AudiMod:

AudiMod: Spatial gains and losses

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ICATALIST

A methodology to audit modernisation projects from an environmental perspective

- Plan
  - AudiMod: the origins
  - AudiMod: the results
  - AudiMod: Lessons learnt and way forward

Plan

An Audit methodology of irrigation modernisation

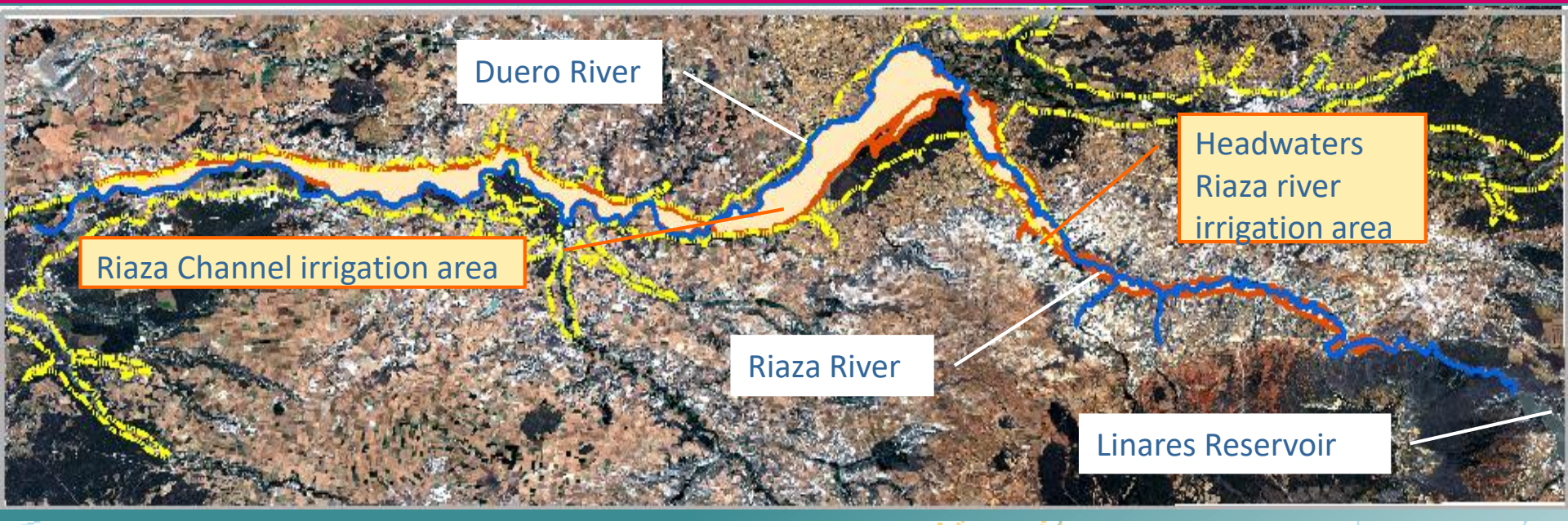
1.- **OBJECTIVE 1**: Estimate the **water demand** in irrigation áreas ex ante and ex post in modernisation.

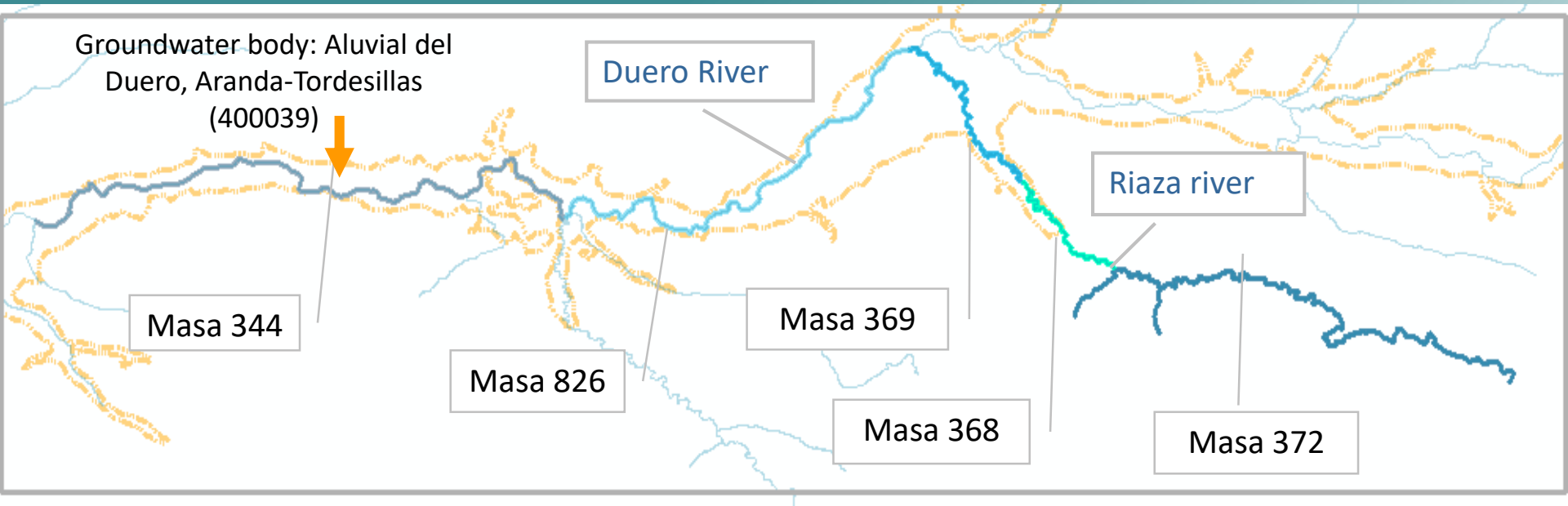
2.- **OBJECTIVE 2: Indicators** for follow up and evaluation: water bodies and overall/integrated analysis

