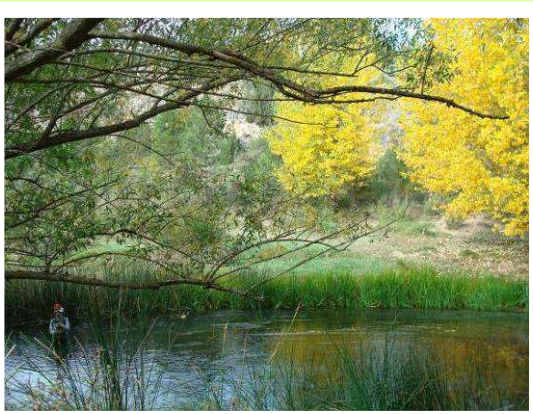
Evaluation of direct and indirect anthropic effects over riparian vegetation zonation in several stretches of Mediterranean rivers in Spain



Alicia García Arias (algarar2@posgrado.upv.es)

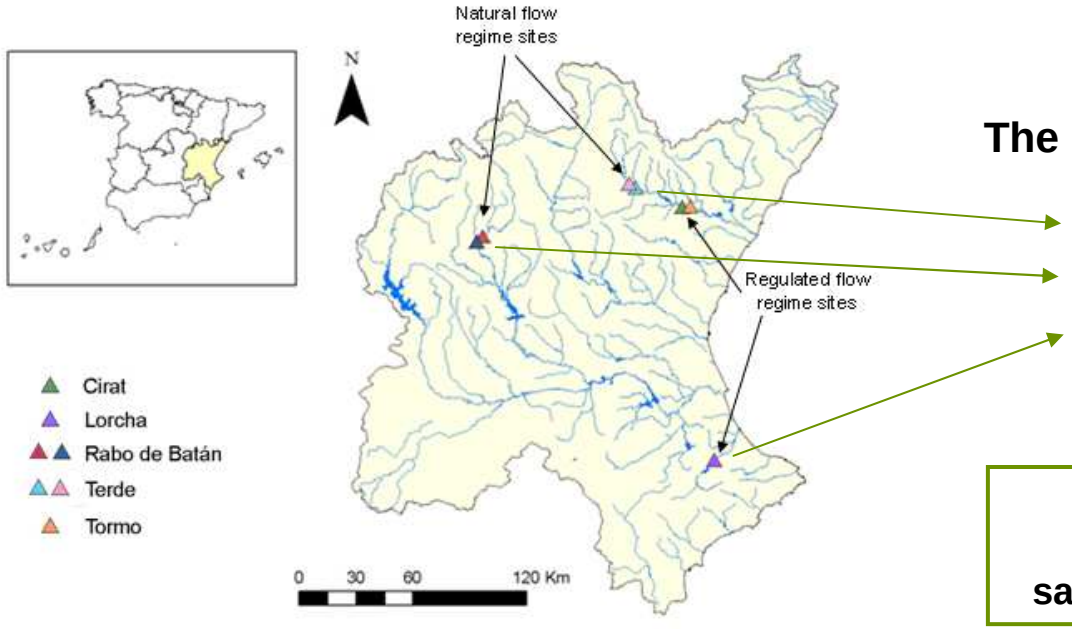
OUTLINE

1. Introduction
2. RibAV model calibration
   - 2.1. Calibration in disturbed flow regime
   - 2.2. Default vegetation parameters
3. RibAV model validation
   - 3.1. Validation in natural flow regime
   - 3.2. Validation in disturbed flow regime
   - 3.3. Versatility of the model
4. Cases of study
   - 4.1. Climatic change scenarios
   - 4.2. Flow regulation scenarios
5. The QBR index
6. Results
7. Conclusions

1. Introduction

The Júcar River Basin District is one of the most important in the Mediterranean region of Spain

- scarce water resources
- high water demand: urban (20%), agricultural (80%)
- tight balance between available water resources and demands (3,200 hm3/year)
- half of the hydrologic available resources are extracted from groundwater
- surface reservoirs: regulation near to 1,200 hm3/year



The district system includes:

- **Mijares river**
- **Cabriel river**
- **Serpis river**

Several stretches have been selected as a representative sample of the River Basin District

2. RibAV model calibration

- **A sensitivity analysis determined that the most relevant model parameters were:**
  - **Zr:** maximum root depth (m)
  - **Ze:** effective root depth (m)
  - **Zsat:** saturation extinction depth (m)
  - **Rj:** transpiration factor from the saturated zone ()
  - **Ri:** transpiration factor from the unsaturated zone ()
- **The model has been calibrated and validated using as objective function a confusion matrix:**

The confusion matrix compares the observed and the simulated riparian vegetation zonation

OBSERVADOS \ SIMULADOS	RH	RJ	RA	TV	RH+RJ	RH+RA	RJ+RA	RA+TV	Total
RH					-	-	-	-	
RJ					-	-	-	-	
RA					-	-	-	-	
TV					-	-	-	-	
RH+RJ						-	-	-	
RH+RA					-		-	-	
RJ+RA					-	-		-	
RA+TV					-	-	-		
Total unicas									Tot obs
Total todas									Tot sim

Group A Group B Group C

- **The Cohen's *k* test (Cohen, 1960) → *k*, coefficient of agreement for nominal variables**

2. Calibration

2.1. Calibration in disturbed flow regime

- Stretch: **Lorcha** (Serpis River)
- All vegetation functional types observed in field
- 431 simulation points
- 36 simulations required

BALANCE	Simulados	Observados	% Aciertos
RH	25	70	**35.71%**
RJ	2	5	**40.00%**
RA	17	18	**94.44%**
TV	110	125	**88.00%**
RH+RJ	8	20	**40.00%**
RH+RA	12	17	**70.59%**
RJ+RA	31	84	**36.90%**
RA+TV	92	92	**100.00%**

		SIMULADOS									
		RH	RJ	RA	TV	RH+RJ	RH+RA	RJ+RA	RA+TV	Total	
OBSERVADOS	RH	**25**	3	39	3	-	-	-	-	70	
	RJ	0	**2**	1	2	-	-	-	-	5	
	RA	0	0	**17**	1	-	-	-	-	18	
	TV	0	0	15	**110**	-	-	-	-	125	
	RH+RJ	3	5	5	7	**8**	-	-	-	20	
	RH+RA	0	1	12	4	-	**12**	-	-	17	
	RJ+RA	2	2	29	51	-	-	**31**	-	84	
	RA+TV	0	0	51	41	-	-	-	**92**	92	
	Total únicas	**25**	**5**	**72**	**116**	8	12	31	92	431	Tot obs
	Total todas	30	13	169	219					431	Tot sim

