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Abstract

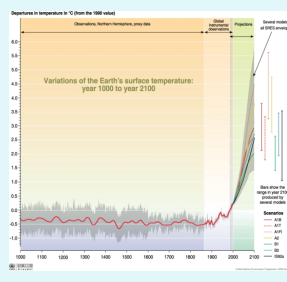
Keywords: Hydraulic Heritage. Climate Change. Cultural Heritage.

The hydraulic heritage is a collection of building sites that combine work and social organization between human being and nature, showing the use that our ancestors have done for water resources. This resource is a set of integral elements of territorial units that are traditional landscapes, and having a high vulnerability, resulting from the loss of cultural heritage sites (Payano Almanzar, 2011; Vecco, 2010). The current situation suggests the enhancement of our hydraulic heritage to the effects of climate change: extreme weather events (floods, droughts and climate), natural and human events. Therefore, it is appropriate to know the heritage of water from a reasonable prospect for new strategies and policies for management, seeking to expand and clarify the knowledge of these resources and decode their meanings and their associated values. Climate change can be subtle and can occur over a long period of time. However, some climate change parameters such a freezing, temperature and relative humidity shock can change by large amounts over a short period of time. To identify the greatest global climate change risks and impacts on cultural heritage, the scientific community uses the climate parameters tabulated (Table 1) (UNESCO, 2007). These risks and impacts of climate change are occurring on the hydraulic heritage.

Tendencies, changes and hydraulic heritage

It is expected that the global average surface temperature increase between 1.4 °C and 5.8 °C during the period 1990 to 2100 (Fig. 1). According UNSECO (2007), the total content of water vapor and precipitation increase during the twenty-first century, and are highly likely over-year variations in rainfall in most areas that are expected to increase in the average. Also expected changes in extreme weather events and dangerous as heat waves, droughts, intense rains and tropical cyclones. Therefore, the hydraulic heritage will be affected in different ways and to varying degrees by climate change, according to their vulnerability.

Thus, the greatest damage occurs during the drying process, so that the most relevant data are related to dryness and the temperature of the time after precipitation. For this reason, there is a reducing the flow that goes through a network of acequias for irrigation and in physical appearance and disappearance of other cultural heritage (wells, dregs and chain well) sites.



Sources. Nakicenovic et al. (2000), in GRID-Arendal-United Nations Environment Programme (UNEP). Available in http://www.grida.no/graphicslib/detail/temperature-trends-and-projections_5870#

