The impacts of climate change and variability in Portugal: key points regarding the transboundary rivers shared with Spain

António Guerreiro de Brito[1], Manuel Ruano Lacerda[2]

[1] River Basin Administration North, R. Formosa – Oporto / University of Minho, Braga, agbrito@deb.uminho.pt

[2] River Basin Administration Tejo, R. Braancamp – Lisbon, manuel.lacerda@arhtejo.pt

1. Expected impacts of climate change and climate variability on water resources in Portugal and deriving impacts on society and economy

In general, the **water resources balance** in Portugal is characterised by a demand that is largely exceeded by the available surface and groundwater water resources (≈36.400 hm^3/year). However, there is a significant inter-annual unevenness of precipitation and there is no temporal coincidence between the monthly demand and the resources availability. Like other Mediterranean countries, Portugal faces a strong decline of rainfall in summer, which goes along with the reduced runoff on water courses. In addition, the average rainfall in river basins (960 mm/year), decreases from the North (2200-3000 mm/year) down to the South (570-450 mm/year). This pattern of asymmetry is significant also between the coastal areas and some areas of the interior, which tend to be waterless. All these circumstances compelled to the implementation of an expanded system of reservoirs in order to grant all water allocations, mainly irrigation but also drinking and hydroelectricity.

In Portugal, the **climate change forecast** until the end of this century is not full clear yet. Most models converge to an average air temperature increase up to 6%, a decrease of the annual precipitation between 5-25% and a reduction in the annual flow up to 30%. The uncertainty regarding these values is very significant. In fact, some scenarios even suggest a tendency for an increase of the winter precipitation that will overcome the summer reduction, resulting in a net annual flow increase. The foreseen concentration of the precipitation intensity in winter may increase the frequency and the magnitude of the extreme events and flooding phenomena. Furthermore, the rise of the mean sea level will aggravate this risk due to the reduction of the river flow capacity. On the other hand, the increase of the temperature and reduction of the precipitation expected along the summer can aggravate the risk of severe droughts. Therefore, Portugal is not a resilient and a water-proof country regarding climate change. Most probably, the most important conclusion is just to perceive the climate vulnerability as an opportunity towards an efficient use of natural resources.

As for the **economic sectors** and climate change, the expected impacts mediated by water rely on following elements:

Water supply and wastewater services - Increase of the water scarcity risk and raw water contamination and an increase of facilities flooding risk;

Agriculture - Increase of water demand for irrigation and a reduction of agriculture productivity;

Energy- Reduction of power generation and hydro-electrical potential, problems on thermoelectric power stations functioning and increase of water management conflicts in multipurpose infrastructures, including ecosystems services;

Coastal areas - Increase of coastal erosion risk (already very problematic) leading to changes on the coastal morphology;

Tourism - Changes on attractiveness and demand on tourism areas, changes on seasonal spread of tourist flows and, consequently, on pressures on water resources;

Aquatic ecosystems - Changes on the freshwaters and associated terrestrial ecosystems. Among the future scenarios, the migration to the north or in altitude of species not adapted to warmer conditions may be expected.

2. Portugal and Spain cooperation in addressing climate impacts

In the Iberia peninsula, Portugal and Spain share **5 transboundary water courses** (Minho, Lima, Douro, Tejo and Guadiana rivers). Portugal is the downstream country and 64% of the surface water inflow to its territory comes from river basins shared with Spain. The average annual precipitation in those international river basins is 182 250 hm^3, out of which 70% corresponds to the wet semester in both countries, and the average annual runoff is about 63.100 hm^3.

The hydro-political issues among the two riparian countries are well known since a long time. The discussion over transboundary Portuguese-Spanish water courses had its first step in the Treaty of Limits of 1864, which defines hydro-boundaries and principles for water uses on boundaries stretches in accordance with the concept of mutual benefit and no damage. In 1927, the first bilateral Agreement regarding a river boundary stretch for a specific use was signed aiming at a hydroelectric equity exploitation of Douro river. However, despite the signs of co-development assigned in subsequent water treaties, only in 1998, a modern framework on cooperation for promotion and protection of good surface water and groundwater status of river basins and for mitigating the effects of floods and droughts was signed, the *Convention on Co-operation for Portuguese-Spanish River Basins Protection and Sustainable Use*, the so-called **Albufeira Agreement**. The Agreement entered into force in 2000 and defined two governance bodies with a peer character, namely the *Conference of the Parties* and the *Commission for the Application and Development of the Agreement.* The Commission is the framework for monitoring and controlling the management process, the first stage for solving conflicts and is based on a consensus method for decision-making.