Riparian *vs* terrestrial

$k = 0.81 \pm 0.10$

(99% confidence limit)

Parameter		Zr Maximum Root Depth [m]	Ze Effective Root Depth [m]	Zsat Extinction at Saturation [m]	Ri Transpiration Factor from Unsaturated Zone [ ]	Rj Transpiration Factor from Saturated Zone [ ]	Cov Vegetation density [ ]	CRT Maximum Soil-Root Water Conductance [mm/Mpa/h]	Pwp Wilting Point Matrix Potencial [Kpa]	Pcrit Critical matrix potential [Kpa]
Riparian Herbs	RH	0.8	0.7	-0.75	0.8	0.6	1	0.97	1500	500
Riparian Juveniles and small Schrubs	RJ	1.25	0.9	-0.1	0.9	0.35	0.8	0.97	1500	500
Riparian adults Trees and Schrubs	RA	3.5	0.9	-0.3	0.9	0.35	1	0.97	1500	250
Terrestrial Vegetation	TV	2	1.9	0.3	1	0	1	0.97	1500	95

2. Calibration

2.3. Default Vegetation Parameters

Parameter		Zr Maximum Root Depth [m]	Ze Effective Root Depth [m]	Zsat Extinction at Saturation [m]	Ri Transpiration Factor from Unsaturated Zone [ ]	Rj Transpiration Factor from Saturated Zone [ ]	Cov Vegetation density [ ]	CRT Maximum Soil-Root Water Conductance [mm/Mpa/h]	Pwp Wilting Point Matrix Potencial [Kpa]	Pcrit Critical matrix potential [Kpa]
Riparian Herbs	RH	0.8	0.7	-0.75	0.8	0.6	1	0.97	1500	500
Riparian Juveniles and small Schrubs	RJ	1.25	0.9	-0.1	0.9	0.35	0.8	0.97	1500	500
Riparian adults Trees and Schrubs	RA	3.5	0.9	-0.3	0.9	0.35	1	0.97	1500	250
Terrestrial Vegetation	TV	2	1.9	0.3	1	0	1	0.97	1500	95

- ***k*** (**disturbed** flow regime) = 0.81 ± 0.10

0.40 < ***k*** < 0.60	ACCEPTABLE
0.60 < ***k*** < 0.80	GOOD
0.80 < ***k*** < 1.00	EXCELLENT

3. Validation

3.1. Validation in natural flow regime

Stretch - River	Matching cases percentage		*k*	Stretch features
	RIPARIAN	TERRESTIAL		
Rabo del Batán – Cabriel	93.04 %	20.69 %	0.69 ± 0.13	Forest stretch, natural flow
Terde – Mijares	89.15 %	70.83 %	0.69 ± 0.13	Forest stretch, natural flow

3.2. Validation in disturbed flow regime

Stretch - River	Matching cases percentage		*k*	Stretch features
	RIPARIAN	TERRESTIAL		
Cirat – Mijares	29.41 %	Not observed	0.01 ± 0.40	Agricultural, regulated flow
Tormo – Mijares	75.67 %	Not observed	0.40 ± 0.45	Forest stretch, regulated flow

3.2. Versatility of the model

- Agricultural influence introduces high uncertainty in flow data
- The number of simulation points must be high to obtain a representative k value
- The k value should be interpreted with caution if there is absence of any vegetation functional types

Stretch - River	Matching cases percentage		*k*
	RIPARIAN	TERRESTIAL	
Combination	86.50 %	56.44 %	0.74 ± 0.07

4. Cases of study

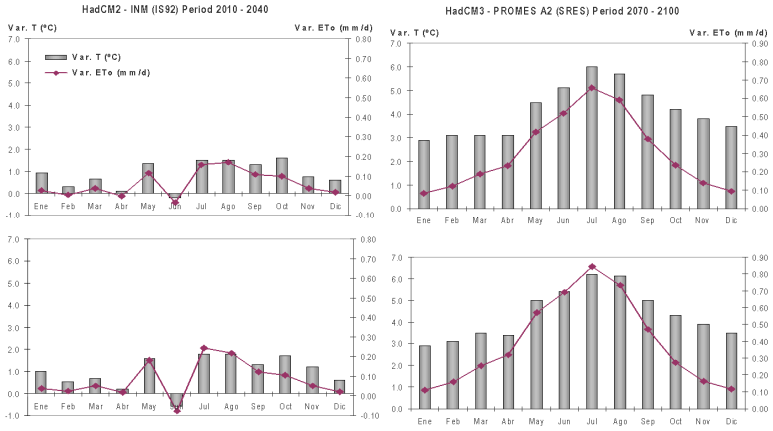
4.1. Climatic change scenarios

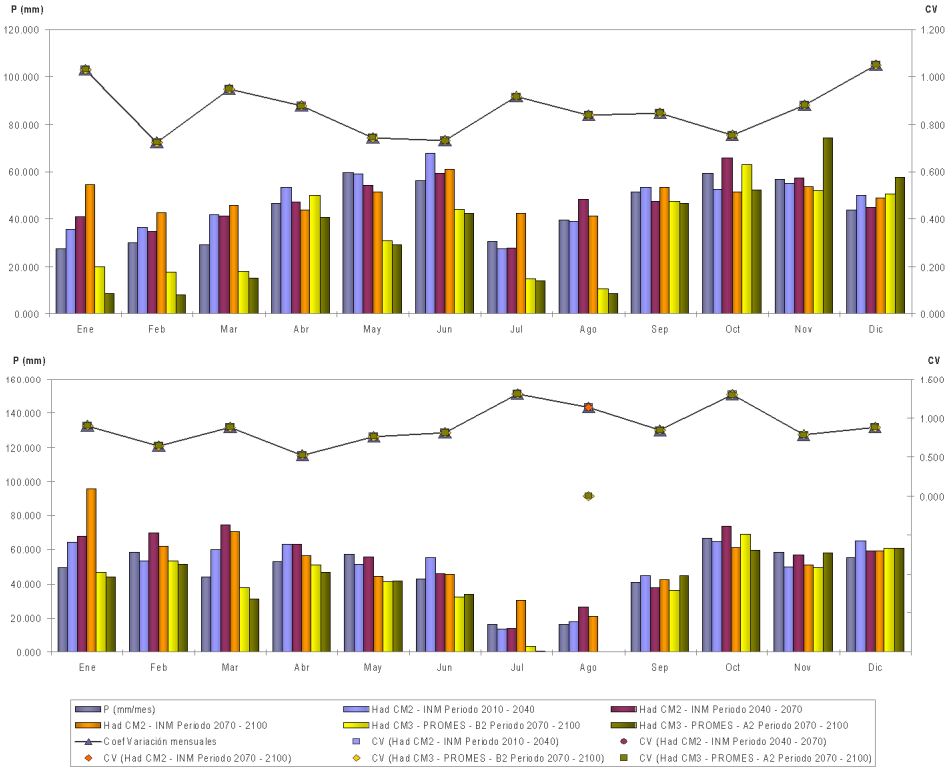
- **Meteorological scenarios**

(Reference period: 1960 – 1990)

