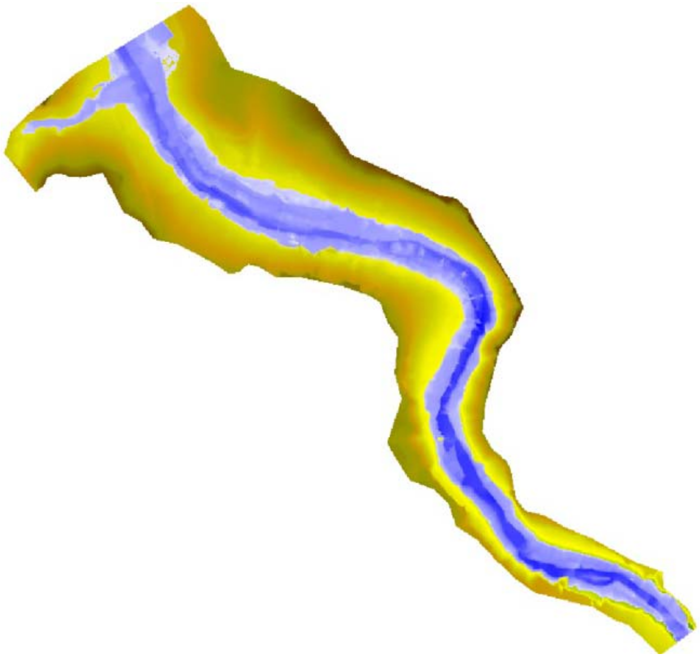
- Definition of succession series and phases
- Present vegetation succession phases map

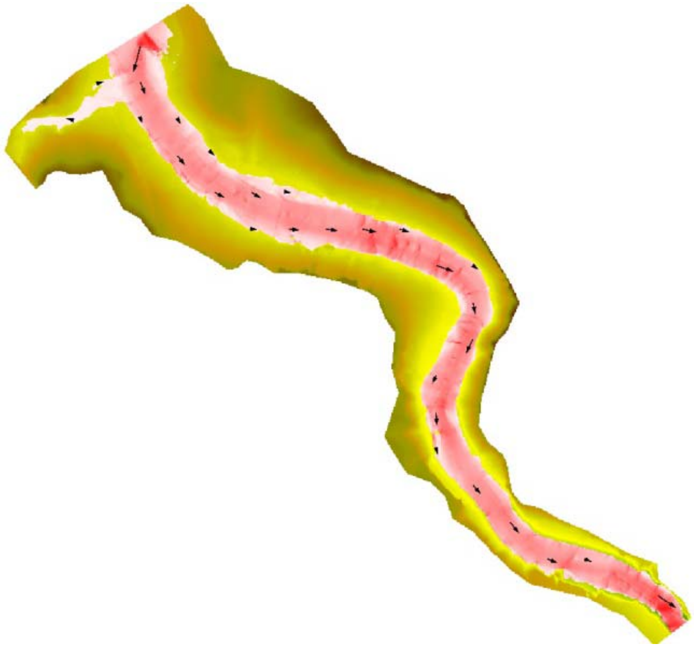
See poster A 391



Hydraulic modelling results

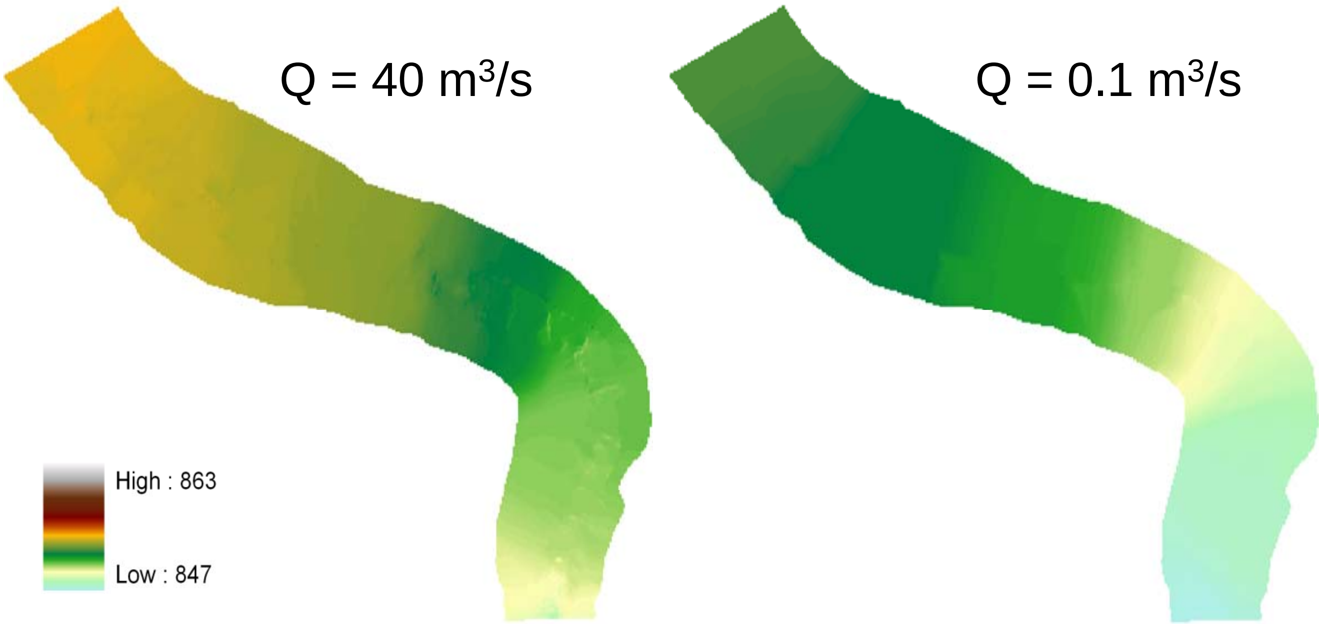
- Saint-Venant 2D equations
- GUAD 2D model: integration by finite volumes with RTIN
  - Water depths and velocities maps for Q from 0 to 150 m3/s





