Incorporating the Water Footprint and Environmental Water Requirements into policy :

Reflections from Doñana National Park (Spain)

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Re-thinking water and food security paradigms
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Water Footprint

Fundación Marcelino Botín

Water Footprint NETWORK

Overview presentation

1. EWR: Theory and definitions
2. EWR: Doñana National Park
3. Concluding remarks



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EWR

Theory and definitions

EWR: Theory and definitions

Environmental flow

water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits (Dyson et al., 2003).

Environmental flow (or water) requirement

the quantity, quality and timing of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (The Brisbane Declaration, 2007).

EWR: Theory and definitions

EWR assessment methods

	Description	Duration of assessment (months)	Major advantages	Major disadvantages
Hydrological Index	- Based on historical flow records -EFR a percentage of average annual flow or percentile from the low duration curve on an annual, seasonal or monthly basis - Minimum flow requirement	½	Low cost, rapid to use	Not site-specific, ecological links assumed
Hydraulic rating	-Based on historical flow records - Assume hydraulics (wetted perimeter, depth, velocity) - habitat availability links - Optimal minimum flow - Absorbed within Habitat simulation or Holistic methods	2-4	Low cost, site specific	Ecological links assumed
Habitat simulation	-Based on hydrological, hydraulic and biological response data - Model links between discharge, habitat conditions and their suitability to target biota	6-18	Ecological links included	Extensive data collection and use of experts, high cost
Holistic	- Based on hydrological, hydraulic and habitat simulation models.	12-36	Covers most aspects	Requires very large scientific expertise, very high cost, (not operational)

Source: based on Korsgaard, 2006

EWR: Theory and definitions

Global assessment Smakhtin et al. (2004)

EWR = LFR + HFR

Low flow requirement (LFR)

LFR = Q90 (monthly flow that is exceeded 90% of the time)

Q90 mostly falls between 0 and 50% of mean annual runoff (MAR)

High flow requirement (HFR)

Highly variable flow regimes	Q90 < 10% MAR	HFR = 20% MAR
	10% MAR < Q90 < 20% MAR	HFR = 15% MAR
	20% MAR < Q90 < 30% MAR	HFR = 7% MAR
Very stable flow regimes	30% MAR < Q90	HFR = 0

Source: Smakhtin et al. (2004)

EWR: Theory and definitions

Source: Smakhtin et al. (2004)

EWR: Theory and definitions

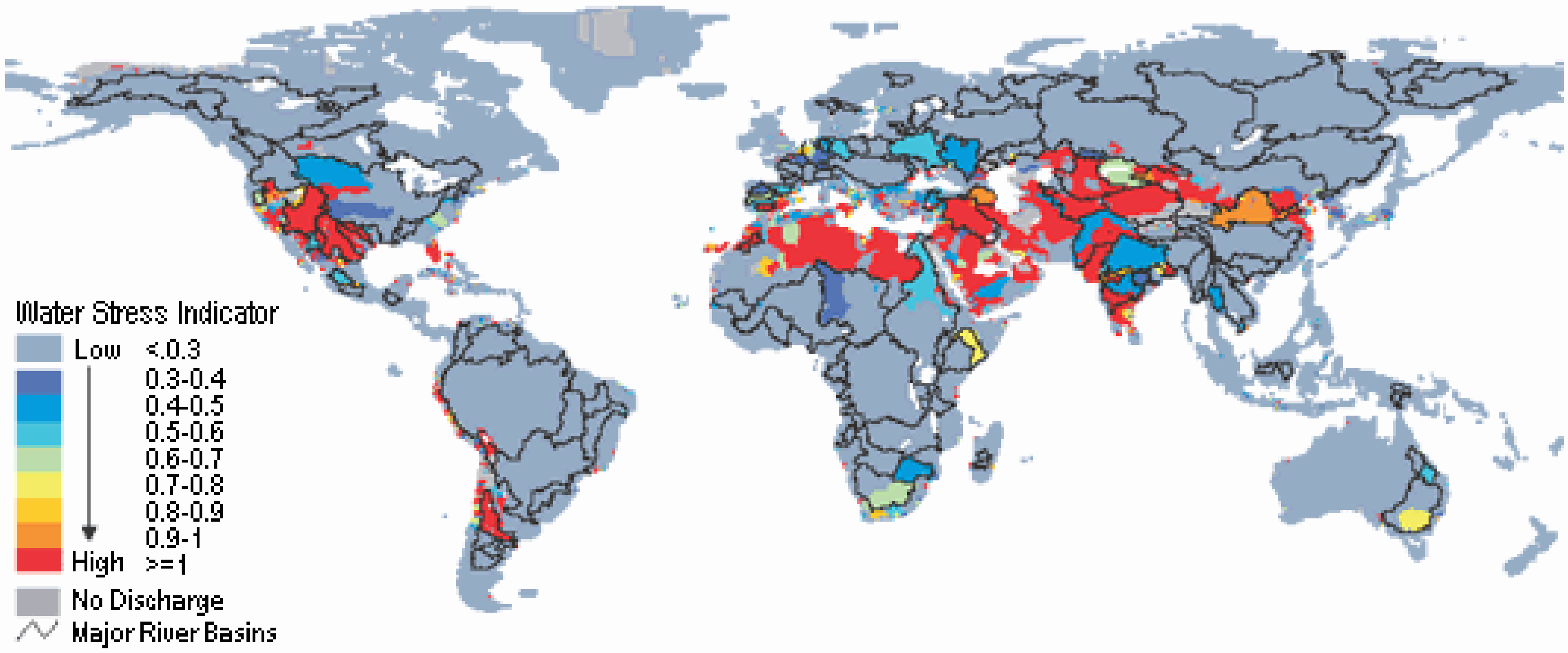
Water scarcity taking EWR into account

the proportion of water withdrawal with respect to water available to human use. Water available to human use is equal to the total amount of water available in the basin minus the estimated environmental water demand (the water needed by the ecosystem to sustain its integrity) (Smakhtin et al., 2004).

EWR: Theory and definitions

Water scarcity: The Traditional View

Human Water Stress by River Basins
Water Use as a Proportion of Total Water Availability

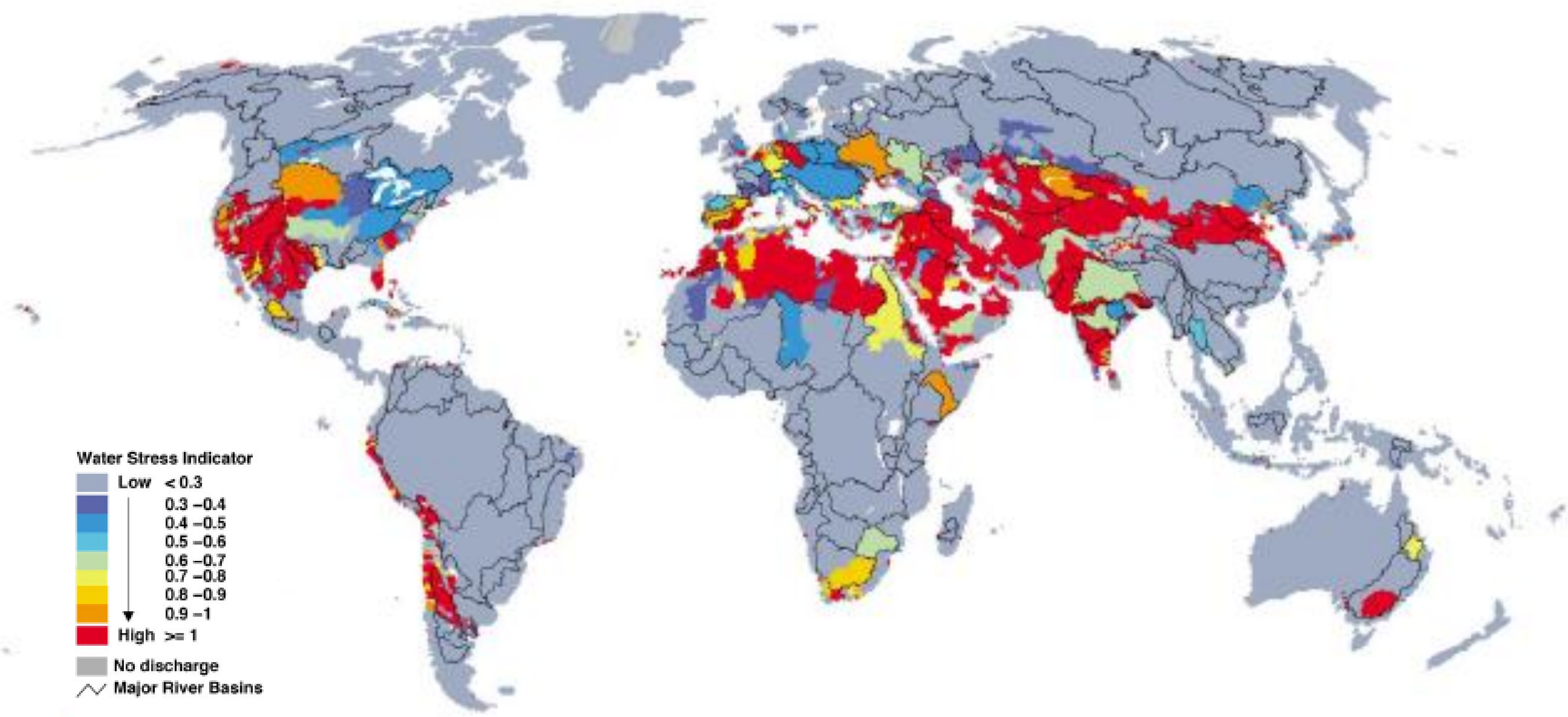


Source: Smakhtin et al. (2003)