~~(3.- **OBJECTIVE 3: Scenarios- management options**: reservoir management; climate change;…)~~

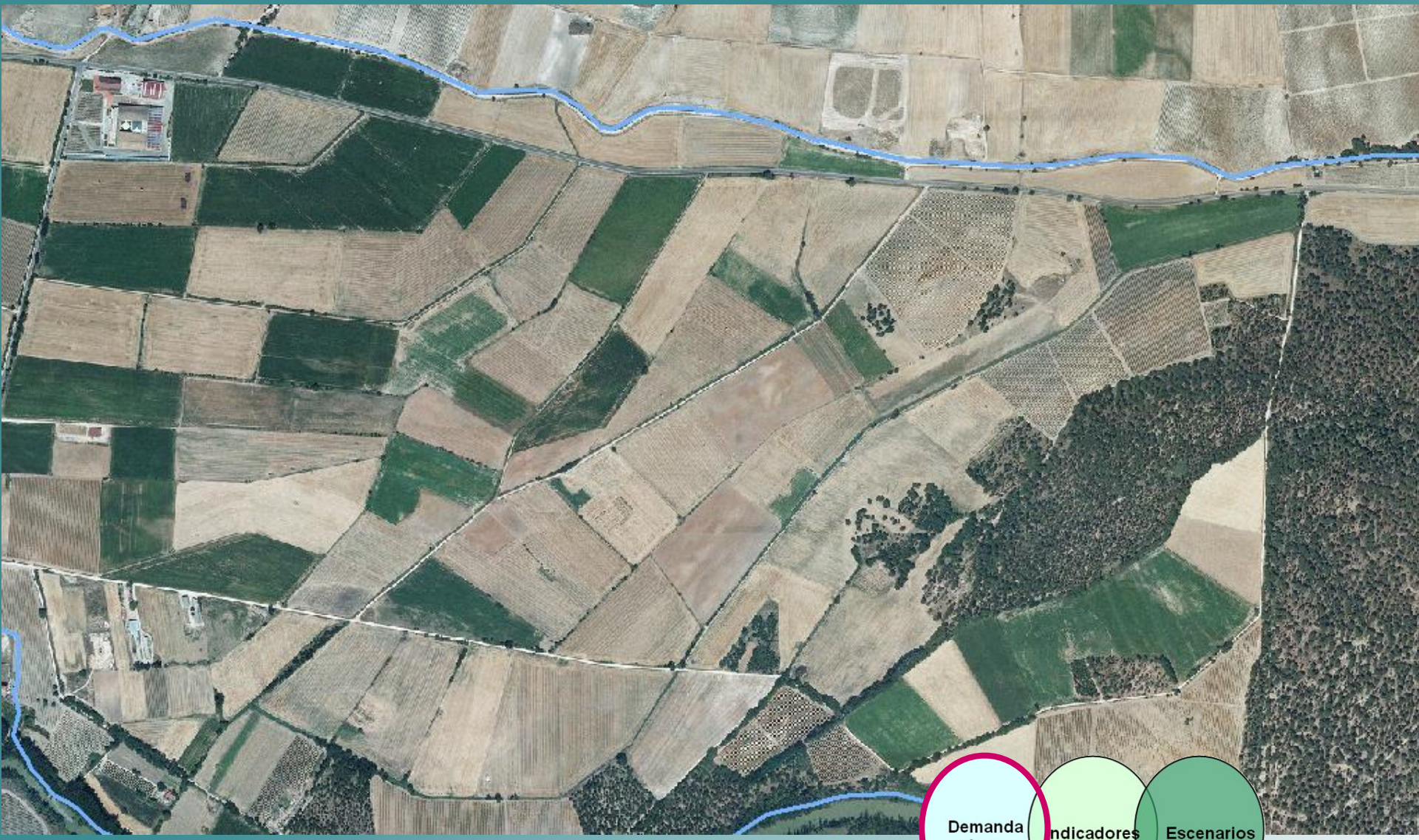
Case study area

Surface water bodies: 344, 826 (Duero) y 368, 369, 372 (Riaza)