HadCM2-INM (IS92): 2010 – 2040
2040 – 2070
2070 – 2100

HadCM3-PROMES
(SRES A2, SRES B2): 2070 – 2100





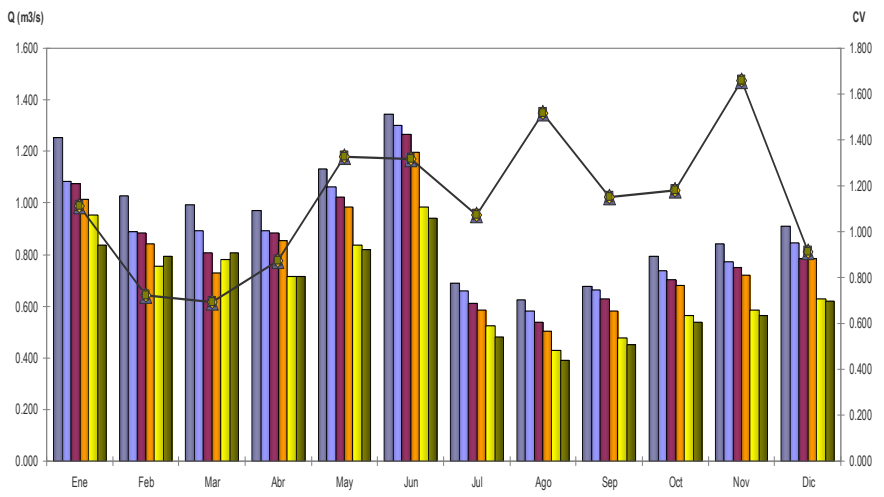
Meteorological scenarios in Terde and Rabo del Batán stretches

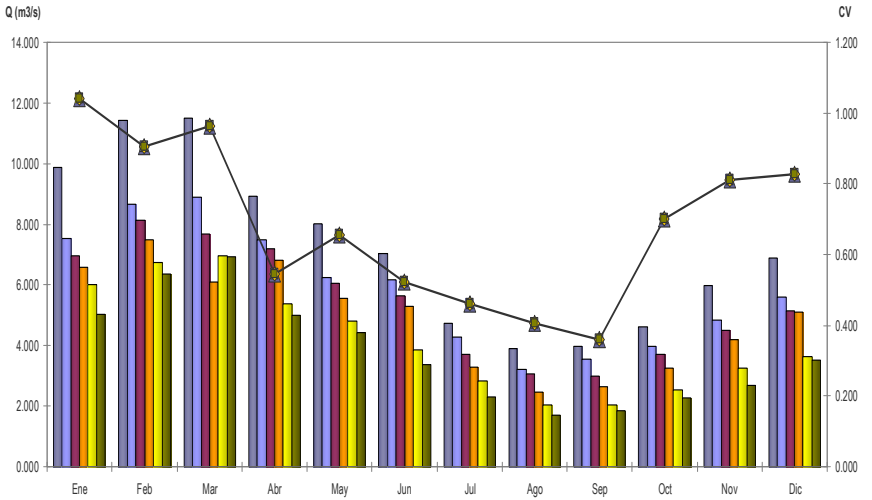
4. Cases of study

4.1. Climatic change scenarios

- **Hydrological scenarios** **(Reference period: 1960 – 1990)**

HadCM2-INM (IS92):	**2010 – 2040**
	2040 – 2070
	2070 – 2100
HadCM3-PROMES	
(SRES A2, SRES B2):	**2070 – 2100**





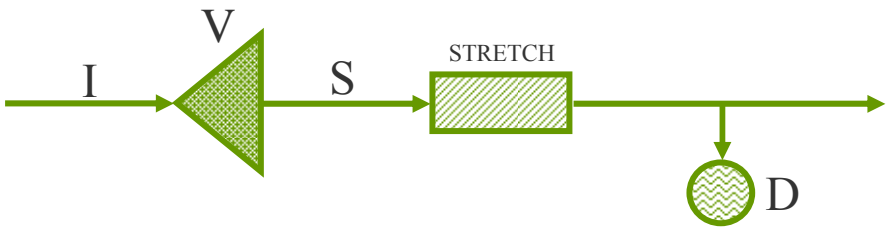
Hydrological scenarios in Terde and Rabo del Batán stretches

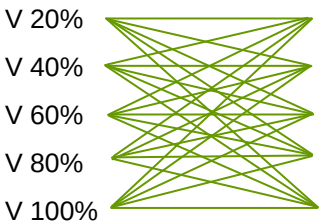
4. Cases of study

4.2. Flow regulation scenarios

Hydrological data series of Terde were modified in order to obtain several flow regulation scenarios:

- Dam regulation by a reservoir 20%, 40%, 60%, 80% and 100% of the annual flow
- Agricultural, urban and hydroelectric demands without consumption





Agricultural demands (20 scenarios: 0.02 – 714.87% mean flow) – monthly variability

Urban minimum demands 10.000 – 2.500.000 hab. (9 scenarios: 2.46 – 616.97 % mean flow) – seasonal var.

Urban average demands 10.000 – 2.500.000 hab. (9 scenarios: 4.67 – 925.47 % mean flow) – seasonal var.

Urban maximum demands 10.000 – 2.500.000 hab. (9 scenarios: 8.78 – 1165.41 % mean flow) – seasonal var.