EWR: Theory and definitions

Water scarcity: Taking Environmental Water Requirements into Account

Human infringement on Environmental Water Demand
Water Withdrawal as a Proportion of Water Available for Human Use



Source: Smakhtin et al. (2004)

EWR: Theory and definitions

Proportions between blue and green water use worldwide

Flow domain	System	Annual freshwater withdrawals/use (km^3/yr)	% of rainfall
Direct blue	Food	1800	2
	Domestic + industry	1300	1
Indirect blue	Instream ecology		
	remaining time-stable runoff	9400	8
	flood runoff	30150	27
	subtotal blue flow	**42650**	**38**
Direct green	Food	5000	4
	Permanent grazing	20400	18
Indirect green	Grasslands	12100	11
	Forests and woodlands	19700	17
	Arid lands	5700	5
	Wetlands	1400	1
	Lake evaporation	600	1
	Evaporation from reservoirs	160	0.1
	Green ares in urban settlements	100	0.1
	Unaccounted green flow	5690	5
	Subtotal green flow	**70850**	**62**
Total		113500	100

Source: Falkenmark and Rockström (2004)



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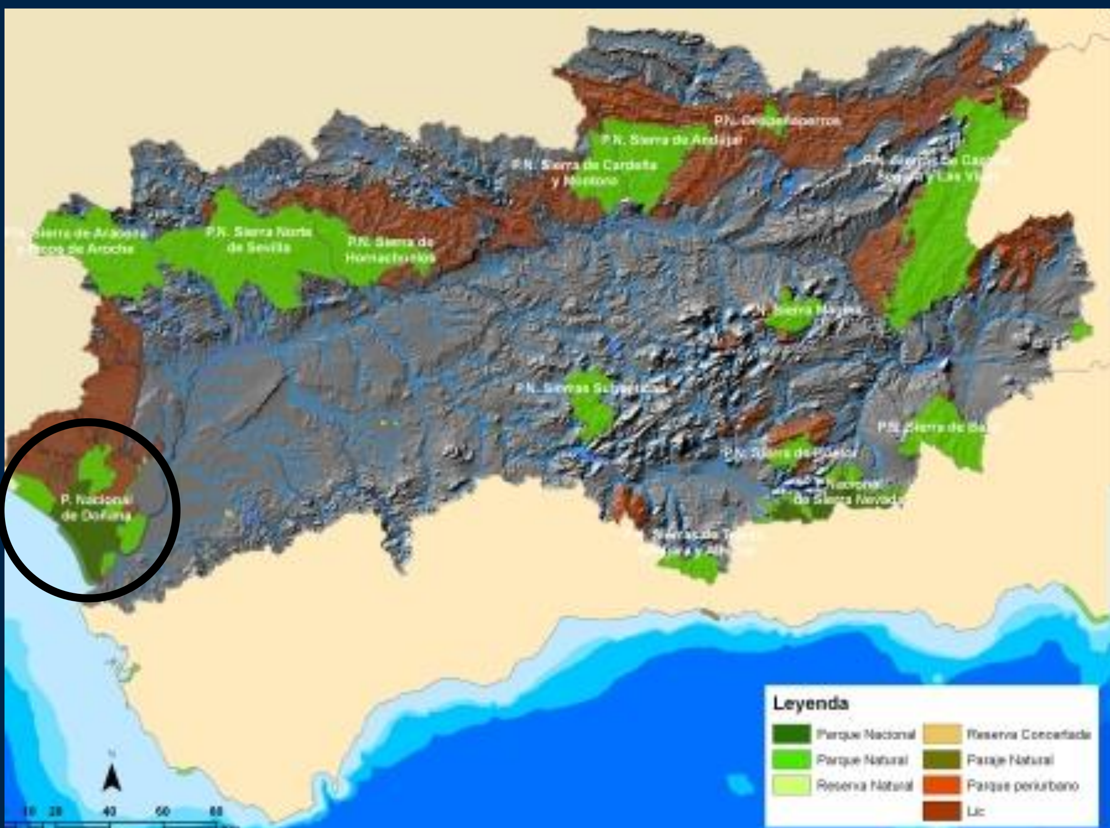
EWR

Doñana National Park

EWR: Doñana National Park

Doñana and Guadalquivir basin (Spain)

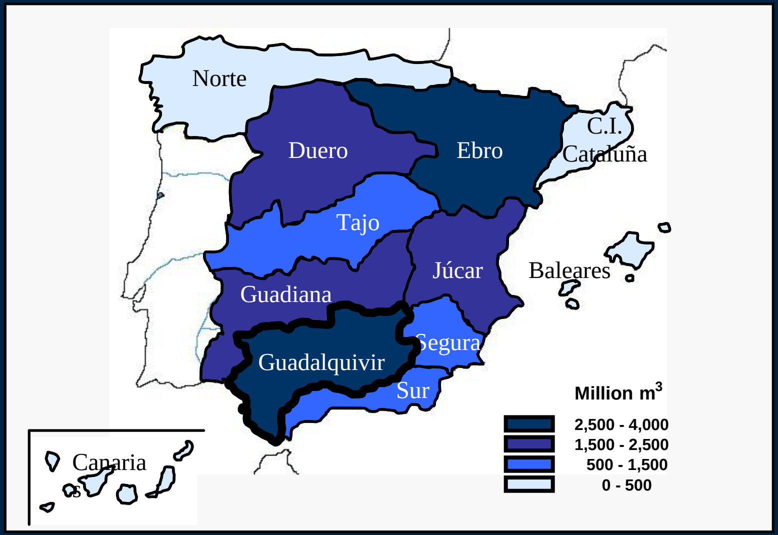


Source: CHG (2009)

- Mediterranean climate (oceanic influence)
- Average annual rainfall 560 mm
- Mean annual temperature 17ºC
- Potential evapotranspiration 900 mm/yr
- National Park: 54,250 ha (World Heritage Site, UNESCO Biosphere reserve, Ramsar)
- Natural Park: 53,800 ha (protected buffer)

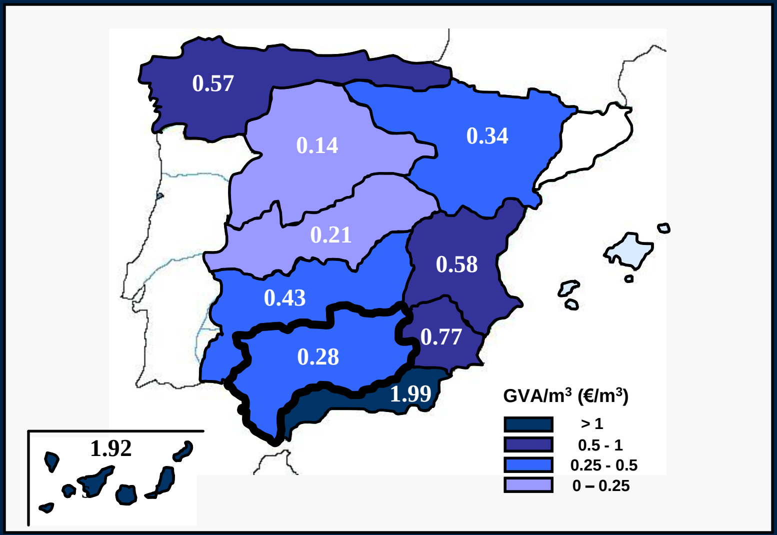
EWR: Doñana National Park

Blue water footprint of crop production by river basin (2006)



Source: Garrido et al. (2009)

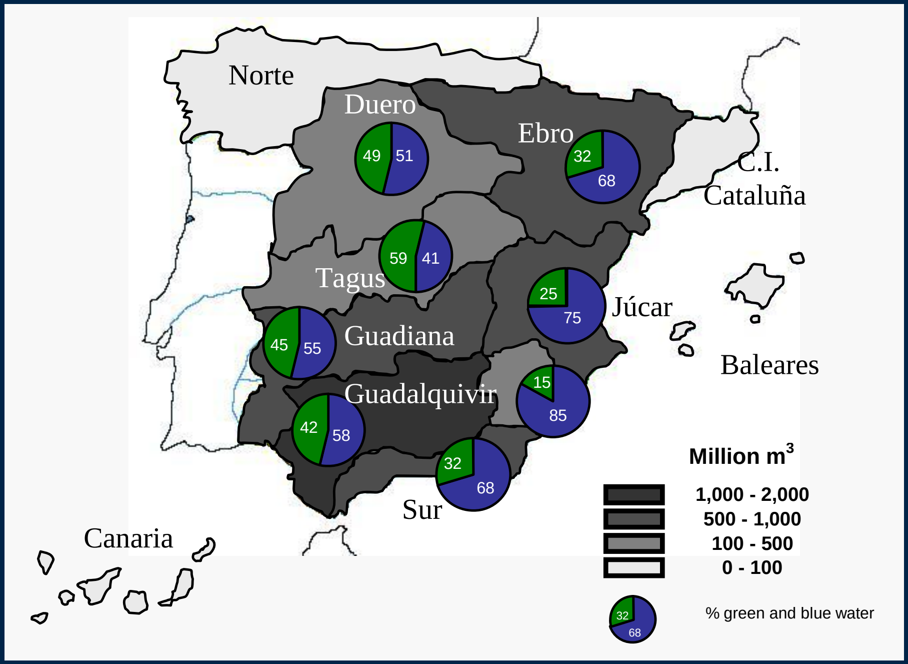
Blue water apparent productivity (GVA/m^3)(2002)