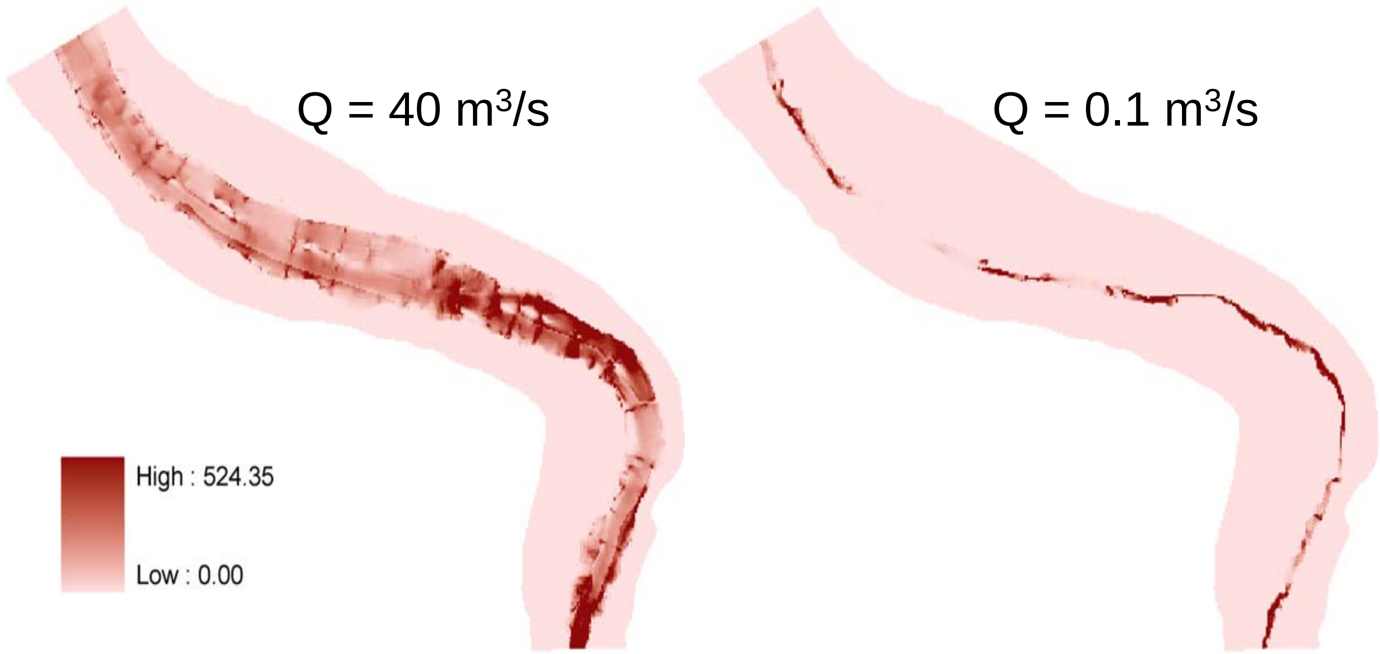
Hydraulic inputs to RIPFLOW

- Water table elevations: “horizontal” water table=> Thiessen polygons



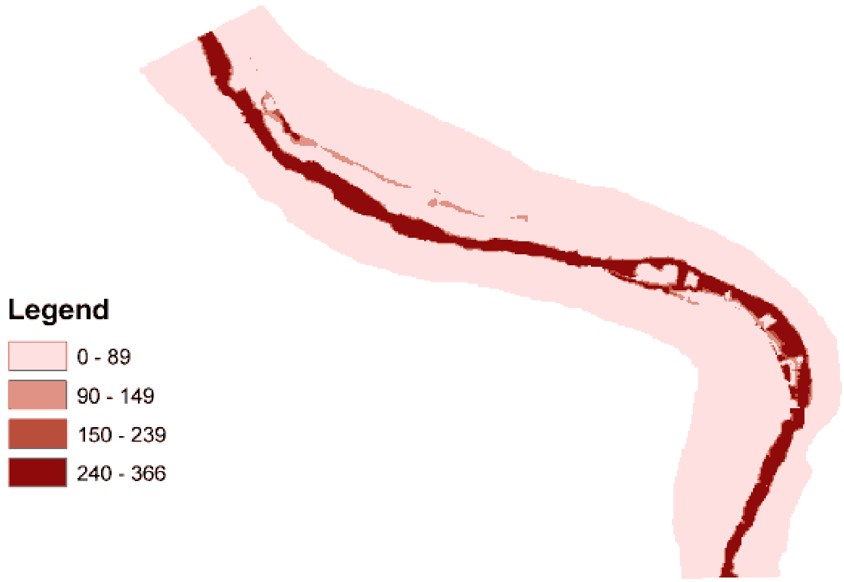
Hydraulic inputs to RIPFLOW