Hydroelectric demands (20 scenarios: 29.17 – 583.43 % mean flow) – constant over the year

The initial volumes of the dams were established iteratively by the mean volume at that specific day of the year, for each dam capacity and demand scenario

5. The QBR index

5. The QBR index of riparian quality (Munné *et al*., 2003)

- Based on four components of riparian habitat: total riparian vegetation cover, cover structure, cover quality and channel alterations

- Is possible with RibAV results to analyze variations of this index over the different scenarios concerning:

  - Total riparian vegetation cover: number of riparian simulated points (RA, RJ and RH) over terrestrial ones (TV)

  - Cover structure: number of RA simulated points respect the total riparian ones (modified by the number of RJ and RH simulated in the points adjacent to the channel)

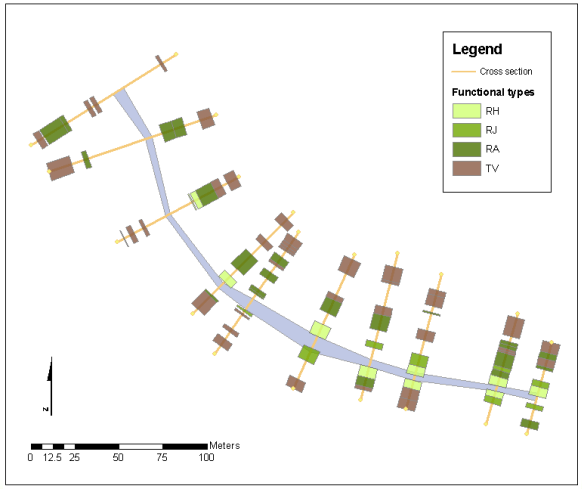
- Cover quality and channel alterations must be assumed constant

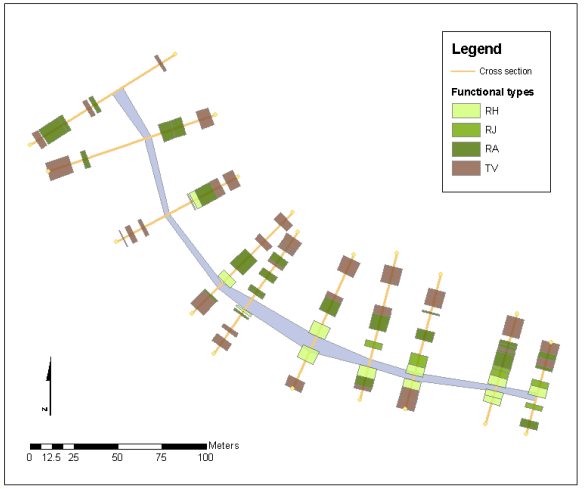
6. Results

6.1. Climatic change scenarios

Terde (Mijares river):

- No changes in riparian vegetation are observed in HadCM2-INM scenarios
- HadCM3-PROMES A2 and B2 scenarios → TV is simulated in traditional riparian zones (inc. 5 - 27.65%), RA presence increases slightly (4.7%)





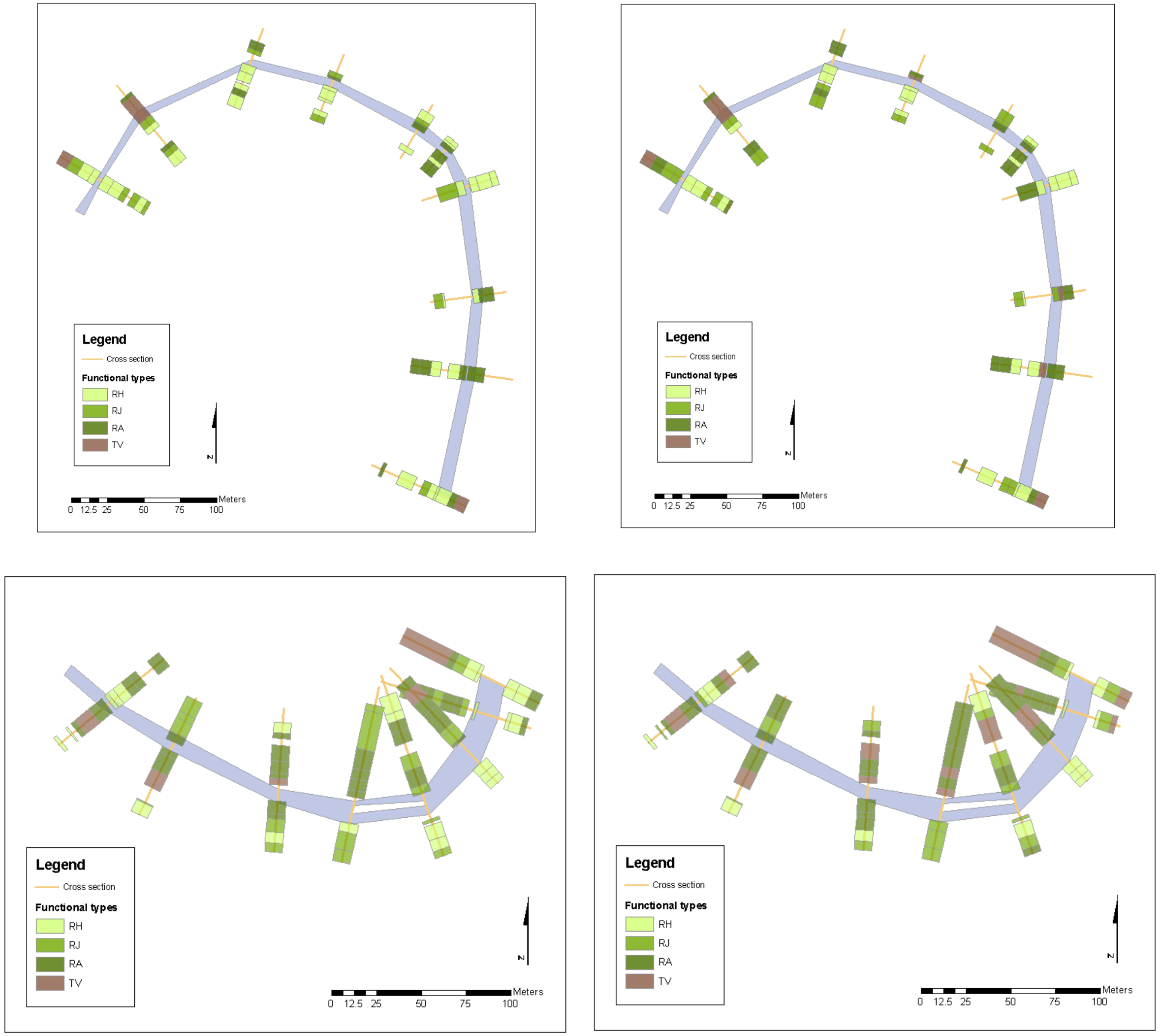
Instituto de Ingeniería del Agua y Medio Ambiente