Source: based on data from the Spanish Ministry for the Environment

EWR: Doñana National Park

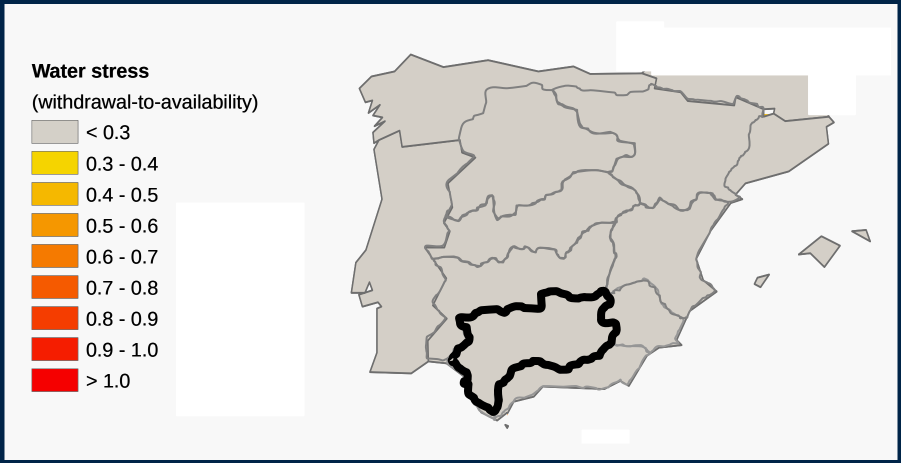
Virtual Water 'exports' by River Basin (2006)



Source: Garrido et al. (2009)

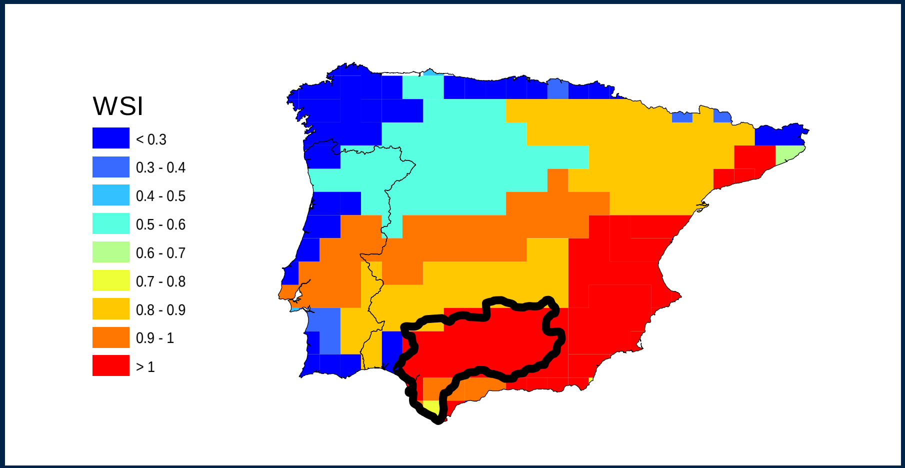
EWR: Doñana National Park

Traditional water scarcity



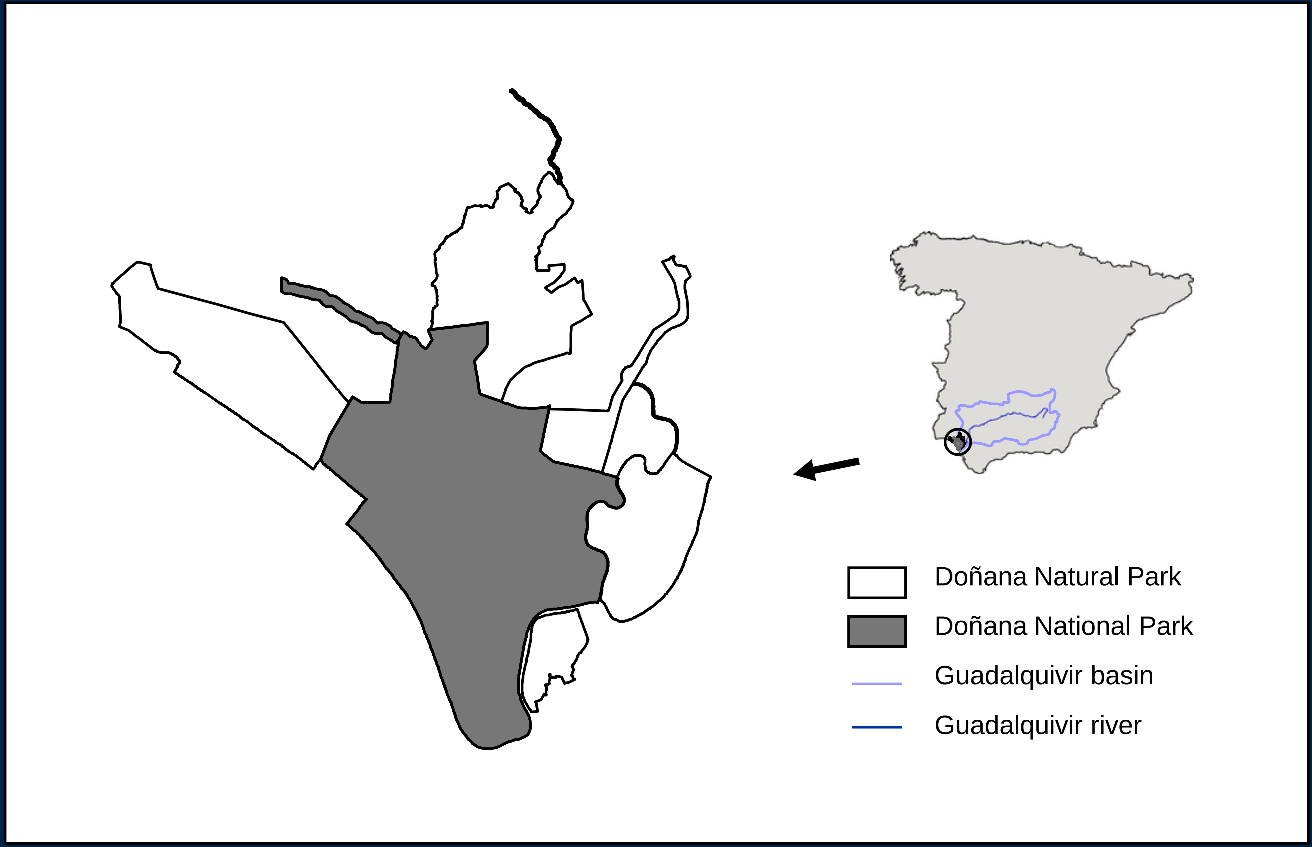
Source: Alcamo et al. (2003)