- Shear stress $\tau = \rho \cdot \mathrm{u}^{*2}$ where: $u^{*} = 2.102 \frac{v \cdot n}{y^{1/6}}$



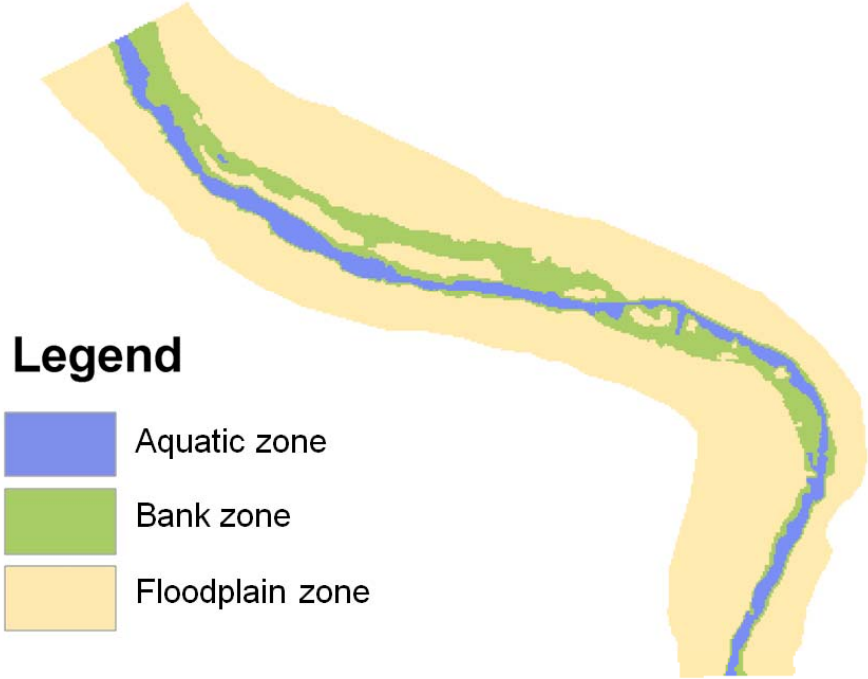
Hydraulic inputs to RIPFLOW

- Flood duration for year types
  - For "very humid year"