6. Results

6.1. Climatic change scenarios

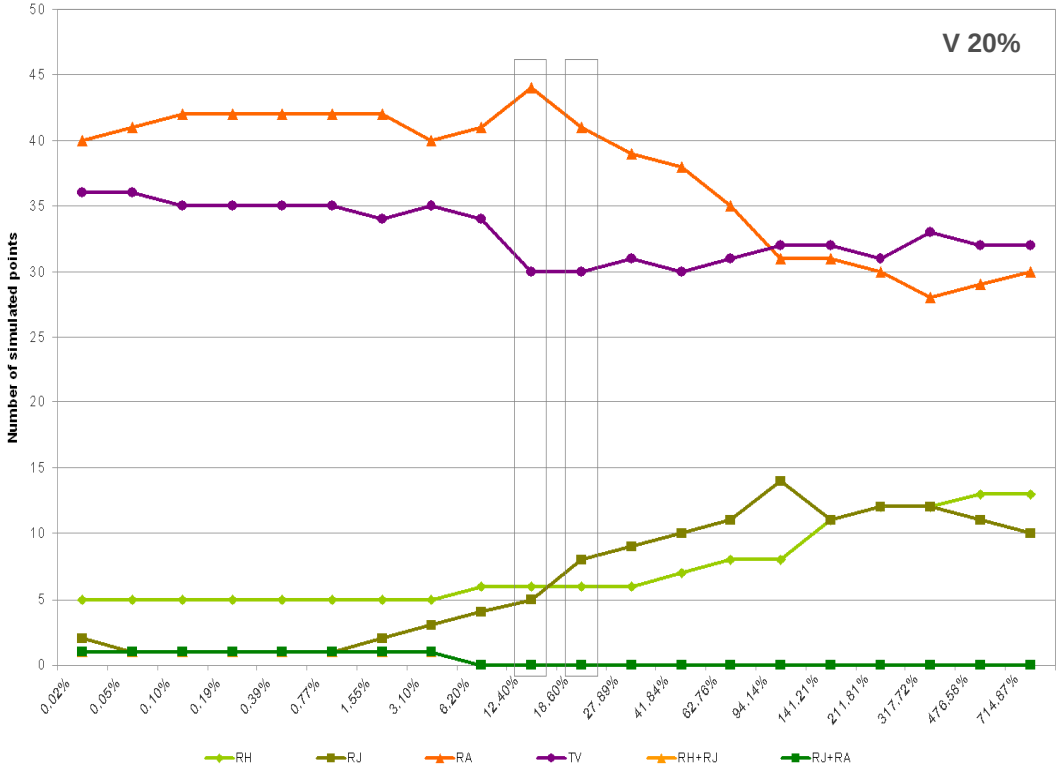
Rabo del Batán I (Cabriel river):

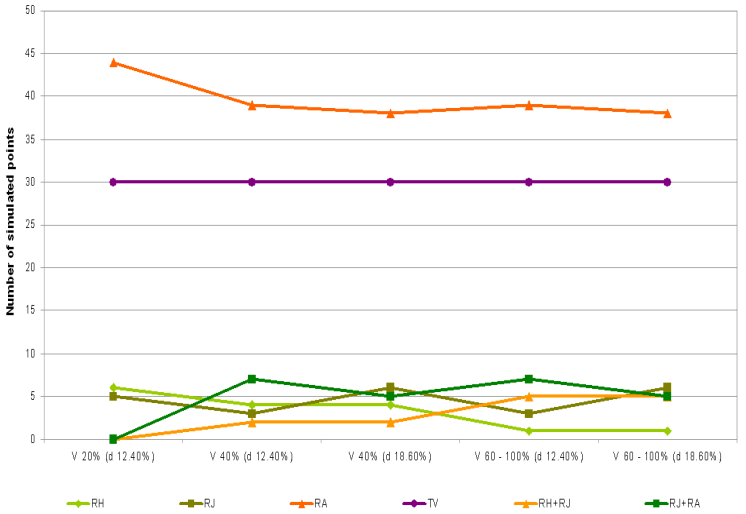
- Tendency shows that TV would be favored during the century, more in the ending years and specially in the most pessimist scenarios (inc. 4.35 – 10.71%)
- Riparian vegetation is expected to reduce the rates of RH (10.71 – 14.49%), increasing slightly RA (2.38 – 4.35%)