Water scarcity taking EWR into account



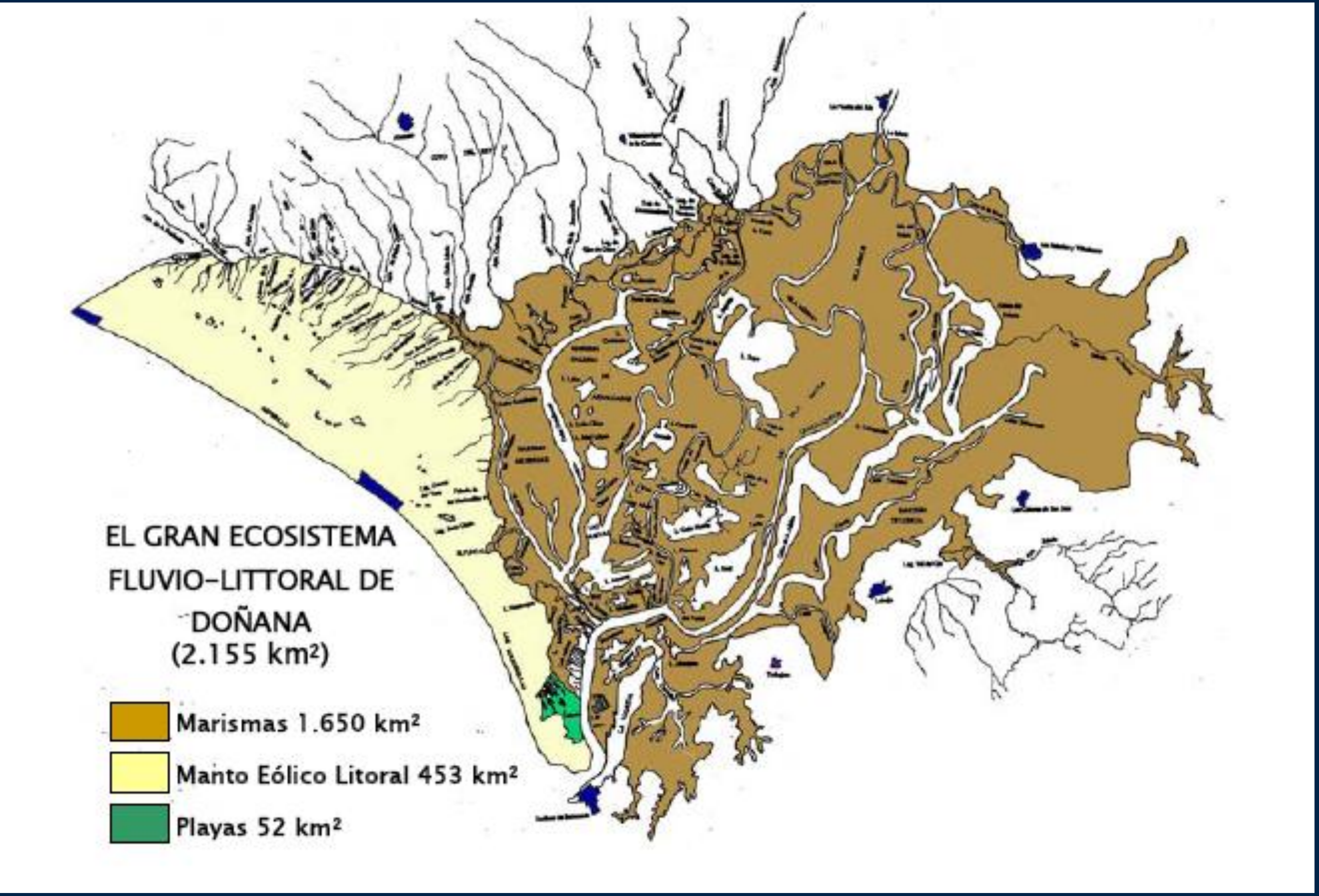
Source: Smakhtin et al. (2003)

EWR: Doñana National Park



EWR: Doñana National Park

Doñana ecosystems

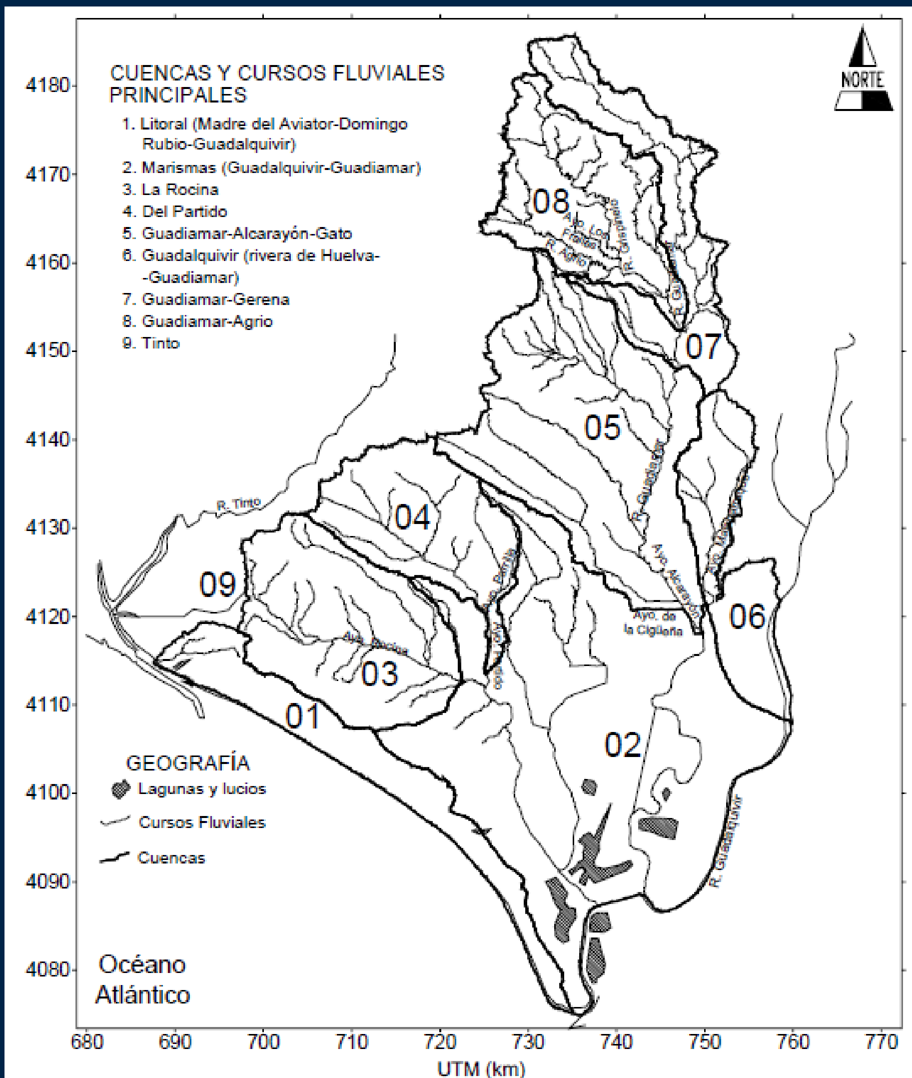


Source: Montes and Borja (in press)