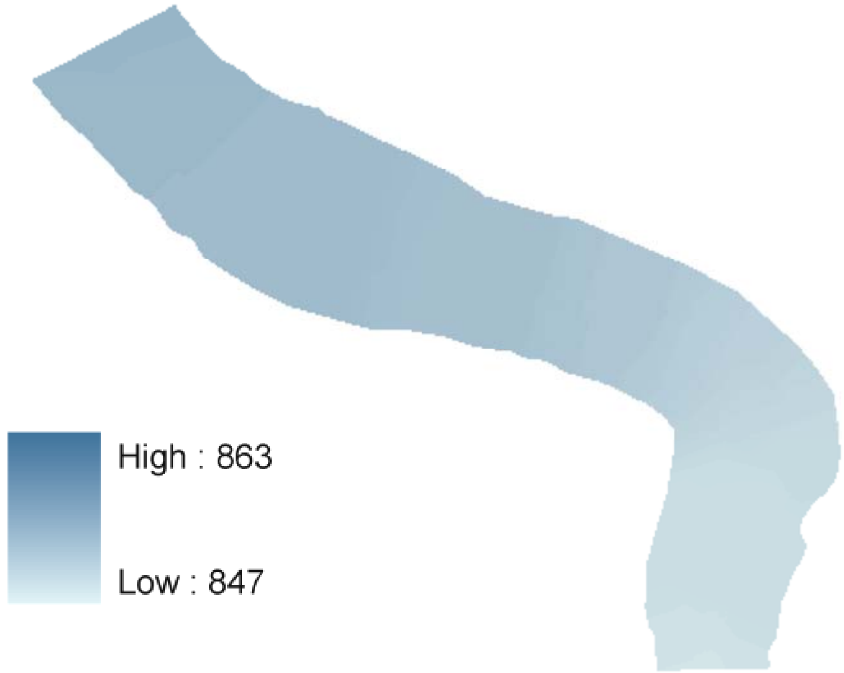
Hydraulic inputs to RIPFLOW

- Definition of aquatic, bank and floodplain zones



Hydraulic inputs to RIPFLOW

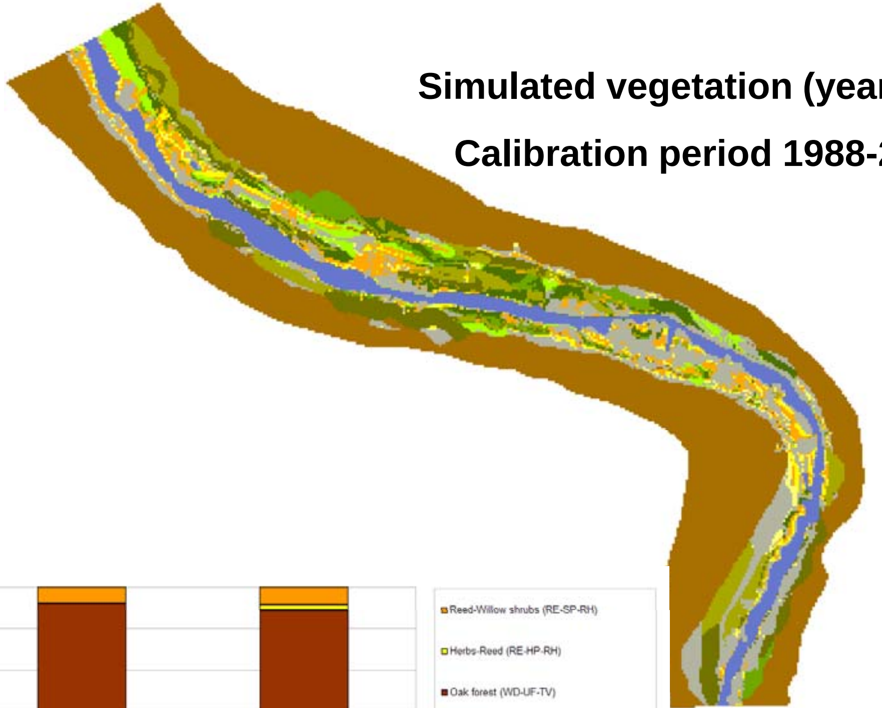
- HBF for year types:
  - For “dry” and “very dry” years (0.2 m^3/s base flow)



