

APPENDIX 1. Resultant matrix from data collection and categorization.

Cycle's phase		Period	Key institutions	Main policy, economic, organizational, and scientific-technical features characterizing each period
WRM	WC			
~K		End of 18 th century	<p>ANCIENT REGIME</p> <p>Ancient Regime – Local nobility entitled by royal governments or local agreements to use highly-valuable resources and to regulate the use of the less valuable by the civilian population. Non-regulated activity of hunters and collectors</p> <p>1778 – <i>Free Trade Decree</i> promoting the reviving of trade at the State level. Seville and Cádiz lose their monopoly</p> <p>1781 – Founding of the <i>Friends of the Country Society of Sanlúcar de Barrameda</i> (ancient province in which Doñana was included) for the promotion of economic development in the region</p> <p>1794 – <i>Royal Order</i> allowing for the implementation of the first large-scale infrastructure in the Guadalquivir Estuary for enhancing navigation, the Merlina's meander cut (1795)</p> <p>1798 – First <i>Disentitlements</i> allowing the expropriation of clergy's wealth (e.g., Jesuits, Charity Institutions)</p>	<p>Planning and management based on scattered projects, maintenance of rudimentary infrastructure and cleaning of natural, accessible water courses</p> <p>Property system based on multi-functional, community-based or municipal properties for agricultural activities and low water consumption regimes, immersed in larger crown and nobility properties</p> <p>Increasing State public deficit</p> <p>Reviving of the promotion of navigation in the Guadalquivir River (navigability tests, blueprints and mythology revival), after Seville's loss of trade monopoly and under the Enlightenment's Spirit of Reform</p> <p>Beginning of a disentitlement (nationalization-for-privatization) process of low-productivity lands for increasing their productivity</p> <p>First public works for enhancing navigation and river defense. Marginal agricultural development</p>
Ω				
α		1 st half of 19 th century	<p>LIBERAL REFORM</p> <p>1805 – <i>Promotion Plan of Sanlúcar Province</i>. First technical planning for the transformation of region, but almost no practical implementation</p> <p>1814 – <i>Royal Order</i> allowing for the constitution of the Guadalquivir Navigation Royal Company, preceded by several navigability tests, topographical surveys and planning</p> <p>1818 – <i>Transaction</i> to the Guadalquivir Navigation Royal Company of one of the largest marshland territories (Isla Menor)</p> <p>1819/1849 – <i>Two acts</i> promoting irrigation agriculture among smallholders through tax exemption</p> <p>1833 – <i>Forestry Bylaws</i> establishing the first protection system for forests</p>	<p>Persistent public deficit, but availability of private investment capital</p> <p>Developing of formal, but inconsistent policies and investment plans promoting the Guadalquivir Estuary and the surrounding left- and right-bank marshlands as a territory with a high commercial and economic potential (navigation, agriculture, colonization, mining)</p> <p>First works modifying the Guadalquivir River course, through meander cuts and the introduction of innovative industrial and engineering technologies (steam engine, mining). These processes are paralleled by the first attempts for drainage and agricultural development, which failed due to lack of adequate technology (e.g., left-bank Isla Menor marshlands)</p> <p>Public works for enhancing the Guadalquivir's navigability, granted to companies participated by private shareholders (e.g., Guadalquivir Navigation Royal Company)</p>
r				