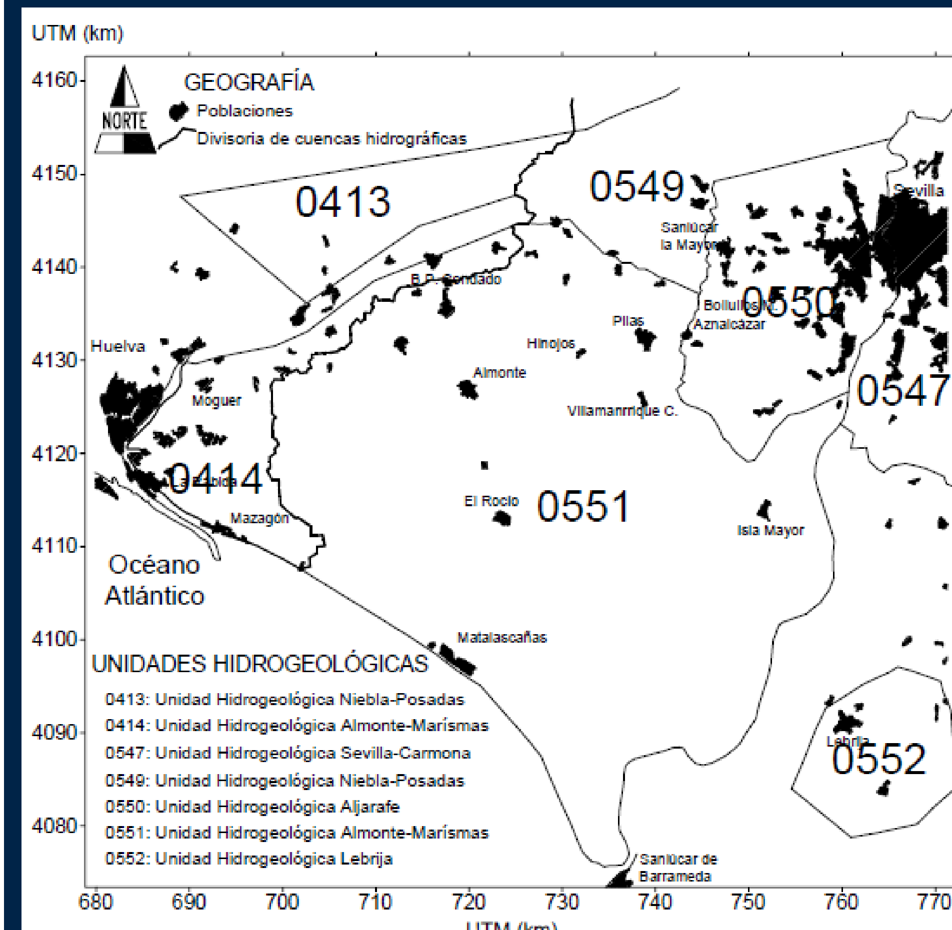
EWR: Doñana National Park

Surface and groundwater components in Doñana

Surface water



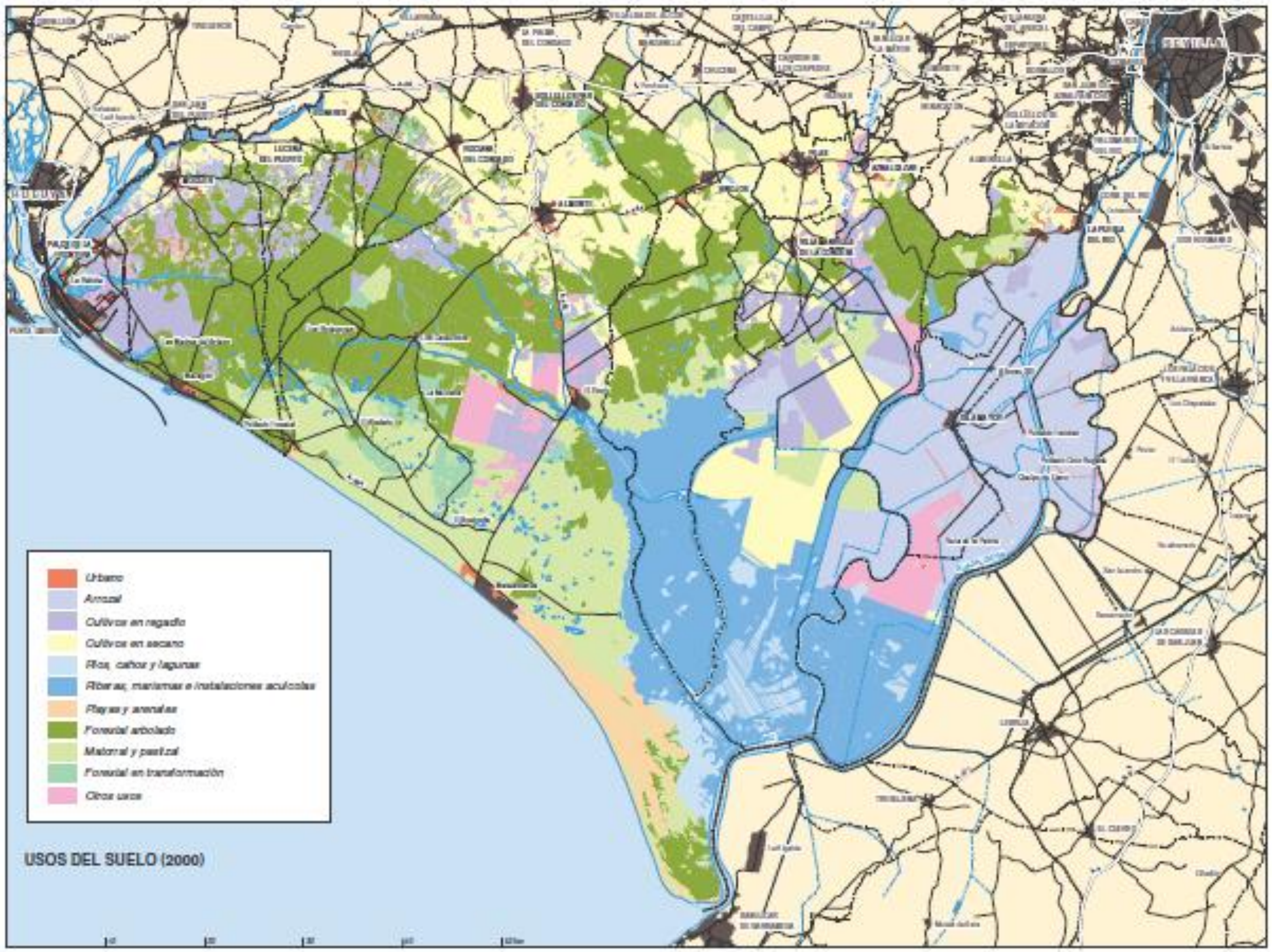
Groundwater



Source: Custodio et al. (2006)

EWR: Doñana National Park

Land uses in Doñana



Fuente: POT Ámbito de Doñana. COPT, 2003.

EWR: Doñana National Park

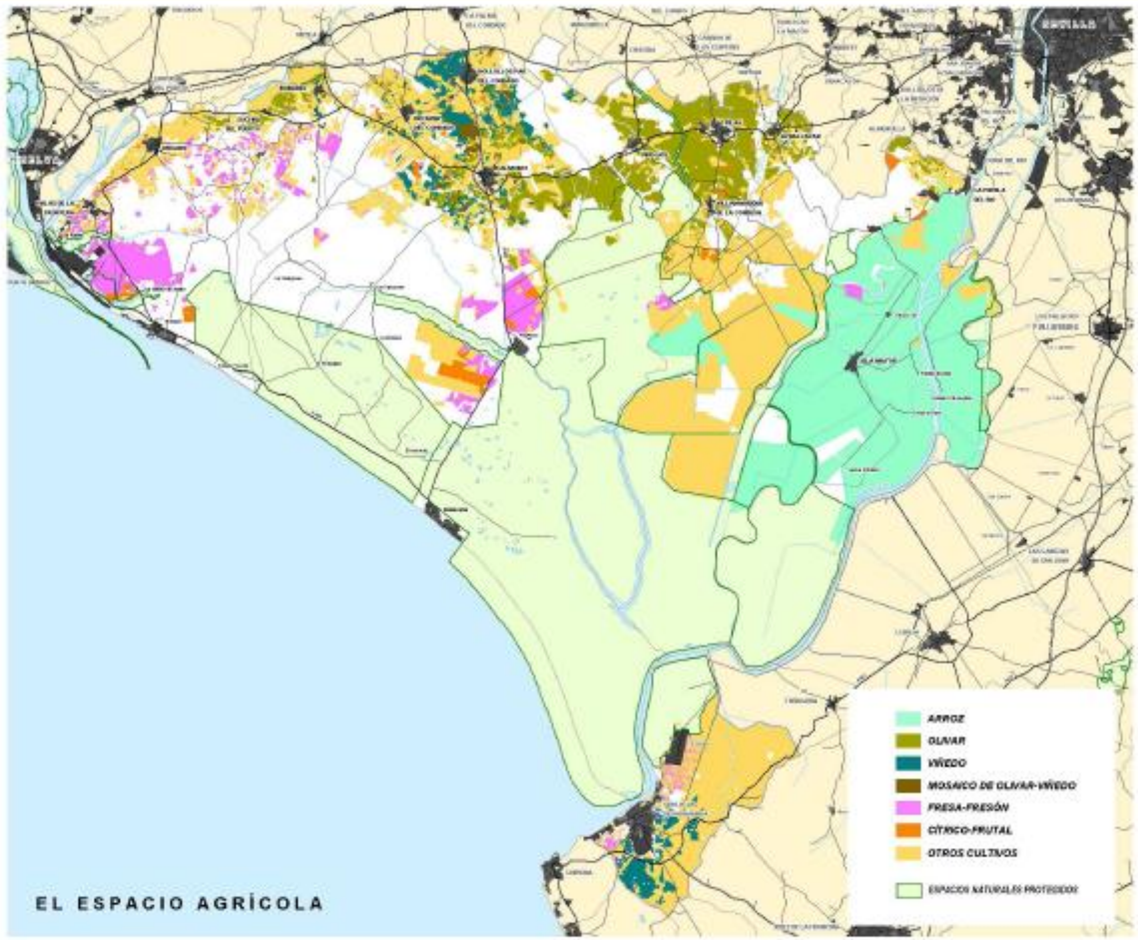
Water Footprint and Environmental Flows (Mm^3/year)

DOÑANA NATIONAL AND NATURAL PARK	Green	Blue		Total	%
		surface	ground		
Agricultural WF[1]	13	21	116	150	39
Urban and industrial WF[2]			14	14	5
Environmental Flows[3]	68	116	38	222	57
Total	81	137	168	386	100
Environmental water requirements[4]		80-200			

1 Source: CHG (2009), Rodríguez et al. (2009), Andalusian Regional Government (1999)
2 Source: CHG (2008)
3 Source: Andalusian Regional Government, 2002
4 Source: WWF (2009)