Figure 2 shows the effects of droughts and

Table 1. Principal climate change risks and impacts on cultural heritage

Climate indicator	Climate change risk	Physical, social and cultural impacts on cultural heritage
Atmospheric moisture change	<ul style="list-style-type: none"> Flooding (sea, river) Intense rainfall 	<ul style="list-style-type: none"> pH changes to buried archaeological evidence Loss of stratigraphic integrity due to trampling and heaving from changes in sediment moisture
	<ul style="list-style-type: none"> Changes in water-table levels 	<ul style="list-style-type: none"> Data loss preserved in waterlogged / anoxic / anoxic conditions
	<ul style="list-style-type: none"> Changes in soil chemistry 	<ul style="list-style-type: none"> Eutrophication accelerating microbial decomposition of organics
	<ul style="list-style-type: none"> Ground water changes 	<ul style="list-style-type: none"> Physical changes to porous building materials and findings due to rising damp
	<ul style="list-style-type: none"> Changes in humidity cycles 	<ul style="list-style-type: none"> Damage due to dry or inadequate water disposal systems; historic rainwater goods not capable of heavy rain and often difficult to access, maintain, and adjust
	<ul style="list-style-type: none"> Increase in time of wetness 	
	<ul style="list-style-type: none"> Salt-chlorides 	
		<ul style="list-style-type: none"> Crystallization and dissolution of salts caused by wetting and drying affecting standing structures, archaeology, wall paintings, frescos and other decorated surfaces
		<ul style="list-style-type: none"> Erosion of inorganic and organic materials due to flood waters
		<ul style="list-style-type: none"> Biological attack of organic materials by insects, mould, fungi, into-site species such as termites
Temperature change		<ul style="list-style-type: none"> Salinity instability, ground heave and subsidence
		<ul style="list-style-type: none"> Relative humidity cycles/shock causing spalling, cracking, flaking and dusting of materials and surfaces
		<ul style="list-style-type: none"> Corrosion of metals
		<ul style="list-style-type: none"> Other combined effects eg. increase in moisture combined with fertilisers and pesticides
	<ul style="list-style-type: none"> Diurnal, seasonal, extreme events (heat waves, snow loading) 	<ul style="list-style-type: none"> Deterioration of fabrics due to thermal stress
		<ul style="list-style-type: none"> Freeze-thaw (frost) damage
		<ul style="list-style-type: none"> Damage inside brick, stone, ceramics that has got wet or frozen within material before drying
		<ul style="list-style-type: none"> Biological deterioration
	<ul style="list-style-type: none"> Changes in freeze-thaw and ice storms, and increase in wet frost 	<ul style="list-style-type: none"> Changes in 'fitness for purpose' of some structures. For example overhauling of the interior of buildings can lead to inappropriate alterations to the historic fabric due to the introduction of engineered solutions
		<ul style="list-style-type: none"> Inappropriate adaptation to site structures to remain use
Sea-level rises	<ul style="list-style-type: none"> Coastal flooding 	<ul style="list-style-type: none"> Coastal erosion/loss
	<ul style="list-style-type: none"> Sea-water incursion 	<ul style="list-style-type: none"> Intermittent introduction of large masses of 'strange' water to the site, which may disturb the metabolite equilibrium between artefacts and soil
Wind	<ul style="list-style-type: none"> Wind-driven rain 	<ul style="list-style-type: none"> Permanent submersion of low-lying areas
	<ul style="list-style-type: none"> Wind-transported salt 	<ul style="list-style-type: none"> Population migration
	<ul style="list-style-type: none"> Wind-driven sand 	<ul style="list-style-type: none"> Deterioration of communities
	<ul style="list-style-type: none"> Winds, gusts and changes in direction 	<ul style="list-style-type: none"> Loss of strength and breakdown of social interactions
Desertification	<ul style="list-style-type: none"> Drought 	<ul style="list-style-type: none"> Pervasive moisture into porous cultural heritage materials
	<ul style="list-style-type: none"> Heat waves 	<ul style="list-style-type: none"> Static and dynamic loading of historic or archaeological structures
	<ul style="list-style-type: none"> Fall in water table 	<ul style="list-style-type: none"> Structural damage and collapse
Climate and pollution acting together	<ul style="list-style-type: none"> pH precipitation 	<ul style="list-style-type: none"> Deterioration of surface due to erosion
	<ul style="list-style-type: none"> Changes in deposition of pollutants 	<ul style="list-style-type: none"> Stone recession by dissolution of carbonates
		<ul style="list-style-type: none"> Blackening of materials
Climate and biological effects	<ul style="list-style-type: none"> Proliferation of invasive species 	<ul style="list-style-type: none"> Corrosion of metals
	<ul style="list-style-type: none"> Spread of existing and new species (insects, fungi, termites) 	<ul style="list-style-type: none"> Influence of bio-colonisation
	<ul style="list-style-type: none"> Increase in mould growth 	<ul style="list-style-type: none"> Collapse of structural timber and timber finishes
	<ul style="list-style-type: none"> Changes to lichen colonies on buildings 	<ul style="list-style-type: none"> Reduction in availability of native species for repair and maintenance of buildings
	<ul style="list-style-type: none"> Decline of original plant materials 	<ul style="list-style-type: none"> Changes in the natural heritage values of cultural heritage sites
		<ul style="list-style-type: none"> Changes in appearance of landscapes
		<ul style="list-style-type: none"> Transformation of communities
		<ul style="list-style-type: none"> Changes the livelihood of traditional settlements
		<ul style="list-style-type: none"> Changes in family structures as sources of livelihoods

Source. Climate Change and World Heritage: Report on predicting and managing the impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management responses (UNESCO, 2007).

floods caused by climate change on two heritage properties: Water Reserve in Cespedosa and Historic medieval structure affected for climate Change- Cordoba (Spain).



Fig. 2. Water Reserve in Céspedes, Salamanca (A) and Historic medieval structure affected for climate Change- Cordoba, Spain (B).
Sources. <http://www.elmundo.es/elmundo/2012/03/12/espana/133584636.html> and
<http://www.iahmedialibrary.net/db/ii6/cordoba%20historic%20medieval%20structure.htm>

The lack of harmony, balance and specific policies for management, conservation and management of the cultural heritage, does not take into account practical reflection as a particular issue (Lempert et al. 2004). Thus, as the environmental performance of traditional water infrastructure under the effects of adverse weather conditions.

The hydraulic heritage posse important values: natural, economic, aesthetic, productive, symbolic, and others, whose consideration is closely related to water management within a given territory. There is a need to evaluate the hydraulic heritage by the danger and risks that this subject due to the conditions of climate change and the frequency of use and intervention of man, a responsibility we must assume, by developing new methodologies and effective management policies. This will make better environmental decisions with regard to these natural assets, with solid and sustainable foundations. It is necessary to disseminate knowledge, prediction and modeling of climate change and its relationship to hydraulic heritage.

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