		19 th century	<p>1851-1852 – <i>Series of Royal Orders</i> settling the project for making the Guadalquivir's navigable</p> <p>1855 – <i>Madoz Disentitlement</i> nationalizing low-yield lands for privatization</p> <p>1859-1862 – <i>Series of State regulations</i> entitling Forestry Engineering corps to catalogue excludable areas from the disentitlement process, partly alleviating forests from devastation (Forestry Catalogue)</p> <p>1865 – Creation of the <i>Hydrographic Demarcations</i></p> <p>1866 – <i>Water Act</i> declaring water of public domain</p> <p>1870 – <i>Channels and Reservoirs Act</i> granting large public-works companies perpetuity rights on the use of infrastructures in which they had invested</p>	<p>Increasing sale and/or public auction of properties (marshlands, scrublands and forests) of the so-called 'dead hands' (clergy and nobility) and beginning of extensive forestry operations (including extensive clear-cuts) across the State, owing to the disentitlement process (agricultural and paper-industry development)</p> <p>Agrarian Technical Reform at the State level – Increasing application of innovative technologies (e.g., impoldering) for the enhancement of agricultural productivity, based on middle-class and corporate private capital. High investment costs and long term recouping (land adaptation to irrigation and crop transformation) slows down technology implementation</p> <p>Increasing promotion of the need for water control (meander cuts, defense works) and regulation in the Guadalquivir Estuary (legal system) for enhanced navigation, communication, flood control and disease prevention</p>

Ω'	2 nd half of	<p>1870 – <i>Royal Order</i> promoting drainage engineering projects at the Lebrija marshes (most of them finished in 1928, due to inadequate planning and the priority given to navigation policies)</p> <p>1877 – <i>Act</i> for the enhancement and afforestation of public forests excluded from the disenfranchisement process</p> <p>1877 – <i>Royal Order</i> granting the first large-scale drainage works within the Doñana marshlands, at Aznalcázar's Marisma Gallega (failed and reinstated in 1910)</p> <p>1879 – <i>Water Act</i> giving priority to irrigation agriculture over navigation at the State level –end of laissez-faire policies.</p>	<p>Middle-class actors (naturalists, ornithologists and hunters) promote the Doñana marshes for naturalistic and hunting purposes (e.g. first expeditions of A. Chapman and W.J. Buck) and contribute to establishing its reputation as one of the most important waterfowl reserves in Europe (e.g. A. Machado y Núñez, H. Saunders, and Lord Lilford)</p> <p>Emergence of an intellectual-scientific movement termed 'Regeneracionismo', aimed at understanding the political, scientific, social and economic causes of Spain's political and economic decline, largely in response to the loss of Spanish overseas territories</p> <p>Sustained conflicts between Civil and Forestry engineers, rooted in the poor discrimination of their respective responsibilities and their contrasting approaches to planning and management</p>
Ω'	α-r	<p>1901 – Creation of the <i>Hidrographic-Forestry Demarcations</i>, precursor of the Water Authorities (1926)</p> <p>1907 – <i>Colonization Act</i> halting emigration and promoting the cultivation of low-yield lands</p> <p>1908 – <i>Protective Forestry Act</i> promoting afforestation of public and private forests</p> <p>1911 – <i>Large Irrigated Lands Act</i> (Gasset Act) establishing the State as the financier and promoter of large public works</p> <p>1916 – <i>National Parks Act</i> in 1916 creating the National Park's Trust Boards</p> <p>1917 to date – <i>Battery of regulations</i> implementing the park-based model</p> <p>1924 – <i>Royal Order</i> of Ministry of Promotion granting a private financial group the drainage and exploitation rights of the Hinojos marshes (~10,000 ha.)</p> <p>1926 – <i>Royal Decree</i> for the creation of the modern water authorities.</p> <p>1927– Creation of the <i>Guadalquivir River Authority</i></p>	<p>Key figures of the 'regeneracionismo' describe regional differences in water availability as the main shortcoming for the development of irrigation agriculture, and promote a revised hydraulic-forestry policy as the panacea for economic development</p> <p>Beginning of the forestry protection-for-conservation policies and regulations in Spain. The Forestry Engineering Corps are entitled to catalogue areas to be protected from colonization and exploitation. Increasing links between nature (forests) conservation and forestry policies</p> <p>High GDP in Spain during the 1920s</p> <p>Increasing State interventionism through hydraulic policies and planning (e.g., National Hydraulic Plans of 1902 -Gasset Plan- and 1933), subsequently defended in several National Irrigation Congresses (1913, 1918, 1921, 1927, 1934) and paralleled by colonization strategies</p>