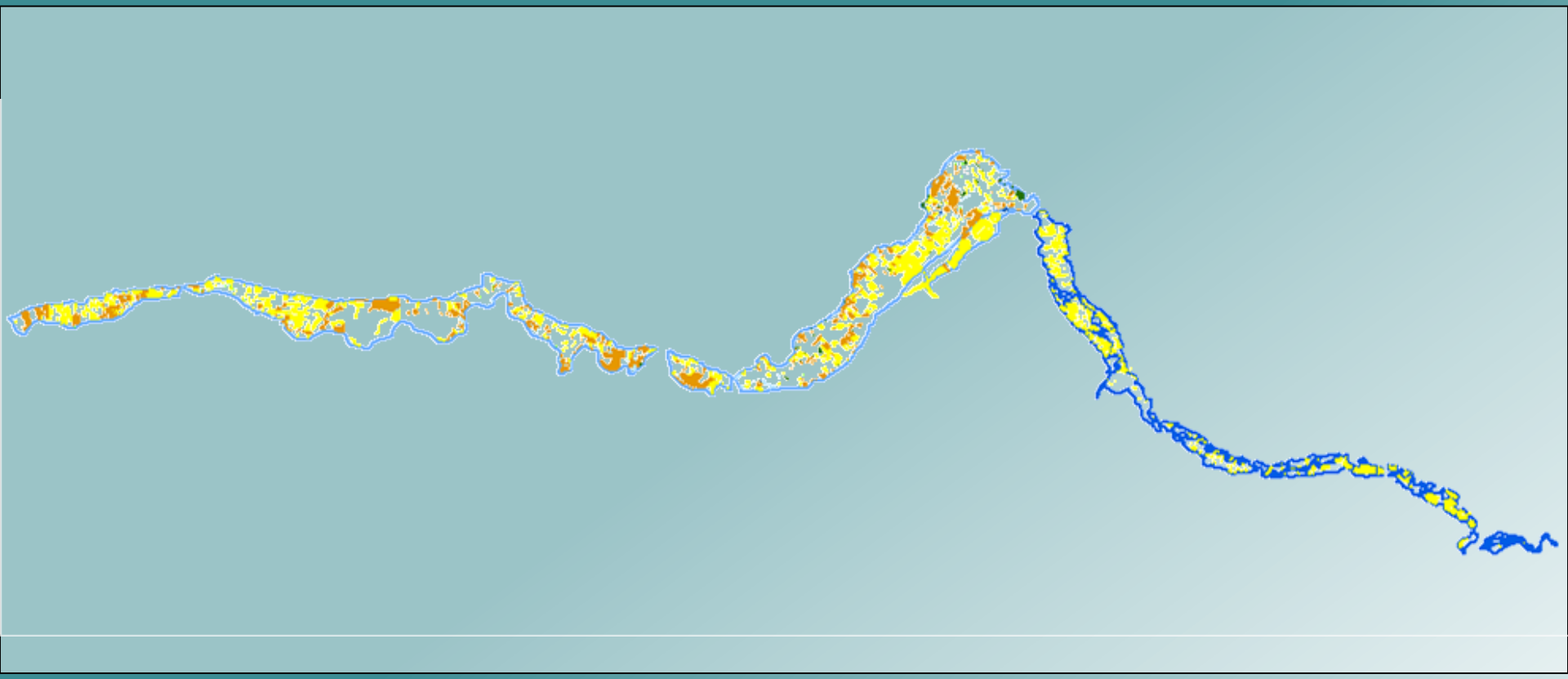




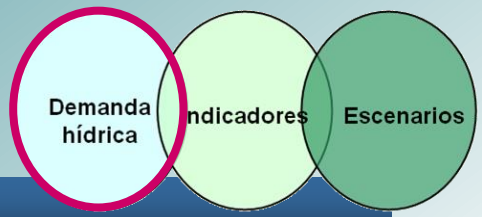
Objective 1: Estimate WATER DEMAND– Crop maps



Objective 1: WATER DEMAND– Crop maps



Summer Crops (case study area)



Objective 1: WATER DEMAND– Crop maps

Water rights (ha)	5.030,0
Total cultivated (ha)	4.463,8
Total could be cultivated (ha)	4.729,4
Irrigated área 2011-2014 (ha)	3.348,9