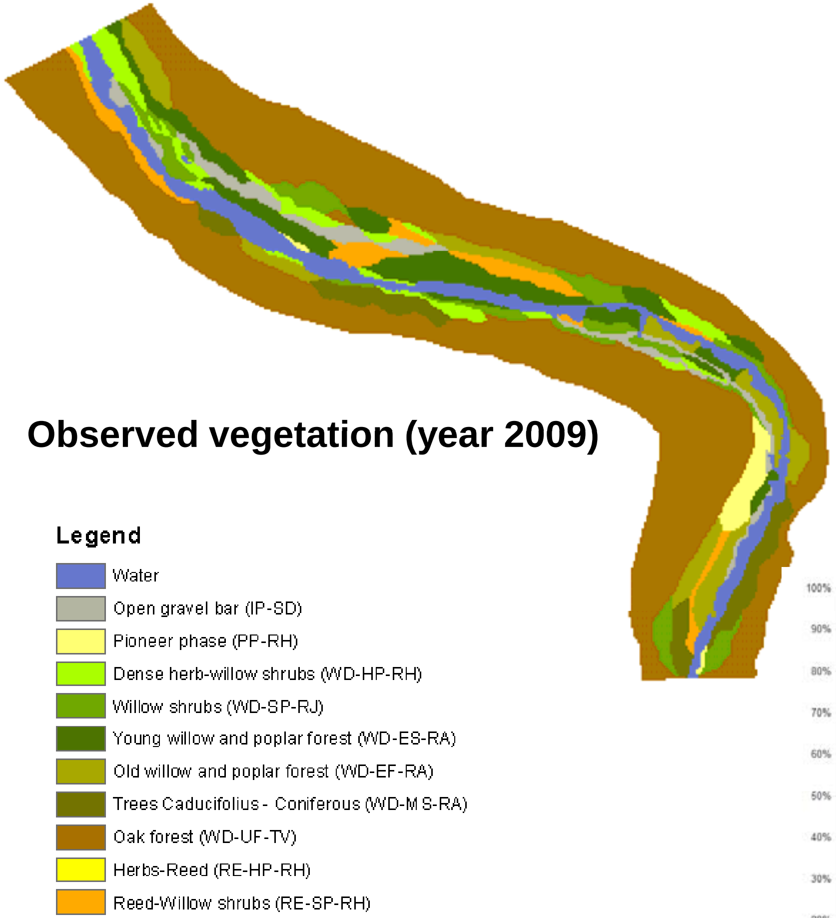
Calibration results

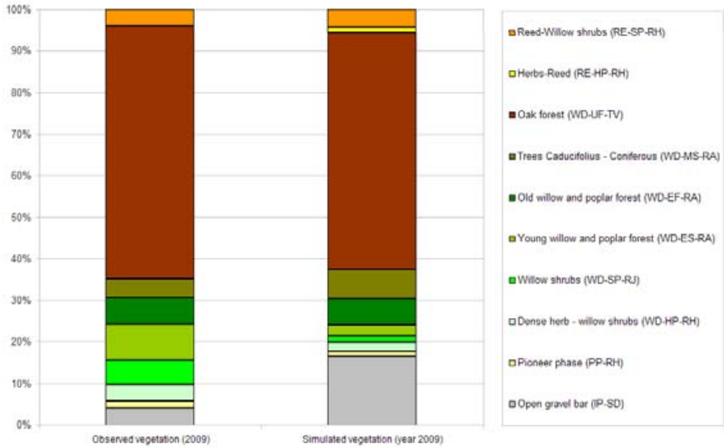
Simulated vegetation (year 2009)

Calibration period 1988-2009



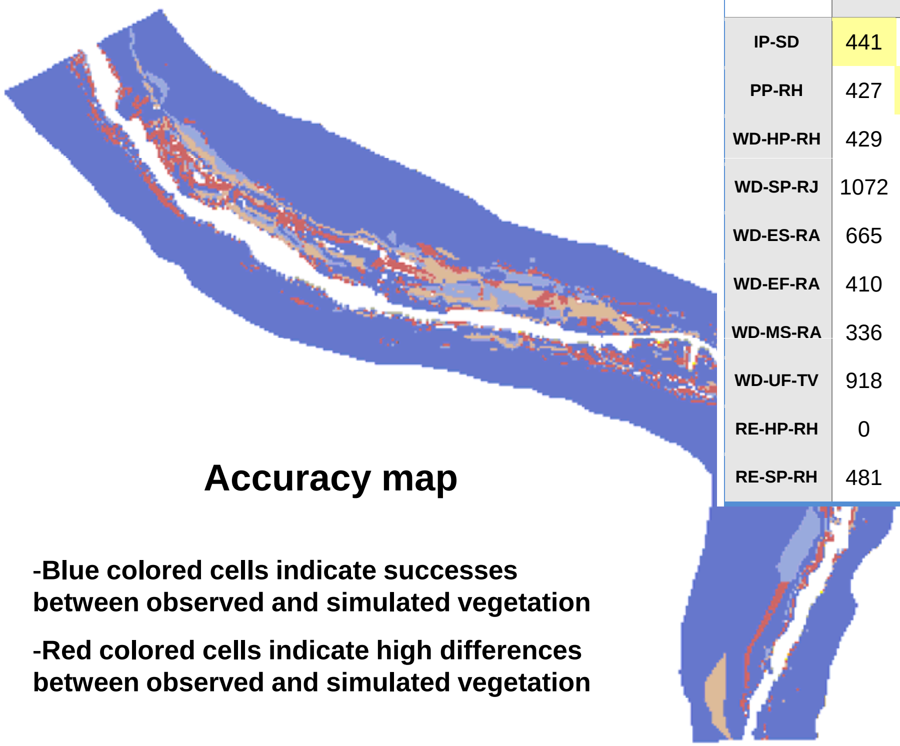
Observed vegetation (year 2009)





Calibration results

	Confusion matrix									
	IP-SD	PP-RH	WD-HP-RH	WD-SP-RJ	WD-ES-RA	WD-EF-RA	WD-MS-RA	WD-UF-TV	RE-HP-RH	RE-SP-RH
IP-SD	441	175	143	50	41	68	18	0	50	239
PP-RH	427	23	1	0	2	1	0	17	37	19
WD-HP-RH	429	10	413	35	54	68	44	27	34	163
WD-SP-RJ	1072	23	23	278	64	42	71	45	41	233
WD-ES-RA	665	30	23	16	615	468	608	59	49	189
WD-EF-RA	410	15	5	1	1	1083	247	62	87	83
WD-MS-RA	336	3	10	6	2	12	1010	4	15	16
WD-UF-TV	918	61	23	44	5	46	136	17721	71	82
RE-HP-RH	0	0	0	0	0	0	0	0	0	0
RE-SP-RH	481	34	74	28	46	235	36	7	30	303