K	I st third of 20 th century (1900-1936)	<p>1932 – <i>Irrigation Act</i> increasing the State responsibilities in the development of secondary and complementary public works</p> <p>1935 – <i>Forest Heritage Act</i> promoting large afforestations with production purposes</p>	<p>Republican attempts for increasing public property in Doñana by declaring the marshes of 'public interest'. However, lobbying by powerful stakeholders and private owners still succeed at promoting the drainage of several hectares of marshes for the culture of rice intended to supply the military</p> <p>Beginning of an intensive shift in jurisdiction in the private-property system, which increasingly goes to the State</p>
Ω'	Ω'	<p>1940 – <i>Act</i> entitling Forestry Engineering Corps for heading National Parks planning and management</p> <p>1941 – Restitution of <i>Forest Heritage Act</i> declaring Huelva province (including Doñana) region of interest for forestry</p> <p>1957 – <i>Forestry Act</i> entrusting the State Ministry of Agriculture with the stewardship of nature conservation and promoting production-driven planning and technologies</p>	<p>1940s – Increasing improvement of the Spanish economy – high GDP</p> <p>1940s-1950s – First large-scale projects in Doñana, backed by the Gasset Act of 1911 (e.g. drainage of the Guadamar River by the Guadalquivir River Authority, executed by public-private contract)</p> <p>1950s – Massive afforestation projects promoted at the State level, both for production (Forest Heritage/Ministry of Agriculture) and for conservation (Directorate of Forestry/Ministry of Agriculture).</p>
K	K		

<p>Ω'- α</p>	<p>2nd third of 20th</p> <p>PROGRESSIVISM*</p>	<p>1969 – <i>Doñana Act</i> creating the Doñana National Park (DNP), preceded by the purchase of 6,700 ha of marshlands by the World Wildlife Fund and the creation of the Doñana Biological Reserve and Doñana Biological Station (1964) by the Spanish Research Council</p> <p>1971 – <i>Decree</i> dictating the merger of the Forest Heritage and the Directorate of Forestry within the Nature Conservation Institute (ICONA), which takes charge of the DNP's stewardship</p> <p>1972 and 1974 – <i>Two Decrees</i> entitling the Institute for Agrarian Reform and Development (IRYDA) to implement large transformation projects in the marshes surrounding the DNP</p> <p>1975 – <i>Nature Reserves Act</i> increasing the decision power of local administrations, land owners and the ICONA within the DNP's Trust Board, and favouring the agricultural projects of the IRYDA</p>	<p>1950s-1960s – First scientific expeditions of key national and international scientists (e.g., J.A. Valverde, F. Bernis), naturalists (e.g., G. Mountfort) and ornithologists (e.g., Roger T. Peterson) to the Doñana marshes, supported by private owners (e.g., M. González) who constituted key stakeholders in the protection-for-conservation processes</p> <p>1970s – Implementation of the Almonte-Marismas Plan and Guadalquivir-FAO Project (preceded by the discovery and delimitation of the Almonte-Marismas aquifer) for the drainage of 35,000 ha of deltaic- and marsh-lands in Doñana, carried out by the IRYDA</p> <p>1970s – Beginning of a long phase during which the conservation of the Doñana marshes depended on the organisational and personal relationships between the Doñana Biological Station and the ICONA, which was itself facing an internal power-contest between pro-conservation and old-school engineers</p>