EWR: Doñana National Park

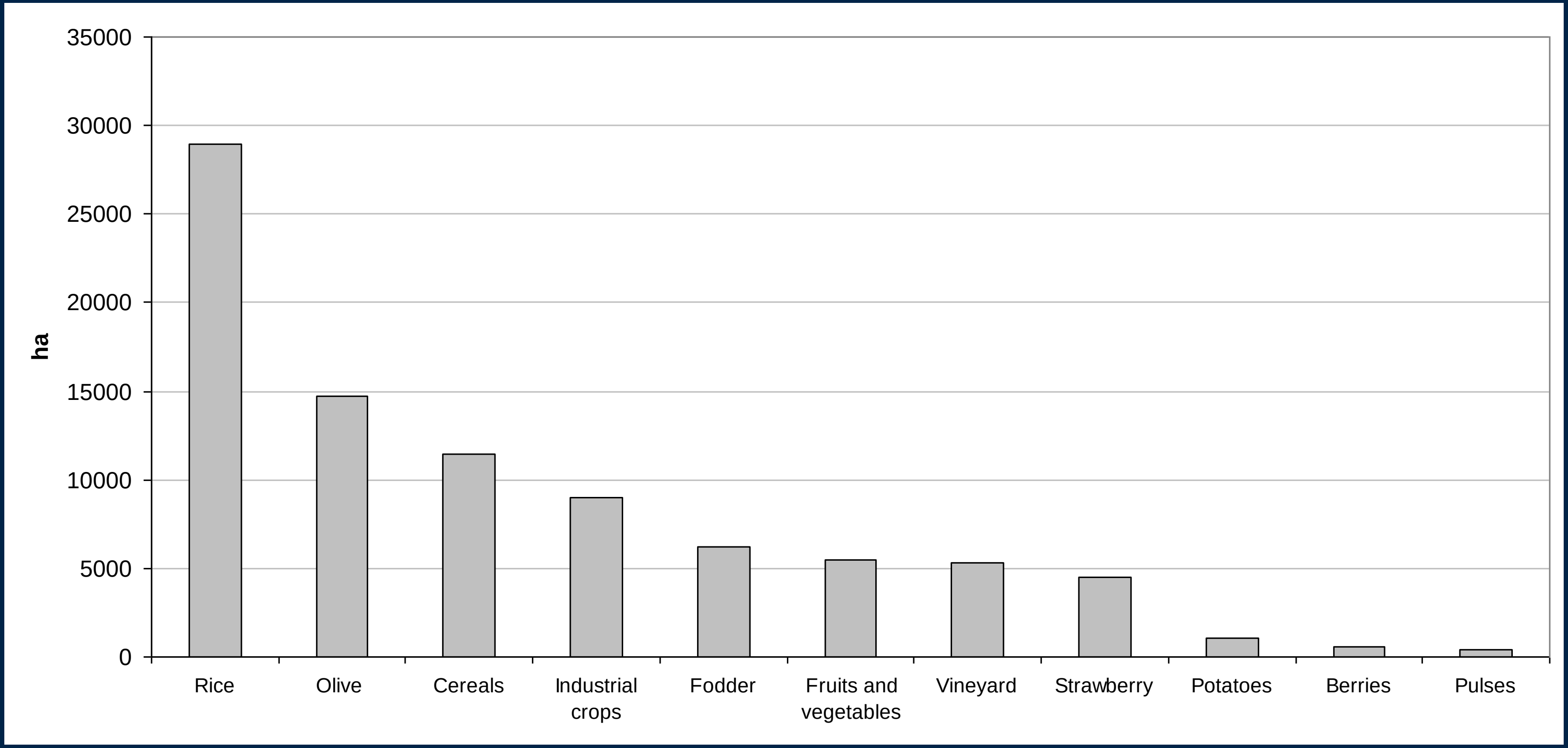
Agricultural land use – Doñana and surroundings



Fuente: Consejería de Medio Ambiente. Mapa de Usos. 2003

EWR: Doñana National Park

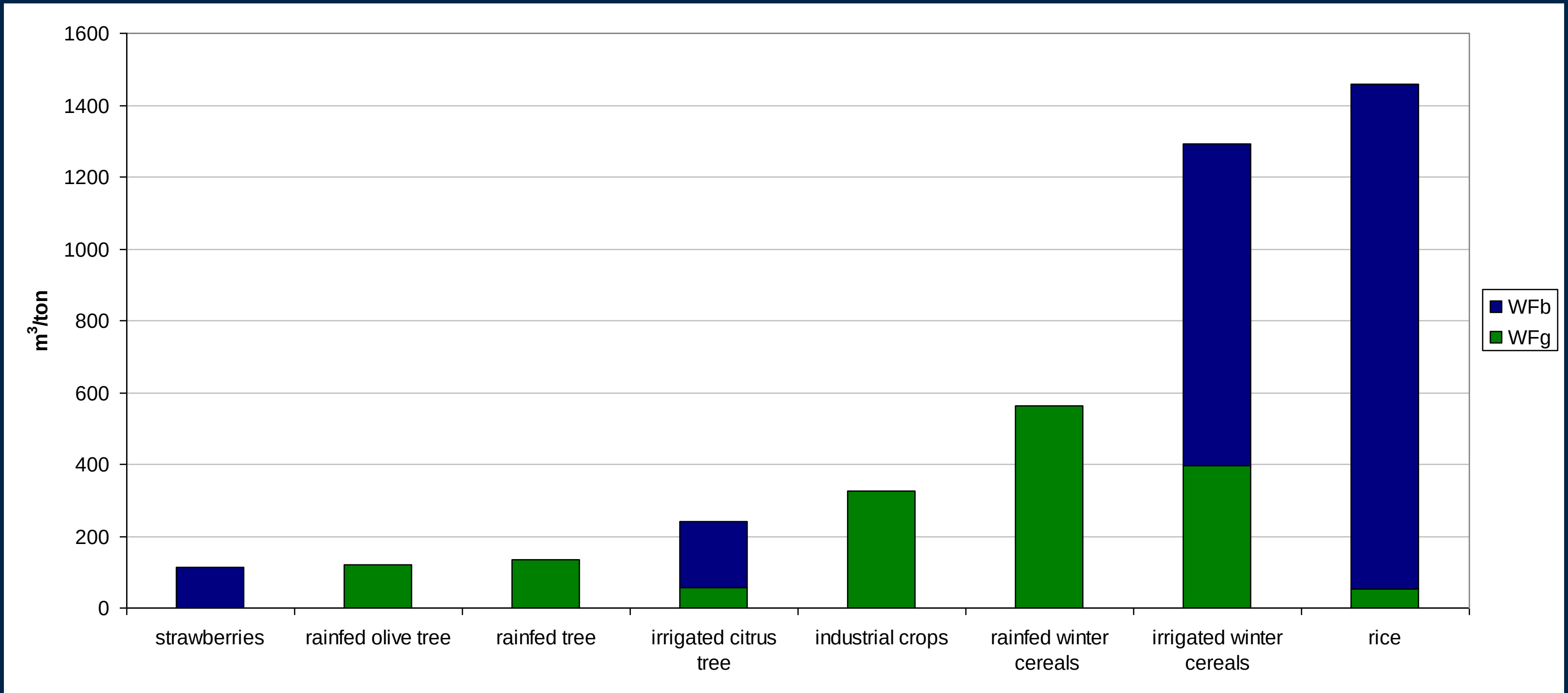
Agricultural land use – Doñana and surroundings



Source: Custodio et al. (2006)

EWR: Doñana National Park

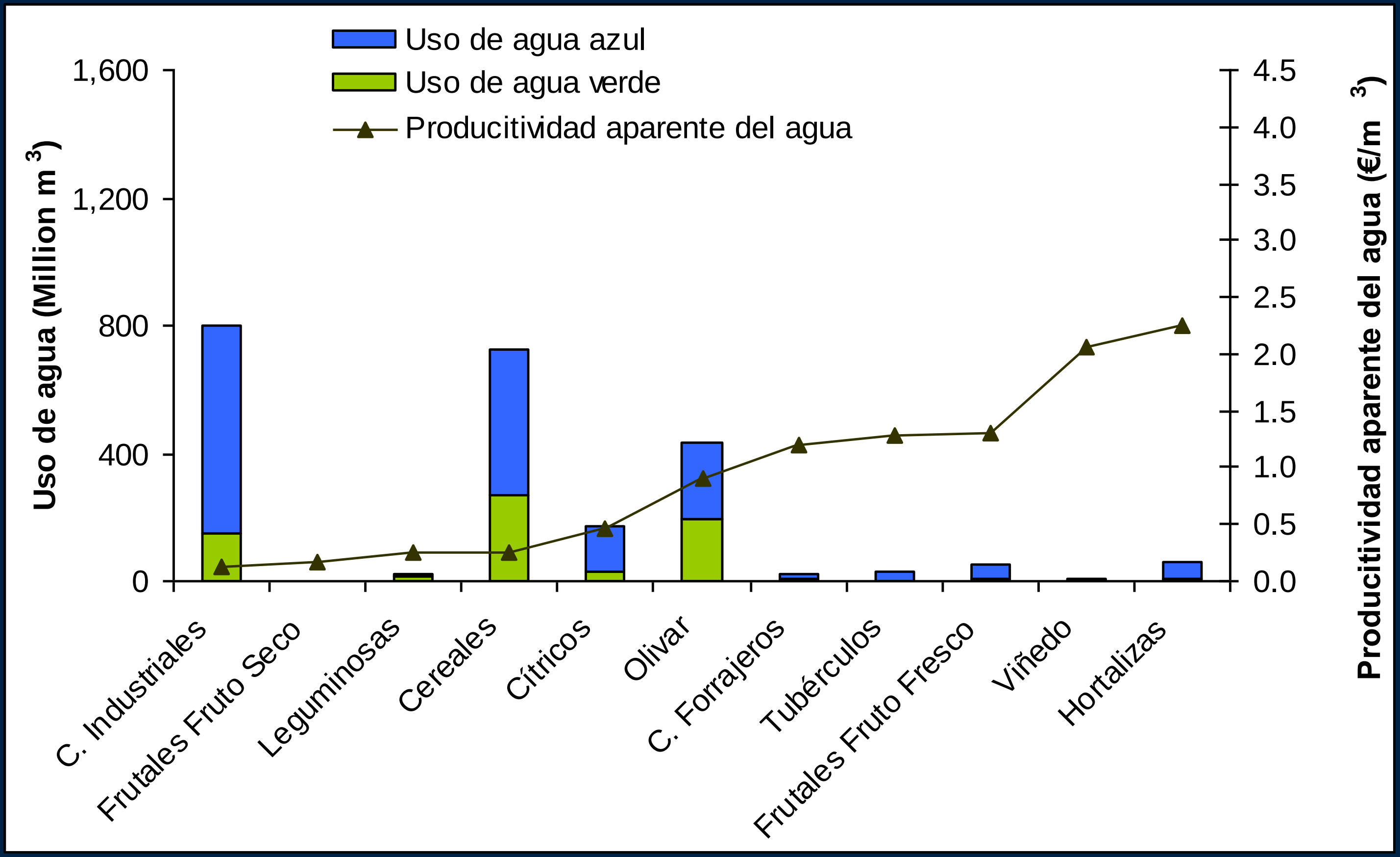
Green and blue WF of agriculture in Doñana
(average rainfall year)