In 2008, the Albufeira Agreement was amended and the **driver of change was the water scarcity**. The guaranteed minimum annual water flow regimes were complemented by minimum trimester flow regimes for Minho, Douro Tejo and Guadinana rivers, as well as minimum weekly flow regimes (in Douro and Tejo rivers). The annual and trimester values were guaranteed, but exceptional situations were considered in situations of low precipitation. In the case of Guadiana river basin, located on the south and the driest part of the territory, both annual and trimester flow regime definition are dependant on referenced precipitation values and on the water storage volume in referenced Spanish reservoirs. Since 2000, a few violation episodes of the Agreement occurred and the 2008 amendment confirm that bilateral water policy is a demanding and challenging task and is a staged process based on hydrologic knowledge, good rules and trust. A new forward move can be foreseen: the need of a sound definition of *ecological flows* and the assessment of their correspondence with the settled *minimum flows*, in order to guarantee the good ecological status in estuarine zones.

Besides the role played by the Commission, the transboundary river basins management is assured by River Basin District institutions and by Portuguese and Spanish national water authorities. A fruitful cooperation among river basin authorities was noticed since 2008, stimulated

by the preparation of the River Basin Management Plans (RBMP) that are mandatory by the EU Water Framework Directive (WFD).

Regarding **climate change impacts**, one should recognize that the issue hasn't been jointly discussed by Portugal and Spain, either by regional or national authorities. Nevertheless, as the 1st WFD management cycle will end in 2015 and the preparation of the 2nd cycle is about to begin, the cooperation between the two countries will be strengthened with the shared development of only one RBMP in each transboundary river basin district. In this context, water issues related to climate change as land use and water demand/supply management should be assessed. Two points should be highlighted:

- Identification of the most **cost-effectiveness** of adaptation measures under climate variability and related uncertainty. In that regard, water allocation for agriculture and agro-industry and the need for **water demand management** is a key point in the periodic framework of severe droughts that both countries face;

- The **sustainability of investments** over the RBMP entire lifetime, taking explicit account of climate change scenarios must be considered explicitly, namely in hydropower schemes. The programmes of measures should be flexible and robust enough to cope with changing conditions; on the other hand, it needs to be ensured that measures do not run counter to adaptation objectives.

In conclusion, the main reason behind water conflicts is always a water shortage problem. Therefore, the optimum use of water should the first strategy for anticipating problems and to find an environmental approach for management of shared resources. However, this technological approach is not sufficient in water policy: a **good water governance** framework is decisive.