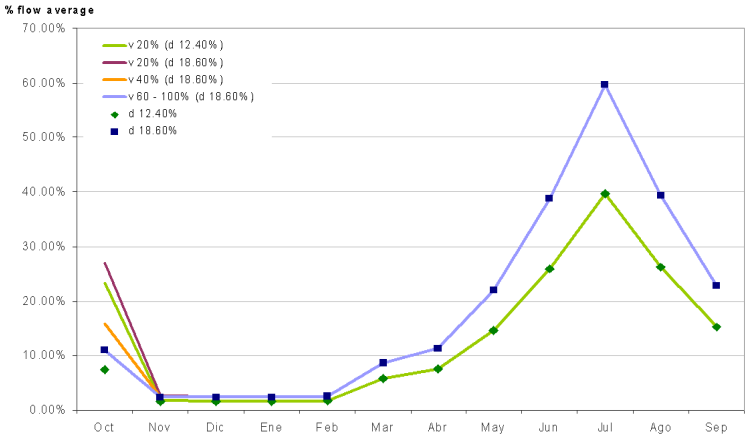


6. Results

6.2. Dam regulation + Agricultural demand

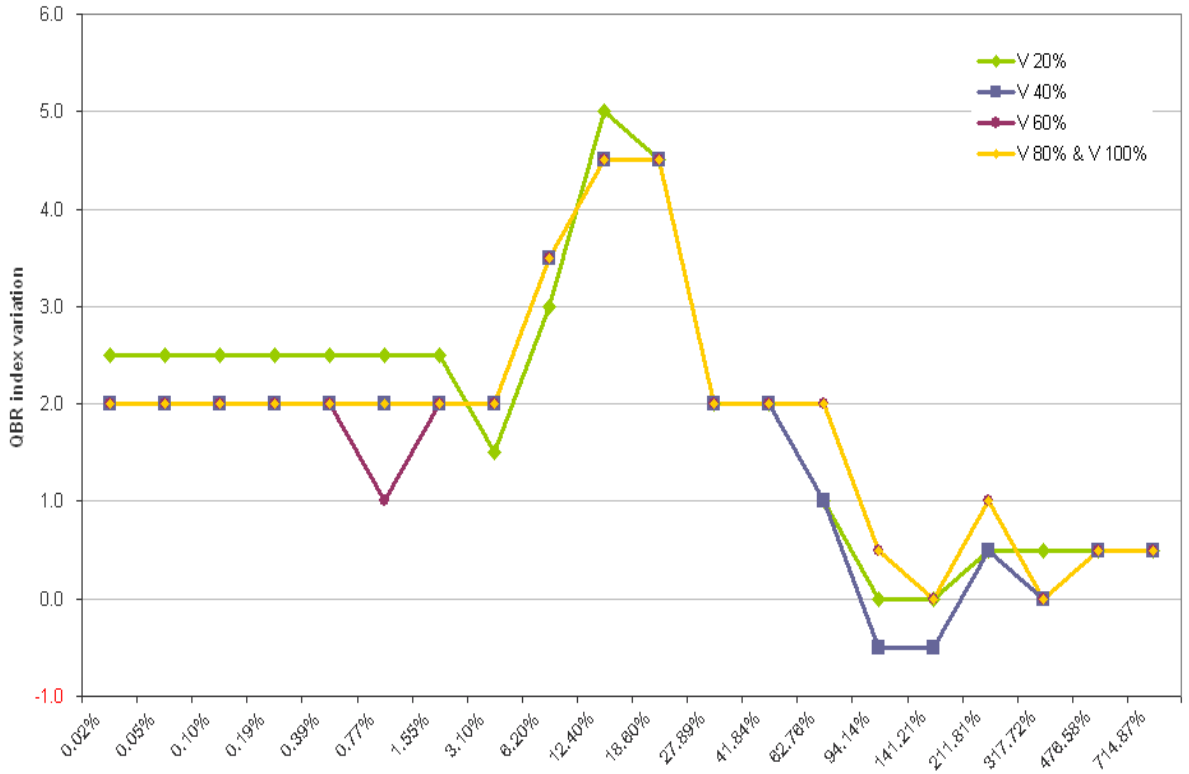


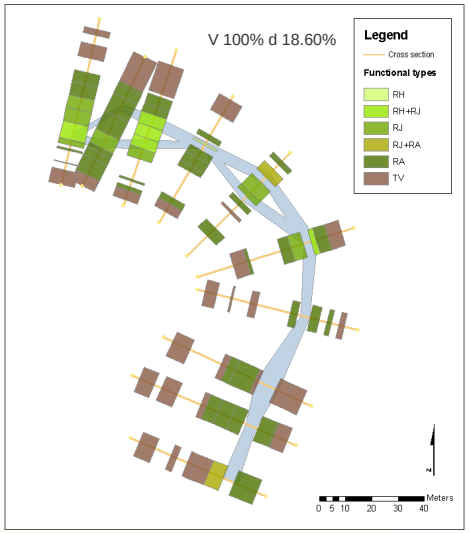




6. Results

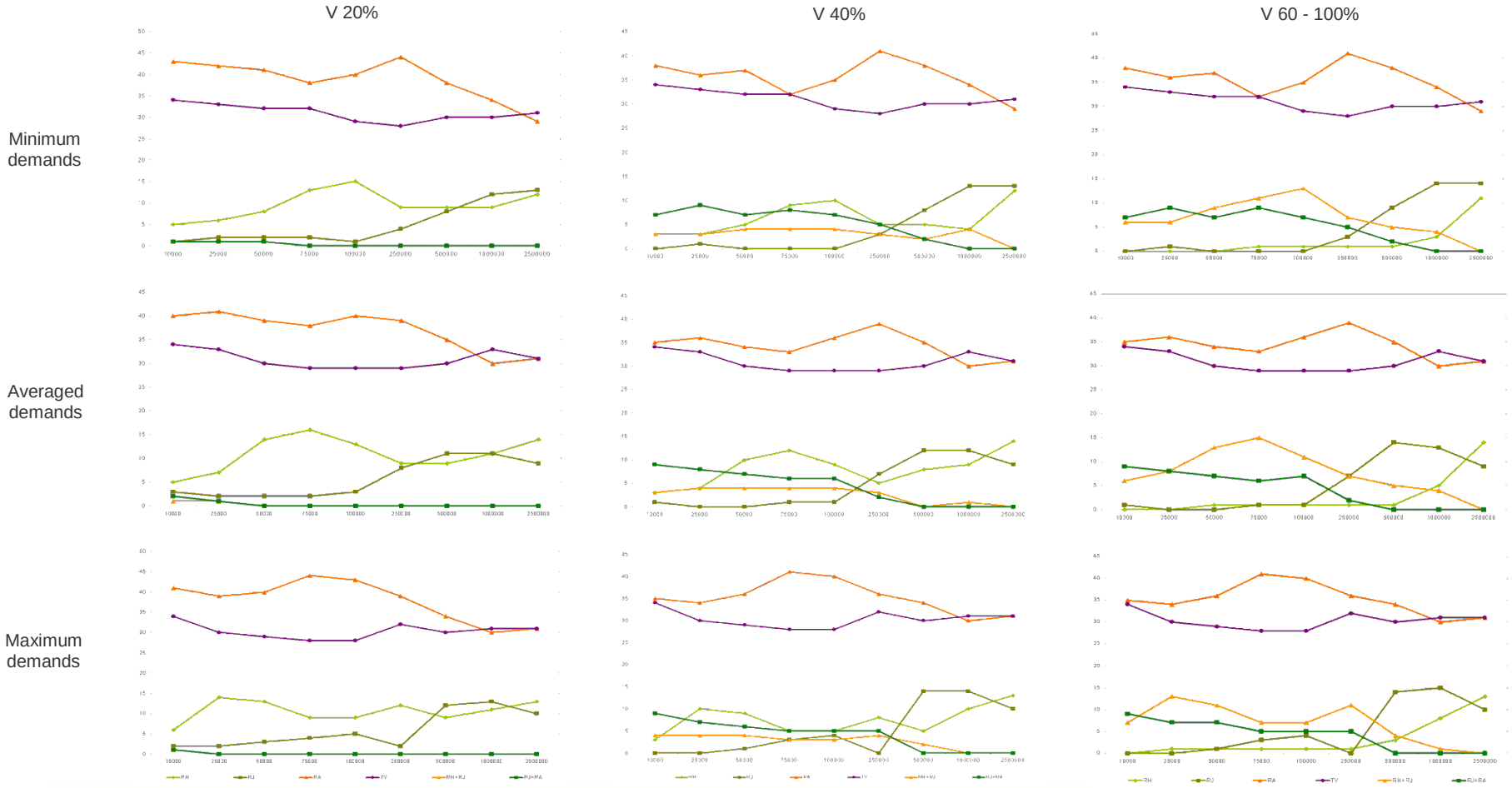
6.2. Dam regulation + Agricultural demand