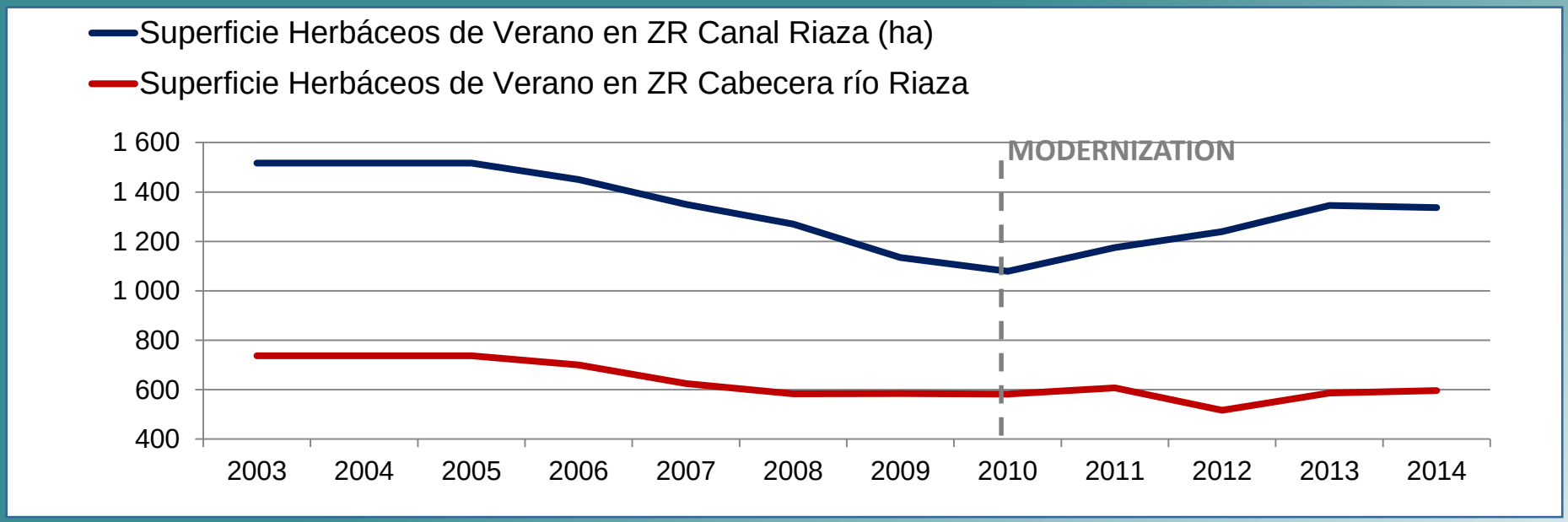
Land use 2014	
Surface Z.R Canal de Riaza	6.180,0
Spring crops	2.203,4
Summer arable crops	1.314,0
Irrigated Woody crops	882,6
Other Woody crops	10,9
Family orchards	8,9
Poplars	44,0
Fallow	265,6

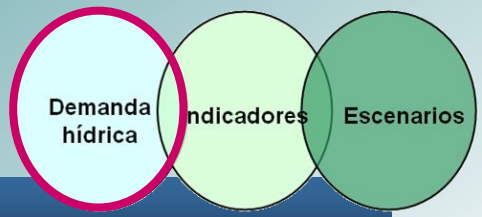
Herbaceous summer crops surface

	Channel HV	Channel Vñ	HV Headwaters
2003	1.405,0	747,3	736,5
2008	1.241,3	823,3	582,9
2009	1.161,8	833,1	583,9
2010	1.043,7	875,6	582,4
2011	1.048,2	879,8	606,8
2012	1.213,8	882,2	516,6
2013	1.306,0	889,1	586,0
2014	1.314,0	882,6	595,8

Results Objective 1: WATER DEMAND

CONCLUSIÓN: The methodology developed, based on the integrated use of remote sensing data and other complementary data, allows **the ex ante and ex post analysis of water demand for irrigation, on an objective basis.** The application of the methodology allows an improvement for knowledge on the **evolution of the water demand** within the modernized irrigated areas





Irrigation Modernization measures Audit: Methodological application to the Riaza river

Results Objective 1- summary: WATER DEMAND

CONCLUSION:

There are very high differences in the available figures on irrigation demand within irrigated areas. One part is due to the lack of differentiation between potential demand and actual annual demand.

- According to the **current Basin Plan**, the demand is **38.68 hm3**, with a reduction target for 2015 up to **30.93 hm3** by 2015, which according to the text "will have to check whether or not it is becoming effective"

The **concession** for the Riaza Canal Regiatable Zone establishes a maximum of **30.18 hm3**.

- The Commission for the Reservoir Management of the Linares del Arroyo reservoir established an average demand of **24.47 hm3** for the period 2008-2010 and of **12.35 hm3** for the period 2012-2013..
- The Regime Zone follow-up reports prepared by SEIASA quantify the water consumption for irrigation at 7.5 hm3 for 2011, and at 10.7 hm3 for the year 2012.
- The developed methodology (AudiMod) provides an estimate of the water derivation and with more stable values:

Volume derived from the Rio Riaza and Duero River (hm3) to meet the irrigation demand of the Canal de Riaza							
2003	2008	2009	2010	2011	2012	2013	2014
16,15	14,14	13,00	12,57	12,33	12,84	13,65	13,61

Objective 2: INDICATORS

1. **Indicators on the status of water bodies (PHD, 2013)**
2. **Other indicators with different angles:**

- Agronómic
- Agro-environmental
- Socioeconomic

AudiMod Riaza 2.0

"Performance indicators are not only tools of system diagnosis and planning, but also for management. Through an integration of the benchmarking approach and remote sensing an objective comparison is possible and areas for improvements can be identified. The adoption of benchmarking implies a continual process of measuring and comparing results and taking corresponding corrective actions"

(Stockholm Water Week, Sept. 2014)

Objective 2: INDICATORS WATER BODIES (IPH)

DATA

STATE OR ECOLOGICAL POTENTIAL

Biological quality indicators

- **Flora**
- **Fitobencton**
- **Benthonic fauna**
- **Invertebrates**
- **Ictiofauna**