Accuracy map

-Blue colored cells indicate successes between observed and simulated vegetation

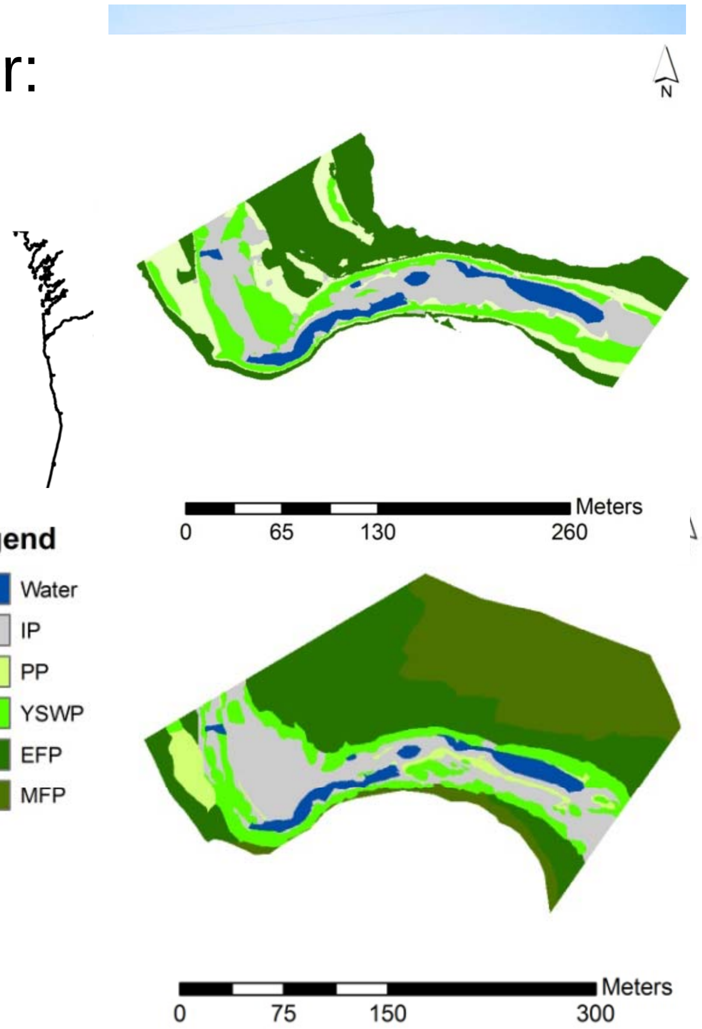
-Red colored cells indicate high differences between observed and simulated vegetation

Calibration results:

Kappa coefficient = 0.7127 ± 0.00675 (95% confidence limit)

Case study: Portugal

- For calibration, the Odelouca River:
  - **Non-permanent** flow regime
  - **No flow regulation** upstream
  - **Near natural conditions**



- **Kappa coef. = 0.61**

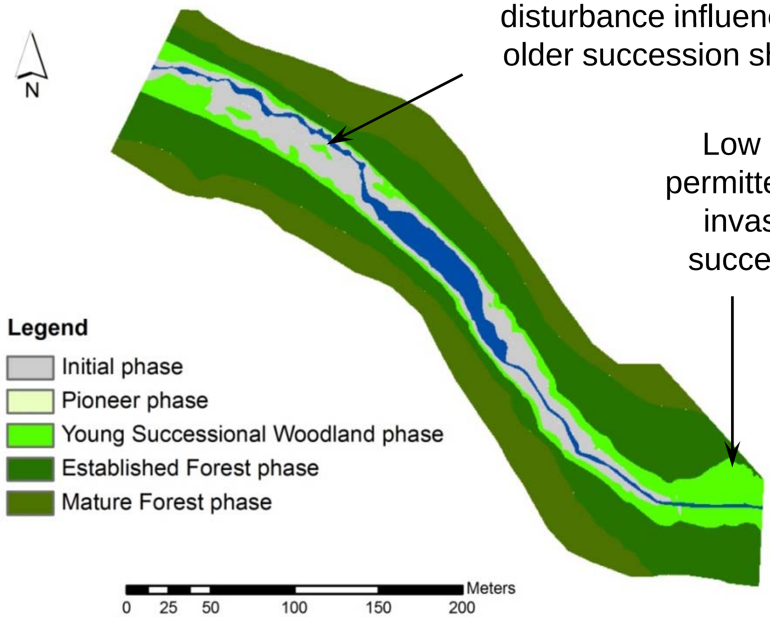
Spatial validation: Sado River

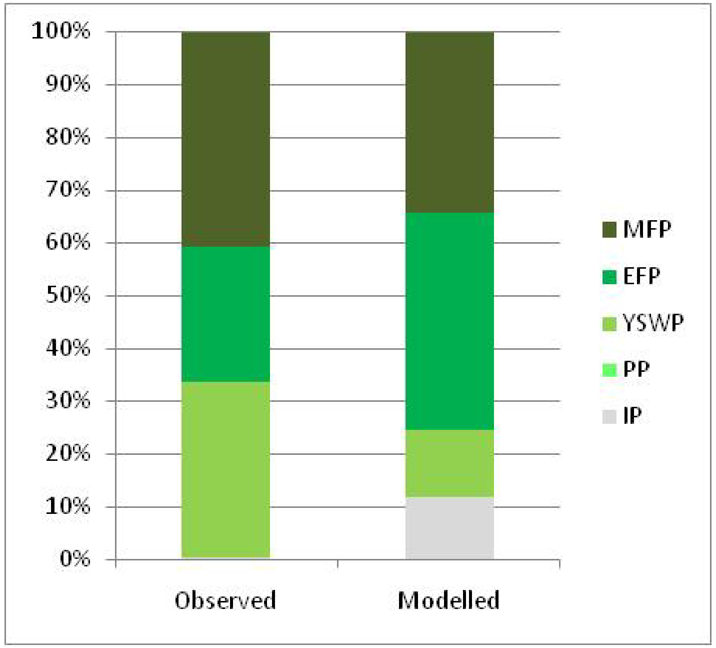
- Oledouca River parameters
- **Kappa coef. = 0.65**