6. Results

6.3. Dam regulation + Urban demand



6. Results

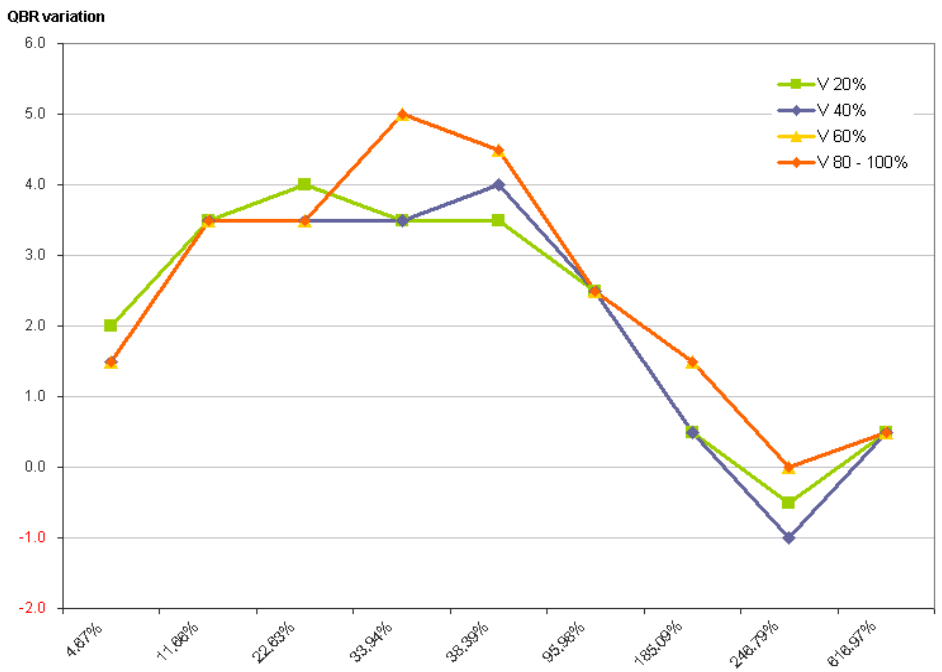
6.3. Dam regulation + Urban demand

QBR var. (Minimum demands)

6. Results

6.3. Dam regulation + Urban demand

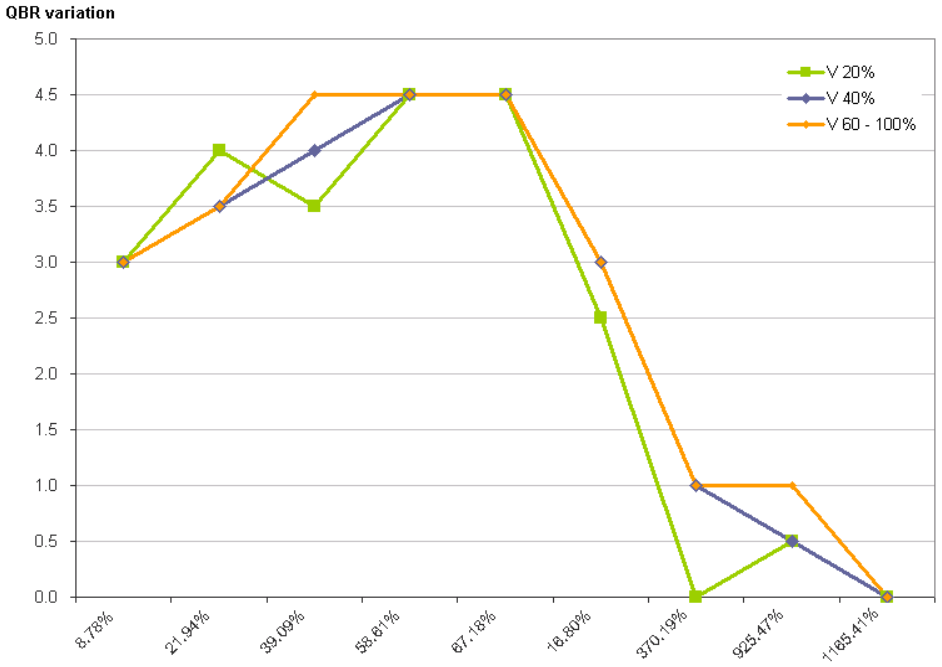
QBR var. (Averaged demands)



6. Results

6.3. Dam regulation + Urban demand

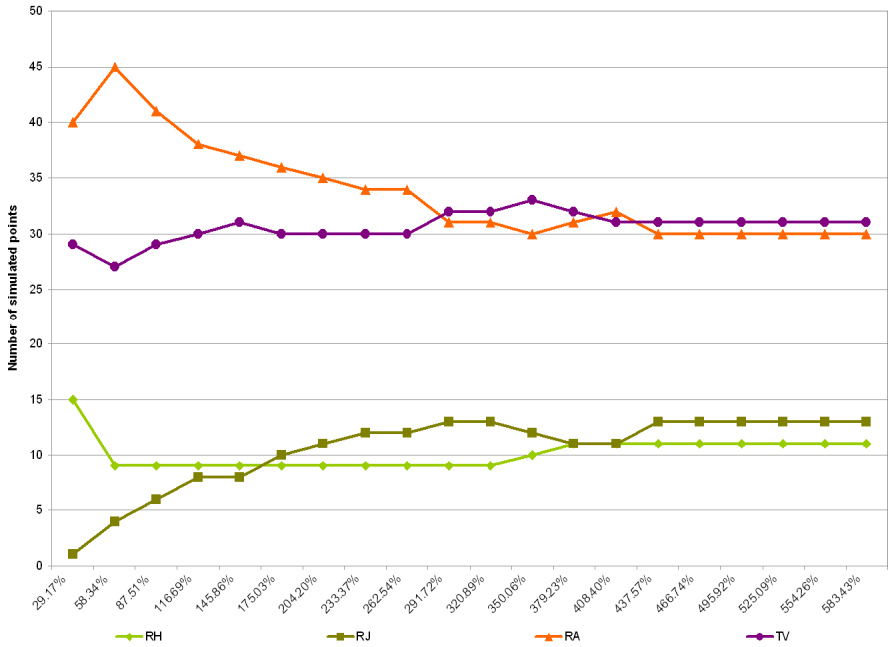
QBR var. (Maximum demands)