Source: CHG (2009), Rodríguez et al. (2009)

EWR: Doñana National Park

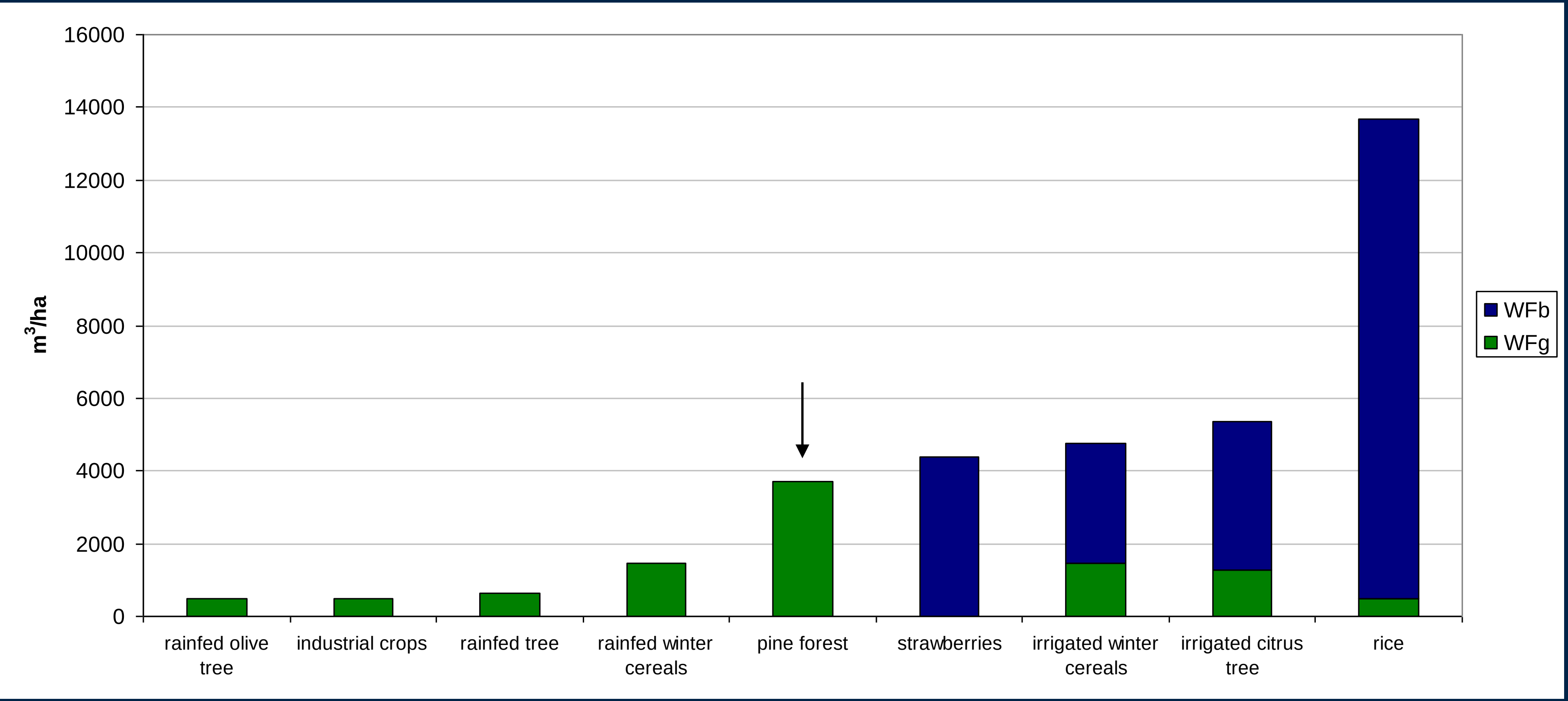
Total water consumption and water apparent productivity in the lower Guadalquivir basin



Source: Rodriguez et al. (in press)

EWR: Doñana National Park

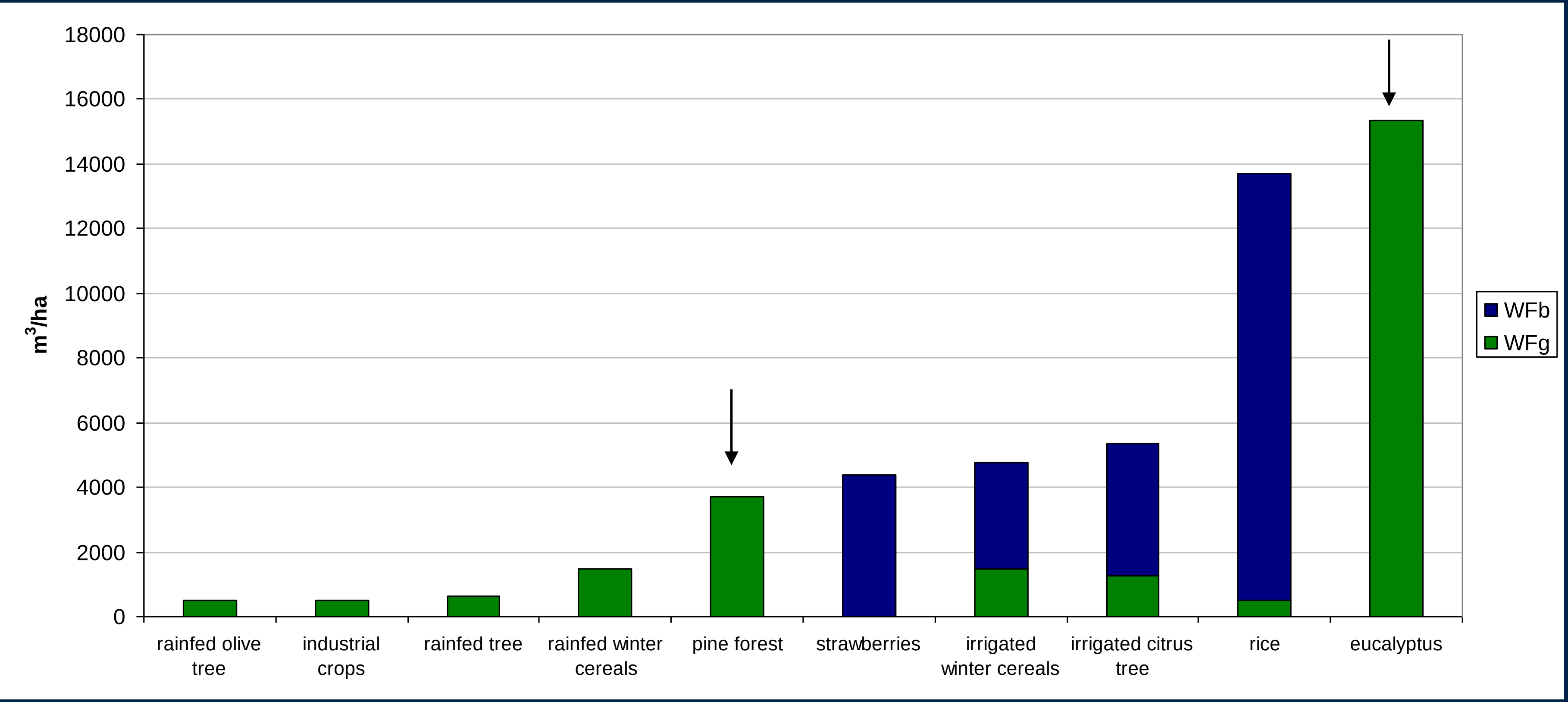
Green and blue WF of agriculture and forests in Doñana (average rainfall year)



Source: Own elaboration, CHG (2009), Rodríguez et al. (2009), Andalusian Regional Government (1999)