3. Adaptation measures implementation in Portugal.

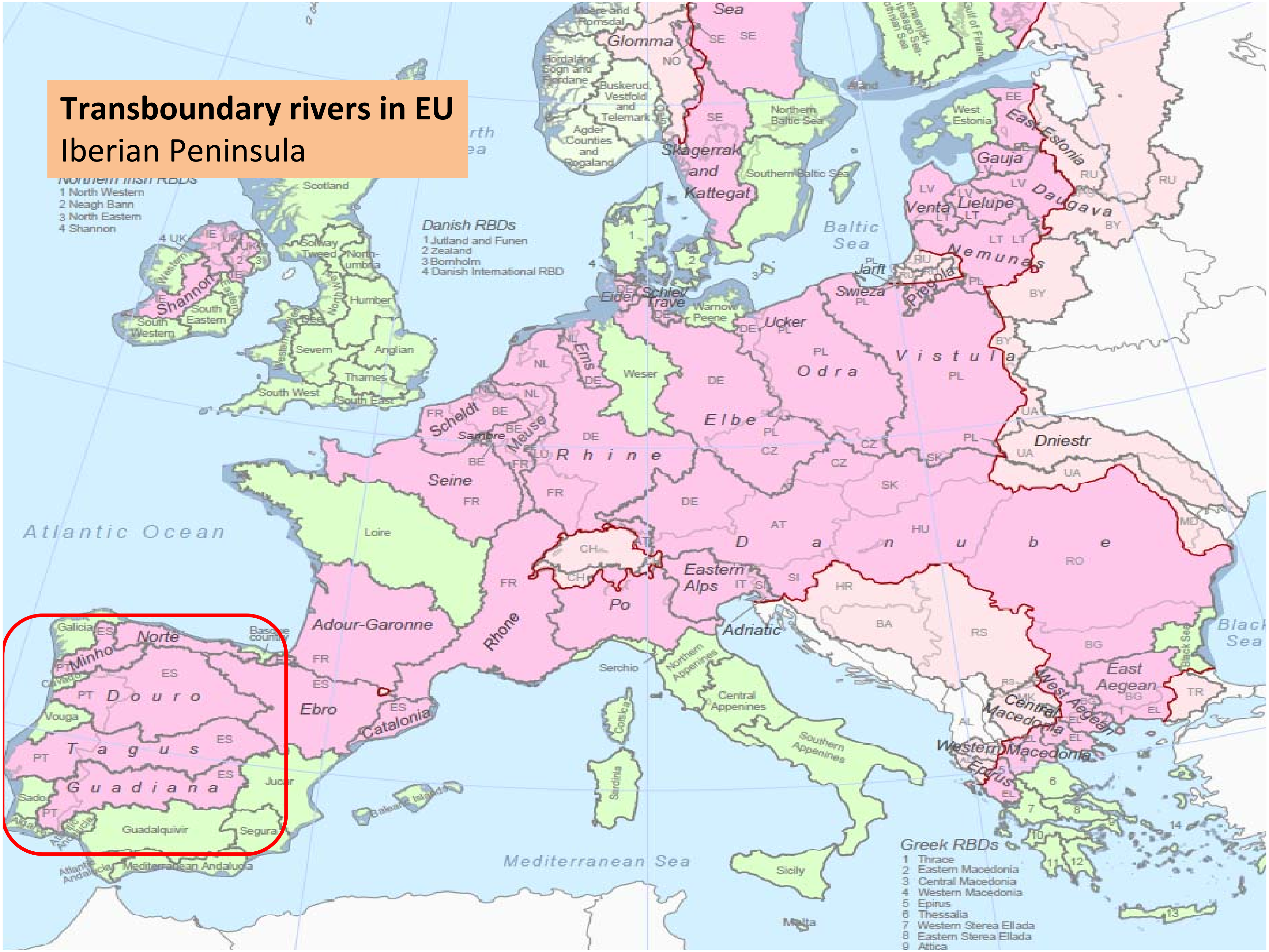
The approach presented in the first generation of portuguese River Basin Management Plans (RBMP), which are now under public consultation, is very preliminary regarding the implementation of adaptation measures and with low detail regarding the scale of analysis. Nevertheless, as mentioned before, the next generation of RBMP should cope with climate change scenarios not only on its development but also on its implementation and monitoring follow-up, ensuring that the programme of measures are *climate resilient* as a default. Therefore, an attempt should be made to carry out an assessment of the current **programme of measures of the RBMP**, which should focus on which measures are enhancing or weakening the adaptative capacities, which measures can be considered as *no regret* or *win-win* solutions, or which measures will be less robust in their effectiveness to achieve the WFD objectives because of climate change. Moreover, the long term surveillance **monitoring** could become more targeted for detecting climate change trends and impacts on water resources in order to improve the data basis for decision-making. Indeed, climate change does not affect the principle of water status assessment, although potentially all quality elements included in the definition of WFD ecological status are sensitive to it, as well as some typology parameters related to meteorological variables. In this context, the reference conditions for some sites can be revised as part of the RBMP characterization, supported on a dedicated monitoring program.

It is also important to develop **strategies for adaptation aiming for multi-sectorial synergies**, namely the link between water resources planning and the water-related sectors policies, such as agriculture, electricity production, inland navigation, tourism, land-use planning, etc. Likewise, other existing water related legislation, programmes and strategies should be considered on the water resources planning and management scene. This approach is committed to a participatory process

at all levels, from the public administration to the civil society. Only an integrated perspective will provide successful solutions and avoid negative cross-sectorial feedbacks or non-action in one sector.

In terms of **adaptation measures** in Portugal, along 2009 and 2010 a nationwide effort was concerned with groundwater water resources protection. The goal was to identify private abstractions in order to discipline permits and to preserve those sources to use whenever necessary. Around two hundred thousand abstractions were recorded. Regarding the hydromorphology adaptation, an effort to introduce ecological flows, fish passages in all dams and the dismantlement of some small dams is being carried out in order to favour river connectivity, but success is limited yet. Besides, knowledge acquisition regarding climate change and adaption of water related impacts are being encouraged by research institutions and a National Strategy is under preparations by the national water authority. Those are good initiatives but not enough in our opinion: **a comprehensive bilateral agenda for the integrated water and management of the Portuguese and Spanish shared watersheds should start immediately.** Therefore, a climate check on the existing RBMP should be made as soon as possible, in order to prepare the multinational plans that should be jointly presented in 2015.