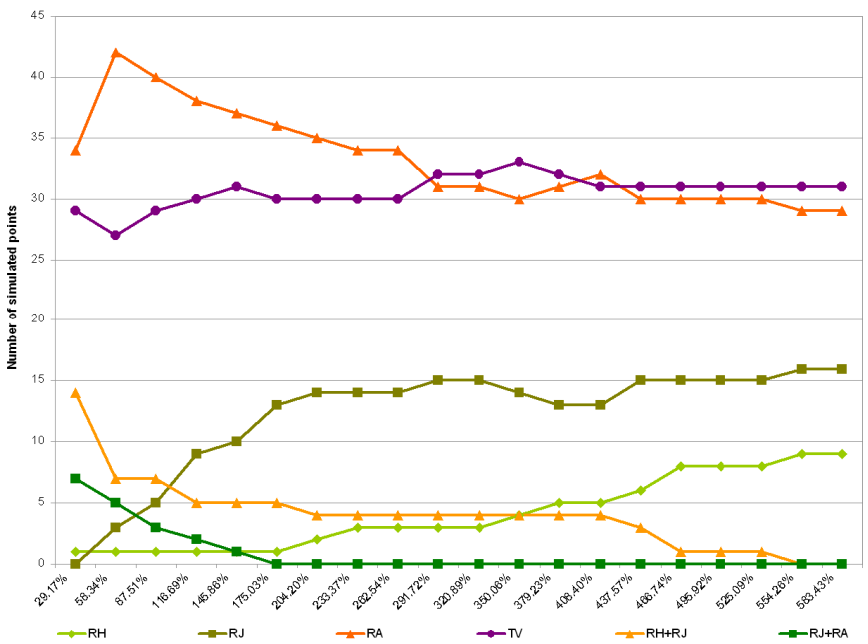
6. Results

6.4. Dam regulation + hydroelectric demand

V 20%

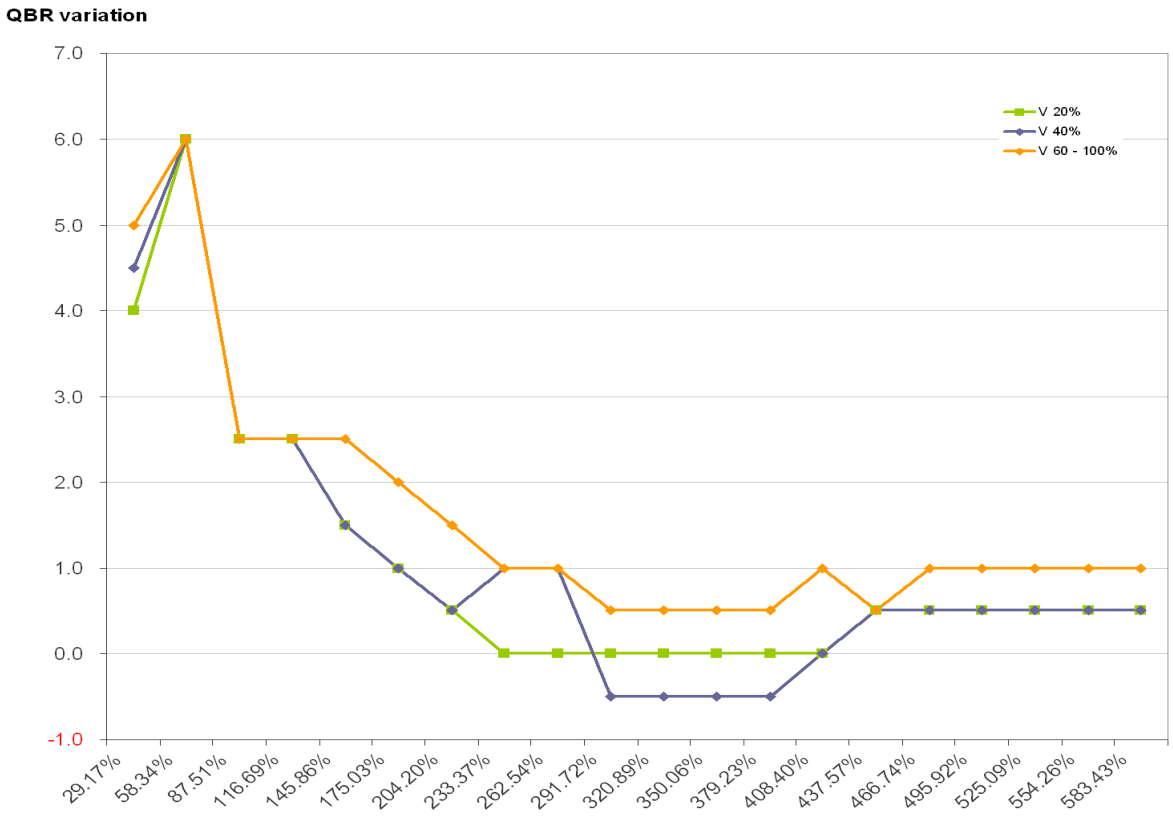


V 60-100%



6. Results

6.4. Dam regulation + hydroelectric demand



4. Conclusions

- Changes in Mediterranean semiarid hydrologic systems cause changes in river associated vegetation
- RibAV model is an useful tool for evaluating several anthropic impacts considering changes in hydrological regimes or changes in the climatic conditions
  - But some predictions should be qualified
- The QBR index is useful to determine riparian quality variations in different scenarios
  - But stretch QBR seems to be relatively insensitive
- Climatic change scenarios results show a greater presence of TV along the century and a reduction of riparian functional types
- Hydrologic regulation by dams (**w/o water consumption**) is not always unfavorable for riparian plants → more analysis is needed and/or Ripflow v3

UNIVERSIDAD POLITECNICA DE VALENCIA

Instituto de Ingeniería del Agua y Medio Ambiente

iwrm-net

Thank you for your attention

Alicia García Arias (algarar2@posgrado.upv.es)