Hydromorphological quality indicators

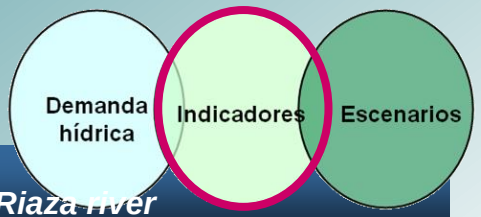
- **Hydrological regime: ecological flow**
- **Hydrological flow: IAH**
- **Hydrological flow: conenexón AASS**
- **Continuity: average length without barriers**
- **Continuity: type of barriers**
- **Morphology: indeex riberine vegetation**
- **Morphology: índex fluvial habitat**

STATE OR ECOLOGICAL POTENTIAL

Physico-chemical quality

- **Temperature**
- **Dissolved O2 disuelto and saturation rate**
- **Conductivity**
- **pH**
- **Nutrients (NH4, NO3-; PO4-)**
- **Non synthetic pollutants**
- **Synthetic pollutants**

CHEMICAL STATUS



Objective 2: AGRONOMIC INDICATORS

YIELD INDICATORS

Superficie regable (Sa)
Superficie regada (Sr) [anual]
Volumen derechos (Vr)
Volumen que entra al sistema (VT)
Volumen total que entra a la zona regable (VTT) [VT + P]
Volumen suministrado (Vs) [Volumen facturado a los regantes]
Evapotranspiración de los cultivos (ETc)
Precipitación efectiva (Pef)
Necesidades brutas (Nb)
Garantía de suministro (Sg) [VT/Vr]
Intensidad de cultivo (SrSa) [Sr/Sa]
Eficiencia de distribución (ED)
Suministro de agua por unidad de área regada (VsSr) [Vs/Vr]
Aporte relativo de agua suministrada (ARWS) [(Vs+Pef)/Etc]
Aporte relativo de agua de riego (ARIS) [Vs/(ETc-Pef)]

FINANCIAL INDICATORS

Costes de manejo del sistema (CMS)
Costes energéticos (CEN)
Costes no energeticos (CNEN)
Precio del agua (PA) pagado por cada agricultor [€/m3]
Costes de manejo del sistema por unidad de agua (CMSVs)
Costes de manejo del sistema por unidad de área regada (CMSSr)
Coste energético por unidad de agua de riego suministrada (CENVs)
Coste energético por unidad de área regada (CENSr)

PRODUCTION EFFICIENCY INDICATORS

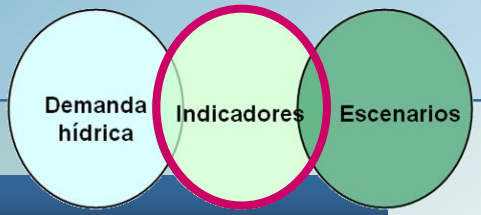
Valor producción agrícola (VP)
Margen bruto (MB)
Valor producción agrícola por unidad de agua demandada por los cultivos [VP/ETc]
Valor producción agrícola por unidad de agua de riego suministrada [VP/Vs]
Valor producción agrícola por unidad de superficie regada [VP/Sr]
Margen bruto por unidad de agua demandada por los cultivos [MB/ETc]
Margen bruto por unidad de agua de riego suministrada [MB/Vs]
Margen bruto por unidad de superficie regada [MB/Sr]

ENERGY USE INDICATORS

Potencia Contratada (Nc)
Energía consumida (Eac)
Potencia Contratada por unidad de área regada [Nc/Sr]
Energía específica [Eac/Vs]
Energía activa consumida por unidad de superficie regada [Eac/Sr]

FERTILISATION INDICATORS

Unidades de fertilizante de nitrógeno (UFN)
Conductividad Eléctrica (CE)
Unidad de fertilizante de nitrógeno por unidad de agua suministrada [UFN/Vs]
Unidad de fertilizante de nitrógeno por unidad de superficie regada [UFN/Sr]