<p>↙ ↘</p> <p>Sync</p>	<p>TRANSITION</p>	<p>1978 – <i>Spanish Constitution</i> replacing the authoritarian government by a democratic government</p> <p>1978 – <i>Doñana Act</i> increasing the Park's surface (50270 ha), and establishing novel guidelines for conservation inside and outside the park, and assigning the direction of the National Park and Biological Reserve to the ICONA (Ministry of Agriculture) and the Doñana Biological Station (Ministry of Education), respectively</p>	<p>1970s – 1978 Doñana Act extending the Park's surface, to include a strip of marine areas; launching a policy of expropriations to consolidate the public domain over most of its land; instituting an Use and Management Plan; setting the path for the establishment of a Master Plan for the regional coordination of socioeconomic development (e.g., road networks, tourist planning, agricultural and stock farming practices) and nature conservation; and allowing for the creation by law of the Doñana Natural Park buffering the core National Park (Nature Reserves Inventory Act of 1989).</p>
<p>K</p> <p>Ω'</p> <p>K</p> <p>Ω'</p> <p>α-r? K?</p>	<p>3rd third of 20th century (1978-2000)</p> <p>DEMOCRACY</p>	<p>1981 – First <i>Doñana Hydraulic Regeneration Plan</i> aimed at the restoration of the main tributaries to the marsh (Guadamar and Travieso Channels) and the modification of the Guadalquivir River levee, allowing to control the marsh inflow and discharges by means of sluices</p> <p>1983 – <i>Water Act</i> implementing the Hydraulic Public Domain</p> <p>1984 – First <i>Director Plan of Use and Management</i> of the National Park</p> <p>1988 – First <i>Director Territorial Plan of Doñana</i> establishing a framework inter-organisational and stakeholder coordination in regional planning, and policy development and implementation</p> <p>1989 – <i>Nature Reserves Inventory Act</i> creating the Doñana Natural Park (54250 ha) buffering the core National Park and the Andalusian Nature Reserves Network, henceforth stimulating and reinforcing the nature conservation legal system, and its protection standards and protocols</p> <p>1993 – First <i>Doñana Sustainable Development Plan</i></p> <p>1998 – “Los Frailes” mining accident</p> <p>1999 – <i>Doñana Nature Reserve Bill</i> aimed at taking over the DNP's management</p>	<p>1980s-1990s – Top-down drastic reductions in the irrigable surfaces established in the plans of the prior decades, which become more intensively used due to technological advances</p> <p>1980s – First, failed hydraulic regeneration projects in Doñana</p> <p>1970s-1990s – The DNP, fed by intensively modified tributaries and streams, is affected by progressive degradation and punctuated by ecological crises (e.g., waterfowl mortalities, biological invasions, mine pollution) and withstands a considerable number of pressures and threats both outside (e.g. irrigated agriculture) and inside (e.g. overgrazing by cattle and introduced herbivores, high risk of botulism outbreaks, deforestation of the inflowing stream basins with subsequent erosion of the banks)</p> <p>1990s – First Sustainable Development Plan: increasing adaptation of the development policies to a changing reality, by developing compatible economic and conservation goals</p> <p>1998 – Mining accident at Los Frailes, after which the Spanish government and the Andalusian government launched the Doñana 2005 and Guadamar Green Corridor restoration projects respectively</p> <p>1980s-2000s – The Andalusian Regional Government engages, and finally wins a political and judicial contest to claim jurisdiction over the Doñana National Park from the Spanish (central) Government</p>

* Franco's dictatorship

Data collected from (in alphabetical order; see Literature Cited): Andrés-Gallego 1981, Borja et al. 2001, Casas and Urdiales 1995, Clemente et al. 2004, Cortázar and Vesga 1994, Cruz 1996, Demerson 1976, Enggass 1968, Fernández and Pradas 2000a, Fernández and Pradas 2000b, Fernández-Albertos and Manzano 2010, Fernández-Delgado 2006, García and Marín 2006, García-Viñas et al. 2005, Gómez-Baggethun and Kelemen 2008, Guadalquivir River Authority 2010, Llamas 1988, Montes et al. 1998, Moral-Ituarte 1991, Moreno 1992, Ojeda 1992, Ojeda and Moral-Ituarte 2004, Orti 1984, Tomás y Valiente 1978, Valverde 2004, Zouwen 2006.