Succession phases after 10 years modelling regulated flow

No recruitment due to scour disturbance influence and older succession shading

Low shear stress permitted channel bed invasion by older succession phases

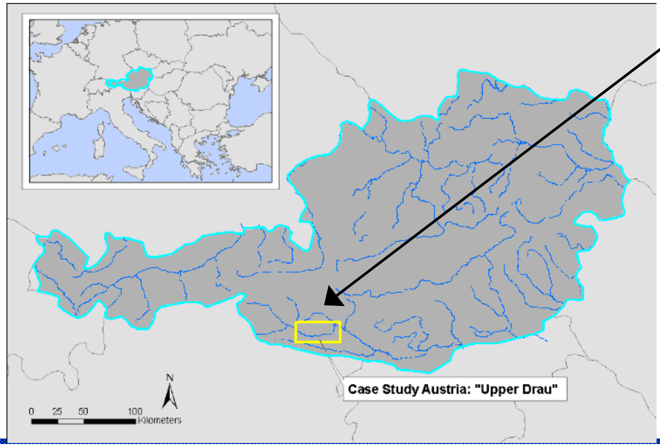




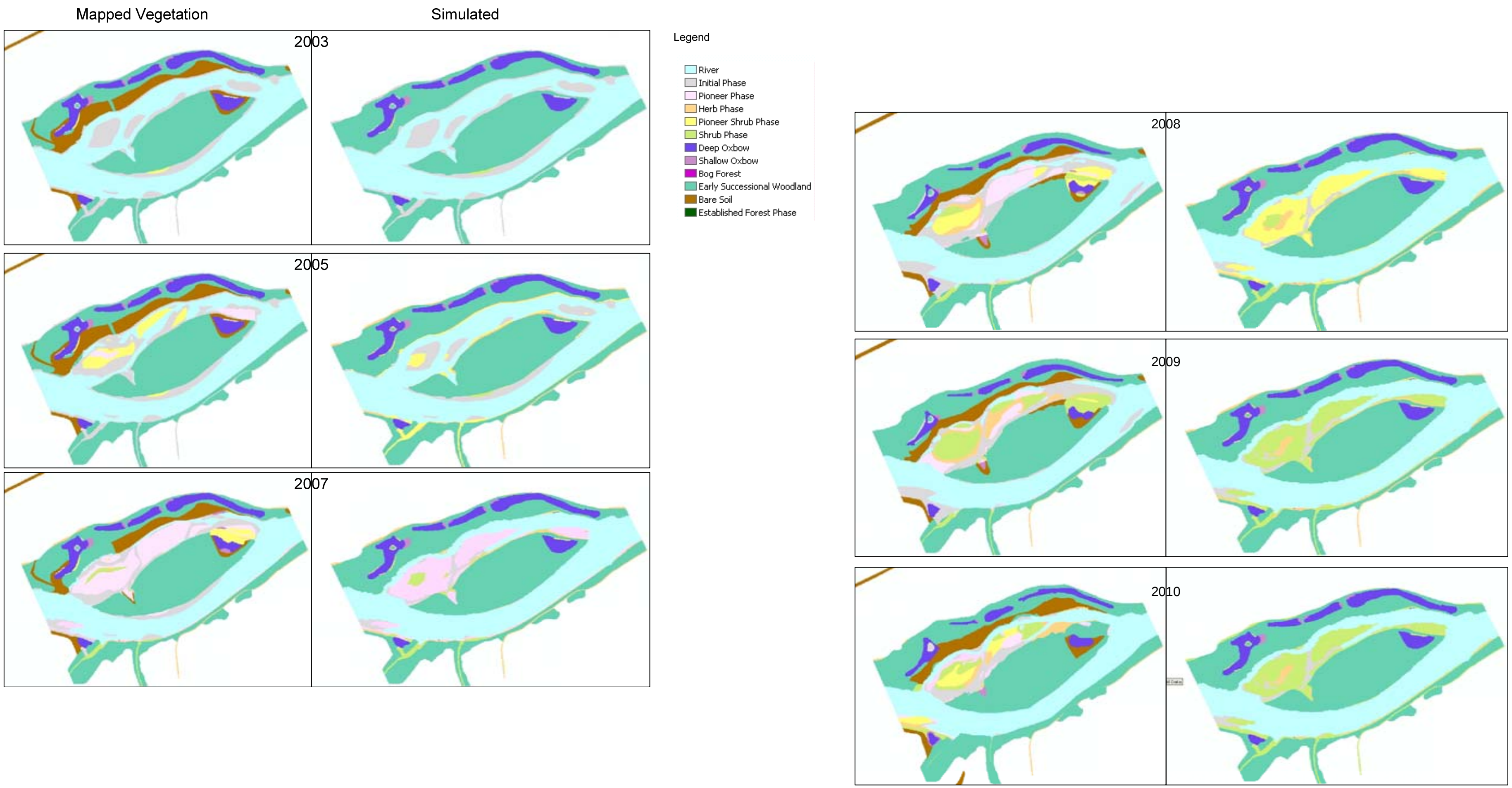
Case study: Austria

- Upper Drau River:

➢ Typical **alpine river**
➢ **Permanent** flow regime
➢ No flow regulation upstream
➢ **Channelized** in the1970s, **restored** in 2002

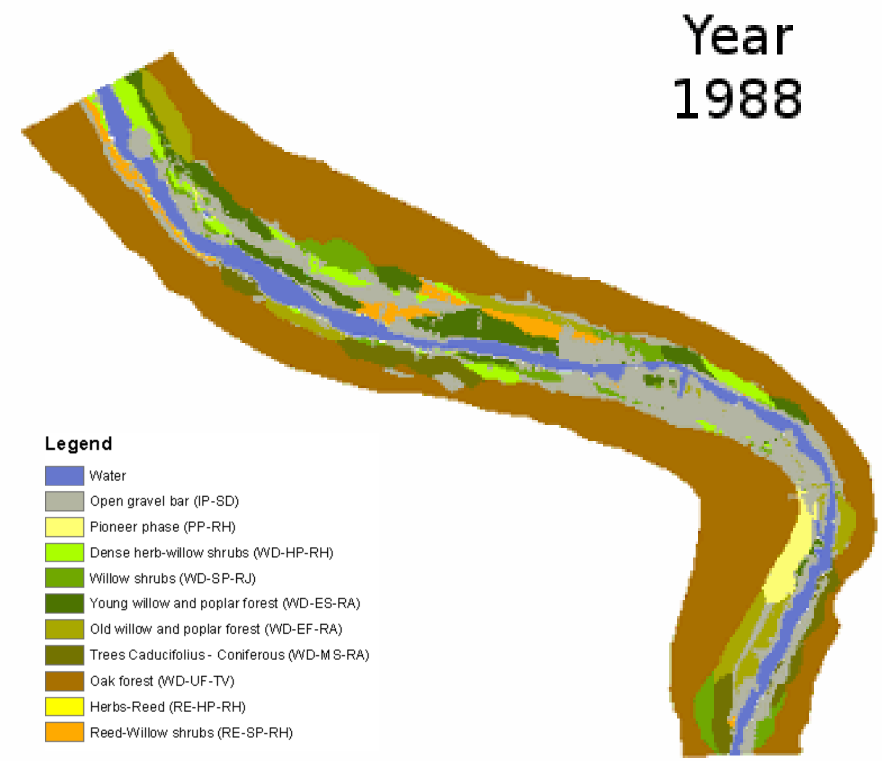


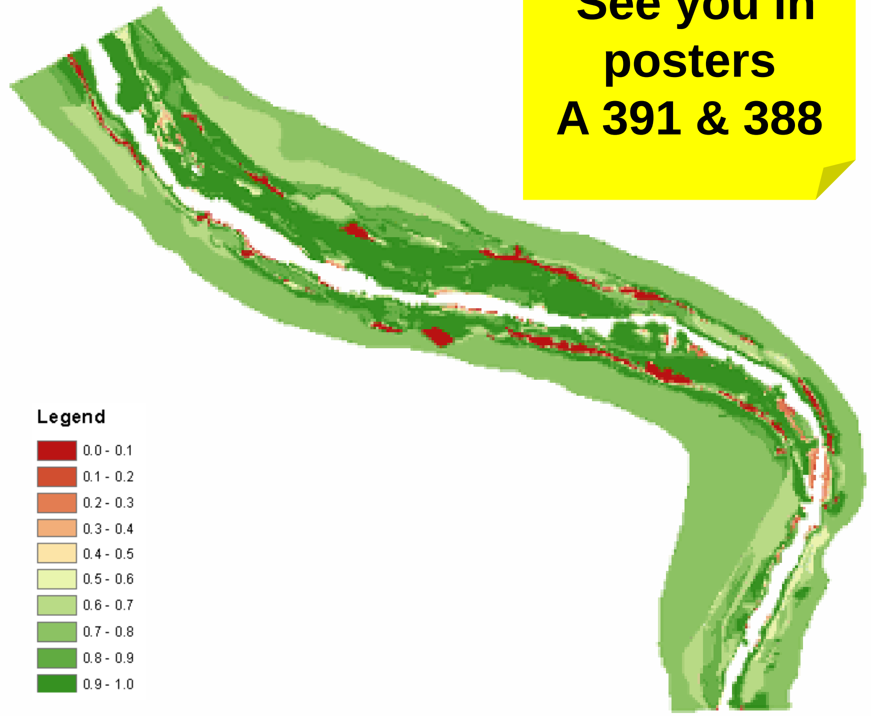
Calibration and temporal validation



Conclusions

1988 – 2009 inTerde (Mijares River, Spain)





See you in posters A 391 & 388

Succession Phases

Tidx