INDICATORS

	CABECERA RÍO RIAZA		CANAL RIAZA	
	2003-2010	2011-2014	2003-2010	2011-2014
INDICADORES AGRONÓMIC IPTRID)				
Indicadores de Rendimiento Agronómico				
Superficie regable (Sa)	1.676,0	1.676,0	5.232,3	5.232,3
Superficie regada (Sr) [anual]	872,4	927,3	3.407,9	3.608,6
Volumen derechos (Vr)	8,92	8,92	30,18	30,18
Volumen que entra al sistema (VT)	6,59	5,05	13,97	13,11
Volumen total que entra a la zona regable (VTT) [VT + P]	9,92	8,38	24,38	23,52
Volumen suministrado (Vs)	5,19	4,55	12,25	11,80
Evapotranspiración de los cultivos (ETc)	4,61	4,90	12,72	13,25
Precipitación efectiva (Pef)	1,46	1,24	3,94	4,20
Necesidades brutas (Nb)	8,05	6,29	17,91	17,31
Garantía de suministro (Sg) [VT/Vr]	0,74	0,57	0,46	0,43
Intensidad de cultivo (SrSa) [Sr/Sa]	0,52	0,55	0,65	0,69
Eficiencia de distribución (ED)	0,79	0,90	0,88	0,90
Suministro de agua por unidad de área regada (VsSr) [Vs/Vr]	0,58	0,51	0,41	0,39
Aporte relativo de agua suministrada (ARWS) [(Vs+Pef)/Etc]	1,44	1,18	1,27	1,21
Aporte relativo de agua de riego (ARIS) [Vs/(ETc-Pef)]	1,65	1,24	1,40	1,30
Indicadores Económicos del riego				
Coste energético por unidad de agua de riego suministrada			0,051	0,042
Coste energético por unidad de área regada			277,8	207,9
Indicadores de Productividad del riego				
Valor producción por unidad de agua demandada cultivos	325.315	382.971	271.417	326.732
Valor producción por unidad de agua de riego [VP/Vs]	404.564	542.340	421.553	538.300
Valor producción por unidad de superficie regada [VP/Sr]	2.723	2.994	2.145	2.494
A) Indicadores Energéticos				
Energía consumida (Eac)	GASOIL	¿?	GASOIL	4.796.011
Energía activa consumida por superficie regada [Eac/Sr]				0,13
A) Indicadores de Fertilización				
Unidades de fertilizante de nitrógeno (UFN)	157.032,0	132.140,3	415.413,0	357.468,4
UFN por unidad agua suministrada [UFN/Vs]	0,030	0,029	0,034	0,030
UFN por unidad superficie regada [UFN/Sr]	180,0	142,5	180,0	142,5

+ AGRI-ENVIRONMENTAL INDICATORS

+ INDICADORS PLAN NACIONAL MODERNIZACIÓN (incl. SOCIO-ECONÓMIC…)

CONCLUSIÓN: Existing indicators relating to the follow-up of modernization projects are not particularly sensitive to changes in the state of the masses.

Objective 2: INDICATORS

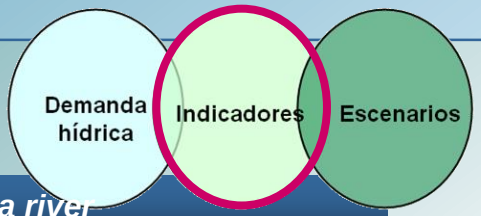
1. **Substantive results Riaza river :**

a) **Has modernisation affected the status of water bodies?**

b) **Are these indicators adequate to measure impact of the measure of irrigation modernisation?**

List key indicadors (+ necessary data and how to measure them)

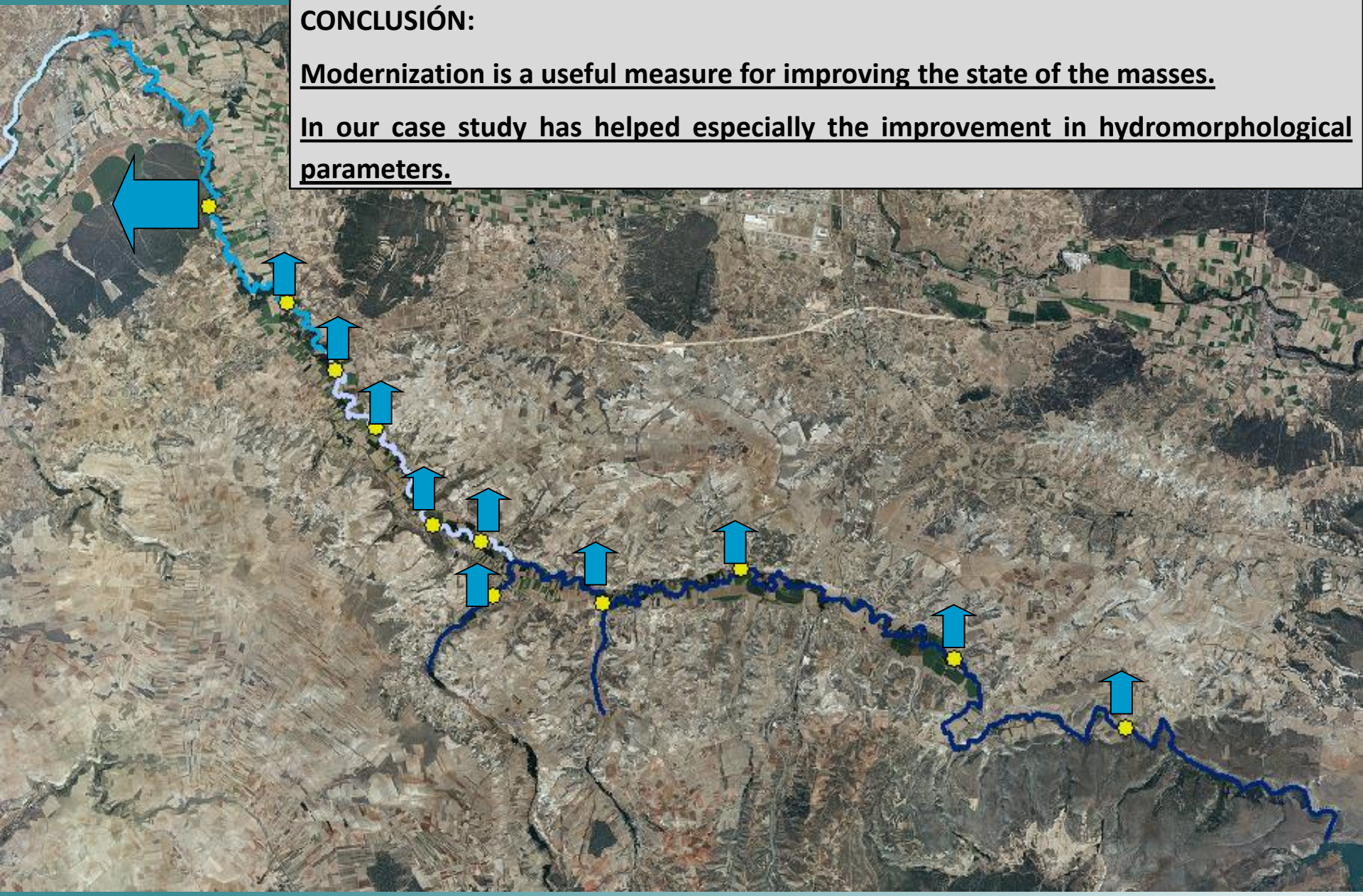
2. **AudiMod Methodology can it be extrapolated (Benchmarking Potential CHD Modernizatios)**