EWR: Doñana National Park

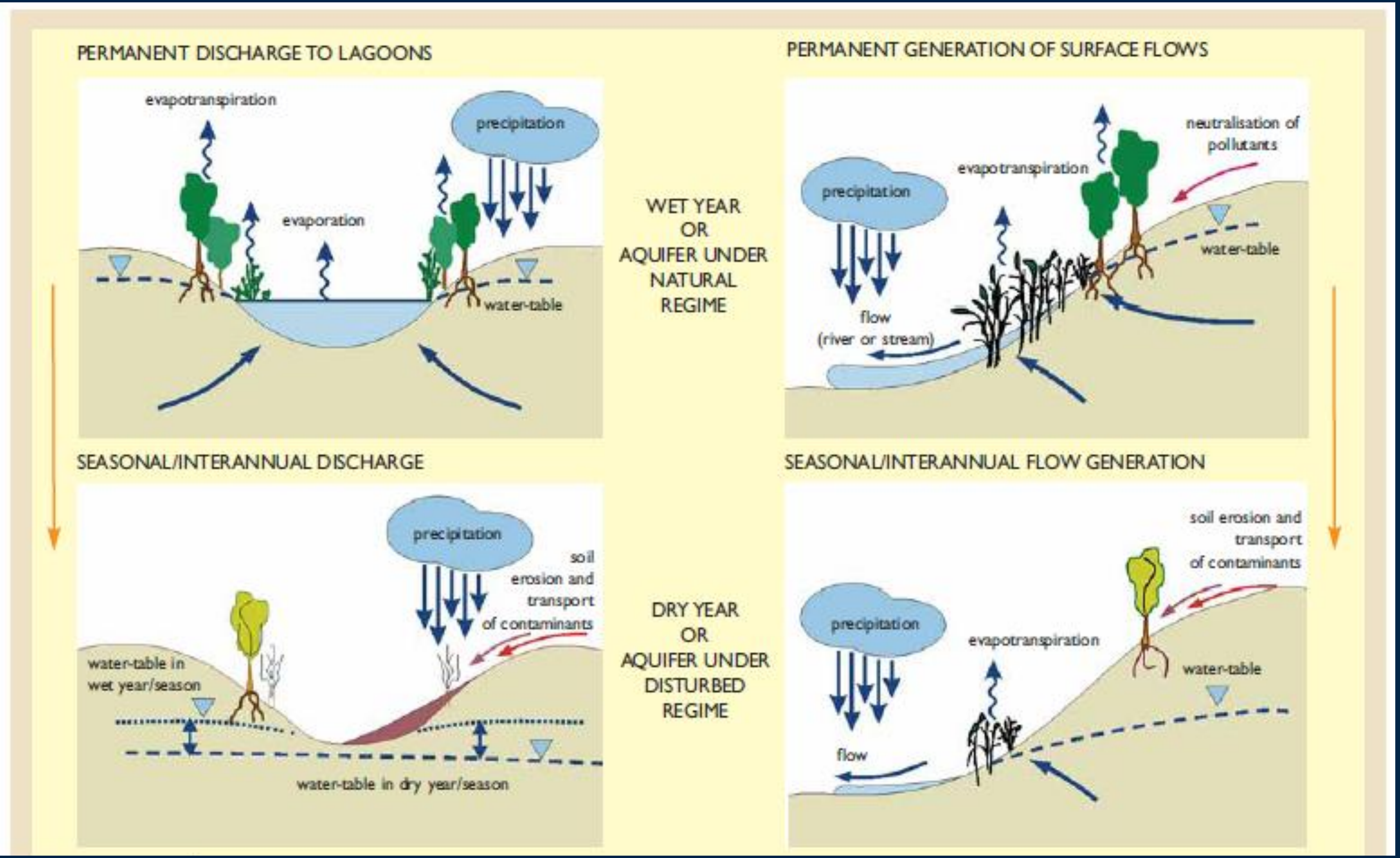
Green and blue WF of agriculture and forests in Doñana (average rainfall year)
Eucalyptus plantations 1950-2000



Source: Own elaboration, CHG (2009), Rodríguez et al. (2009), Andalusian Regional Government (1999), CSIC (2009)

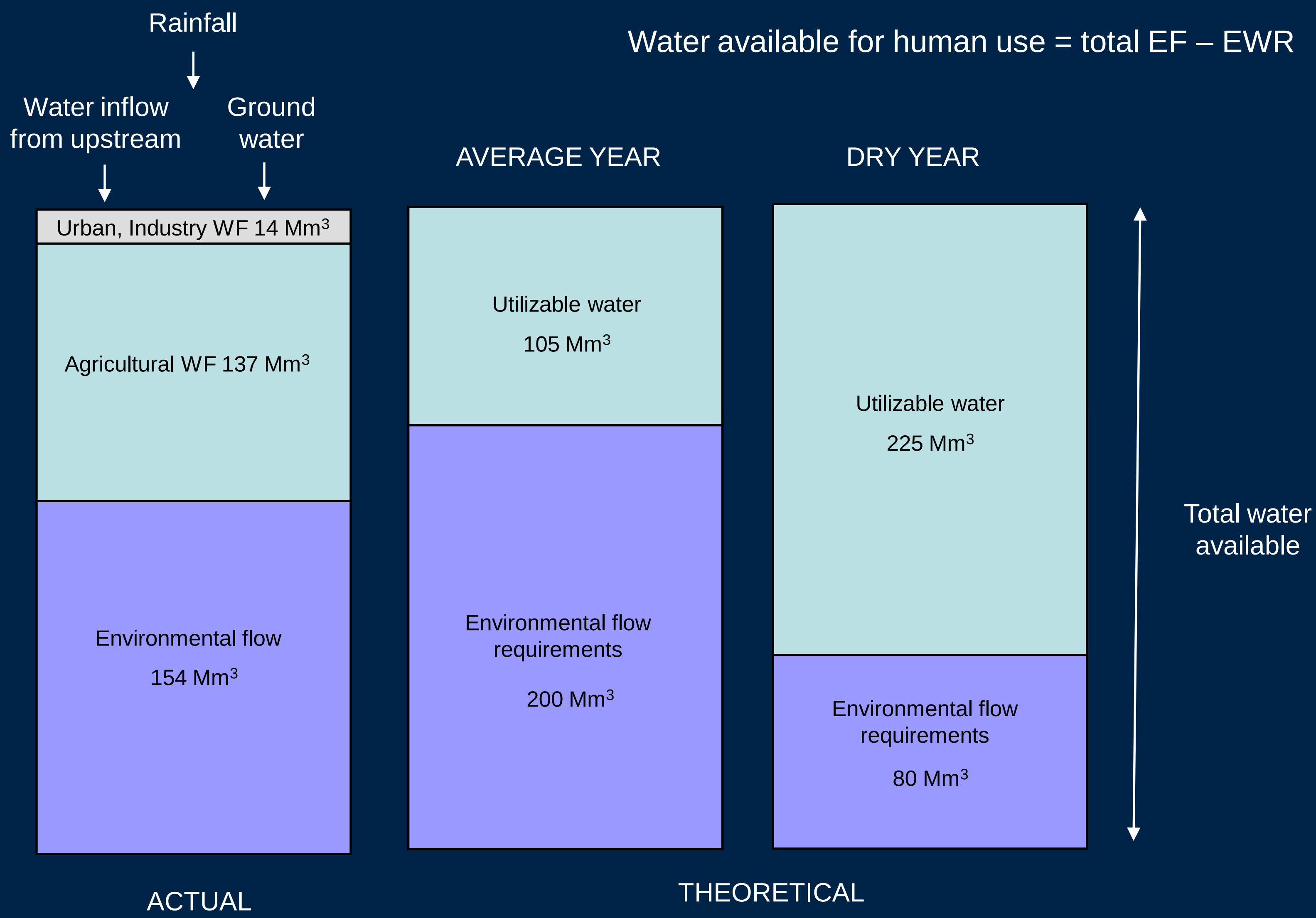
EWR: Doñana National Park

Groundwater dependent wetlands

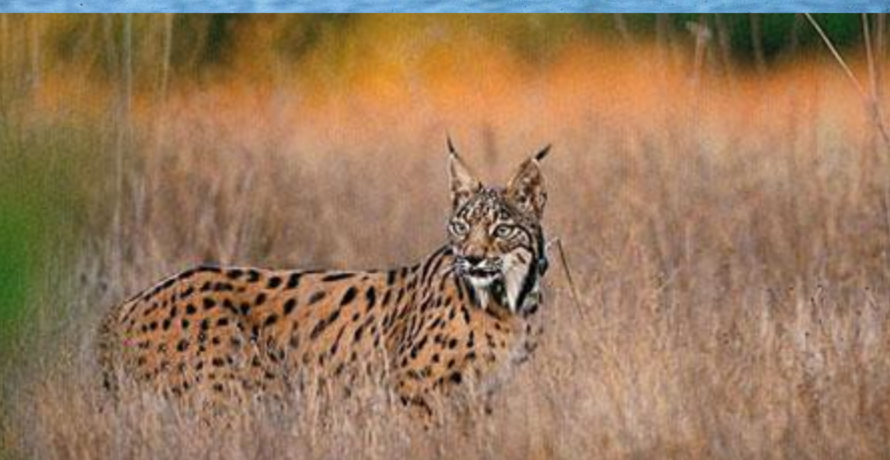


Source: García Novo and Marín Cabrera (2006)

EWR: Doñana National Park







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Concluding remarks

EWR: Concluding remarks

Doñana

- Achieve a more compatible agricultural production with the protection of ecosystems (groundwater wetland conservation)
- Need for integrated water resources management, including surface and groundwater and green water.
- Considering the interlinkages between EFR and land-use changes e.g. wetlands close to the aquifer discharge areas are vulnerable to the effect of water table level fluctuations produced by the intensive groundwater abstraction (agriculture and forest plantations).
- Long-term land and water planning
- EF and WF analyses provide transparent information to take water allocation decisions

EWR: Concluding remarks

EFR Challenges

- Need of an agreed definition of EFR and WS
- Incorporating the whole water cycle (surface, groundwater, and estuaries) into the assessments
- Applying EFR to large-scale land-use changes that intercept and exacerbate overland flows
- Integrating EFR and WF into river basin management plans to inform water allocation decisions
- Developing methods for systematically linking biophysical and socioeconomic impacts
- Incorporating water quality aspects – Grey WF

Thank you