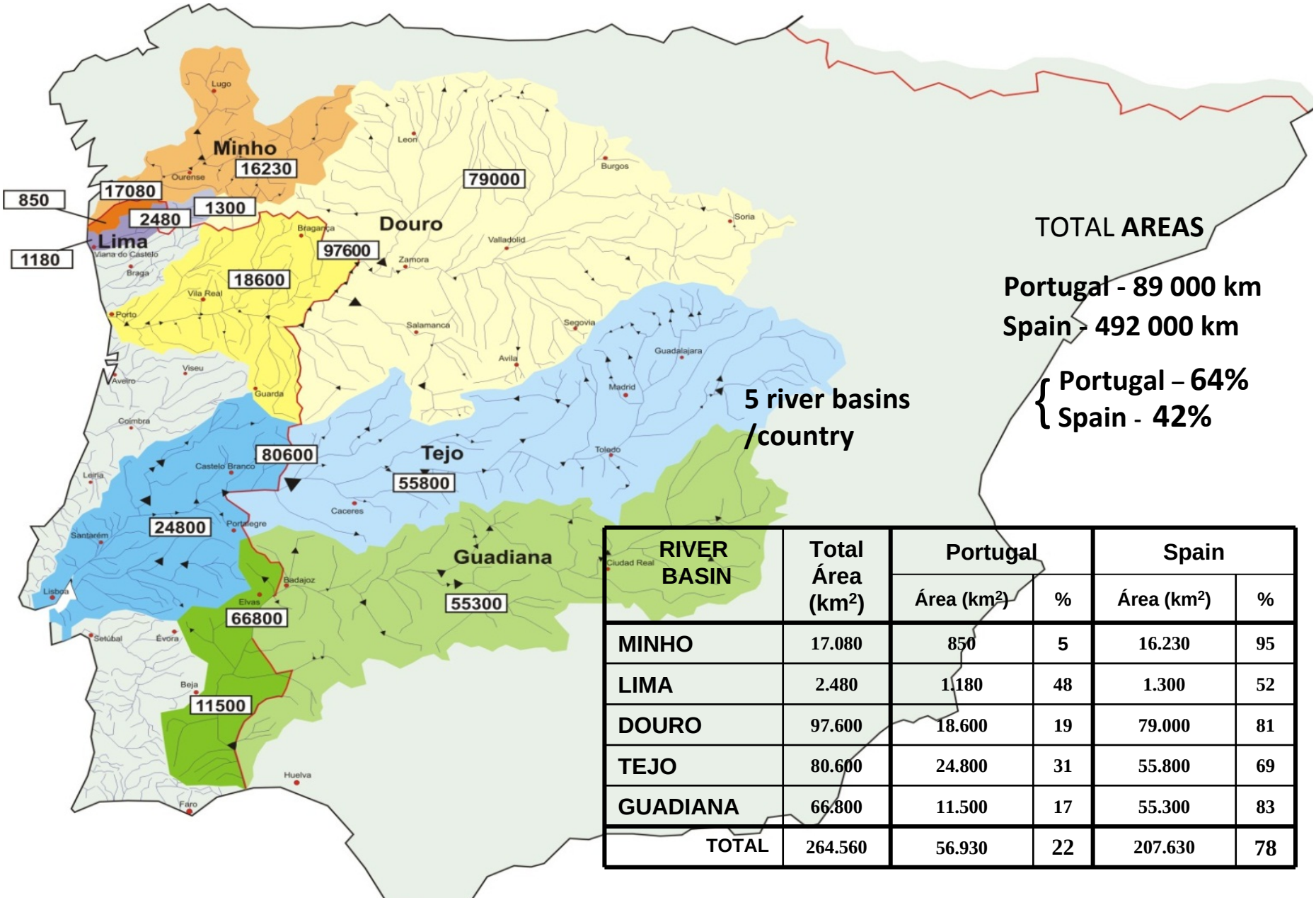
Transboundary rivers in EU
Iberian Peninsula



Impact	Impacts of Climate Change		
	Trend	Causes	Sectors
Water quantity availability	⬇	• Decrease in annual precipitation values • Increase rainfall variability • Increasing asymmetry of regional precipitation • Increasing asymmetry of the seasonal rainfall	• Drinking water services • Agriculture • Hydropower
Surface water quality	⬇	• Decreased flow • Increase in water temperature • Increase in diffuse pollution loads	• Recreational uses • Ecosystems services and biodiversity
Groundwater quality	⬇	• The rising sea level • Increased evapotranspiration • Decrease in recharge	• Local water irrigation • Water security under droughts
Flood risk - Flash floods	⬆	• Increased variability in rainfall regime • Increase of the maximum values of precipitation (North country)	• Coastal areas • Cities


N
1:4.300.000
50 25 0 50 100
Km

Portugal | Spain
5 shared river basins



TOTAL **AREAS**

Portugal - 89 000 km

Spain - 492 000 km

Portugal – 64%

Spain - 42%

5 river basins /country

RIVER BASIN	Total Área (km^2)	Portugal		Spain	
		Área (km^2)	%	Área (km^2)	%
MINHO	17.080	850	5	16.230	95
LIMA	2.480	1.180	48	1.300	52
DOURO	97.600	18.600	19	79.000	81
TEJO	80.600	24.800	31	55.800	69
GUADIANA	66.800	11.500	17	55.300	83
TOTAL	264.560	56.930	22	207.630	78

Convention on Co-operation for Portuguese-Spanish River Basins Protection and Sustainable Use - Albufeira Agreement

CADC - Commission for the Application and Development of the Agreement