CONCLUSIÓN:

Modernization is a useful measure for improving the state of the masses.

In our case study has helped especially the improvement in hydromorphological parameters.



CONCLUSIÓN:

Modernization is a useful measure for improving the state of the masses.

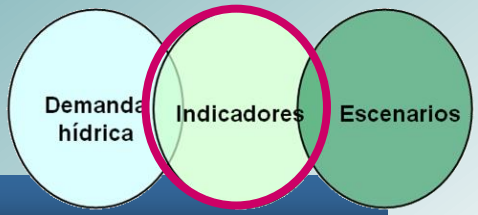
In our case study has helped especially the improvement in hydromorphological parameters.

Results Objective 2: INDICATORS

		WATER BODY 72		WATER BODY 68		WATER BODY 369		
		2003-2010	2011-2013	2003-2010	2011-2013	2003-2010	2011-2013	
1. CLASSIFICATION ECOLOGICAL STATUS (ACCORDING TO WFD)								
PHYSICO-CHEMICAL STATUS								
		VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	=
BIOLÓGICAL STATUS								
IBMWP (Fauna bentónica)	Value	[76/**114**/163]	**143**	[158/**172**/187]	**92**	[127/**138**/154]	[128/**131**/133]	
	Class	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	=
IPS (Fitobentos)	Value	**19,6**	**15,6**	[9,4/**13,6**/15,8]	[14,6/**15,4**/16]	[13,0/**15,0**/17,0]	[17,6/**17,9**/18,2]	
	Class	VERY GOOD	GOOD	GOOD	GOOD	GOOD	VERY GOOD	
HYDROMORPHOLOGICAL STATUS								
IAH (Alteración Hidrológica)	Value	-	**1,13**	**1,29**	**1**	**2,06**	**1,09**	
	Class		**BUENO**	GOOD	**VERY GOOD**	MODERATE	**VERY GOOD**	
IC (Índice Compartimentación)	Value	**7,79**	**5,39**	**36,42**	**28,61**	**13,98**	**13,98**	
	Class	MODERADO	**BUENO**	MODERATE	MODERATE	MODERATE	MODERATE	=
ICLAT (Índice Continuidad Lateral)	Value	**0**	**0**	**0**	**0**	**0**	**0**	
	Class	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	=
QBR (Índice de vegetación de ribera)	Value	[25/**35**/45]	**35**	**50**	**45**	**64**	**64**	
	Class	BUENO	BUENO	GOOD	GOOD	VERY GOOD	VERY GOOD	=
IHF (Índice de Hábitat Fluvial)	Value	[53/**65**/73]	**51**	**65**	[65/**72**/78]	[72/**74**/76]	**75**	
	Class	VERY GOOD	GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	=
2. CLASSIFICATION CHEMICAL STATUS								
ESTADO QUÍMICO		VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	=

Results Objective 2: INDICATORS

Type of water body	Código	Status 2009	Status 2012	Status 2014	Status
Surface	372	Worse tan good	Worse tan good	Good (*)	Good
	368	Worse tan good	Worse tan good	Worse tan good	Very good
	369	Worse tan good	Worse tan good	Worse tan good	Very good
	826	Worse tan good	Worse tan good	Worse tan good	Worse tan good
	344	Worse tan good	Worse tan good	Worse tan good	Worse tan good
Groundwater	400039	Bad	Bad	Not analised	Not analised

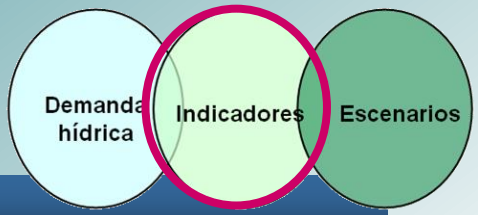


Results Objective 2: INDICATORS

CONCLUSION: Modernization is a useful measure for improving the state of the water bodies.

In our case study has helped especially the improvement in hydromorphological parameters.

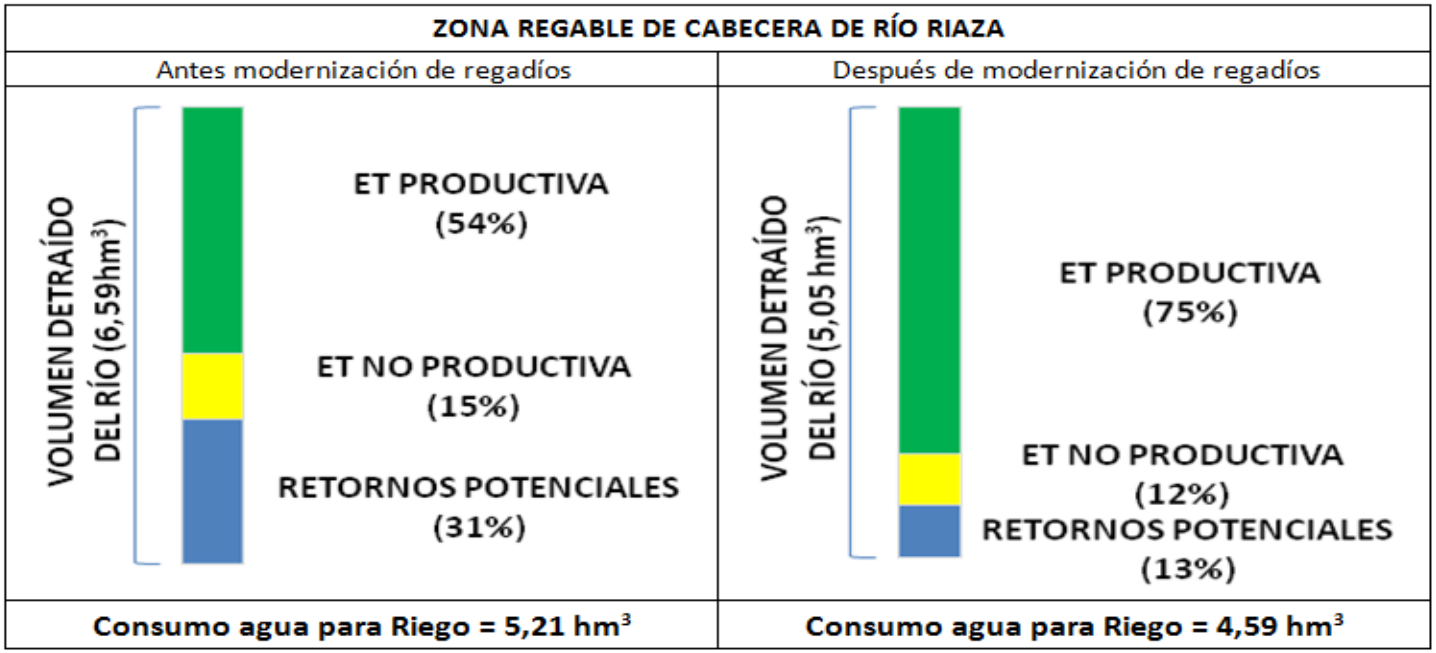
In addition, from the reduction in demand, or a better distribution in the number of shots, modernization can enable other actions (such as the demolition of obsolete dams) with potential to improve the state of the masses .



Results Objective 2: INDICATORS

INDICATOR 1: WATER CONSUMPTION FOR IRRIGATION (quantity pressure)

	CABECERA RÍO RIAZA	
	2003-2010	2011-2014
A) Agronomic performance indicators		
Water consumption for irrigation (CR)	**5,21**	**4,59**
Irrigated área summer herbaceous crops (SrV)	621,4	576,3
Irrigated área (Sr) [annual]	872,4	927,3
Volume that enters the irrigation área (VT)	6,59	5,05
Volume supplied (Vs)	5,19	4,55
Evapotranspiration from the crops (ETc)	4,61	4,90
Irrigation water use efficiency	0,577	0,656



CONCLUSIONS: INDICATORS

CONCLUSIÓN:

The administrative concession is a fundamental document for the analysis, and if possible, the revision of some of its conditions can significantly help the state of the water bodies.

INDICATOR 3: CHANGES IN WATER UPTAKES (water concessions)

	CABECERA RÍO RIAZA		CANAL RIAZA	
	2010	2014	2010	2014
Changes related to the water connectivity				
Operational small weirs	8	1	1	1
Nº weirs that limit connectivity	8	6	1	1
Changes related to the water rights				
Water rights	8,915	8,915	30,18	30,18
Nº water bodies in good or very good status	+ 1		+1	
Delimitactón área with irrigation rights				

CONCLUSIONS

- Is there a *widespread uncritical approach to irrigation efficiency*? Looking at modernisation measures from an environmental perspective sheds news light on other angles beyond “water savings”

- What are the *alternative pathways to approach water savings* Beyond water savings: The river system itself (hydromorphological connectivity)- an alternative “Green” pathway to consider modernisation

- Who gets the *environmental share of the future savings* (e.g. the paracommons) - The importance of good institutions to anticípate the paracommons

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