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# Discovering the roots of human and environmental sustainability in the 'Golden Age' of Muslim civilisation

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## Abstract

Environmental sustainability has represented a challenge to humanity since the beginnings of settled existence. As a consequence, lessons from the past are still relevant today, if not more so in the light of concentrations of populations and technology with global impacts. Principal threats to sustainability centre on the management of key biogeochemical cycles and the land itself.

Water is a prime example of this, where depletion of groundwater resources and pollution as a result of salinization are an ever-present and ever-increasing problem. Collapses of ancient agricultural systems led to early civilisations developing increasingly elaborate practices of water management. This was particularly so in the Islamic Golden Age, where it reached its technological zenith with water raising machines such as those developed by the 12<sup>th</sup>C CE polymath al-Jazari.

Maintaining soil structure and fertility represented another environmental challenge. Renewable nutrients in the form of animal faeces were used as fertiliser, such as in the pigeon towers of Isfahan, Iran, and it was not until the 18<sup>th</sup>C CE that inorganic fertiliser was routinely used. Today, the finite nature of inorganic fertiliser represents a threat to agricultural sustainability and food security.

Managing land and landscapes has a long tradition, and access, land-use and the concept of human-land interaction in semi-natural ecosystems goes back to pre-Islamic times and was codified in the concept of *Al Himā*. These traditions spread throughout the Islamic world during the Middle Ages and their adoption in the Middle East and Mediterranean Basin gave rise to the British/European model of national parks.

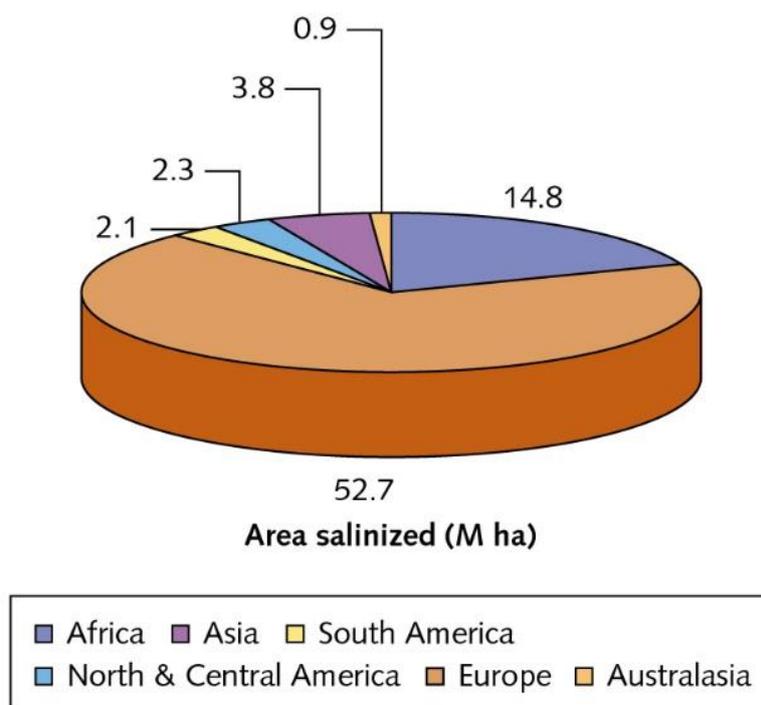
## Introduction

The importance of environmental sustainability in maintaining human health and well-being is well recognised, along with the negative impact of environmental degradation (1). This was recently highlighted by the Rockefeller Foundation-*Lancet* Commission on planetary health, which acknowledged the influential role that health professionals have in promoting planetary health (2). Central to this is the need for scientists and policy makers to adopt an evidence based approach in communicating challenging issues such as risk and uncertainty (3). However, such challenges are not new as can be seen in Ibn al-Haytham's admission that, in the light of evidence available to him in the 10<sup>th</sup>C CE, the flooding of the Nile could not be alleviated without potentially serious consequences (4), (5). So we turn to the history to demonstrate the enduring need for sustainable ecosystem management.

## Lessons from the past

Post-Industrial Revolution society has often viewed the past as irrelevant to development, but in the words of George Santayana (1906) *Those who cannot remember the past are condemned to repeat it* (6).

An example of this is our management of water. Although humankind is dependent on groundwater, lakes and rivers, this is only a very small part of the global extent of the resource, as 97% is in the ocean, 2% in polar and glacier ice, <1% in lakes, rivers and ground water and a mere 0.001% in the atmosphere (7). Thus, even though water is ultimately renewable through the hydrological cycle the fact that we are dependent on less than 1% makes it a precious and frequently fought over commodity. Yet when we get our hands on it we do not always use it wisely. Excessive irrigation of soils, especially in climates where evaporation exceeds precipitation, results in salinization a process by which salts are drawn to the surface of the soil. This is a growing challenge worldwide as over 76 million hectares of land are salinized (see Figure 1) (8) but is far from a new problem.



**Figure 1** The level of salinization worldwide (9)

The water raising machines such as those designed by the great engineer and polymath al-Jazari in his book *The Book of Knowledge of Ingenious Mechanical Devices* (10) brought automation of irrigation to its technological height. However, the application of this technology required skill, so much so that the cradle of agriculture in early Mesopotamia witnessed its collapse and along with it the fledgling civilisation that was starting to build

around it. The peoples retreated north and were able to take their know-how with them and continued to add value to their agricultural technology only to re-emerge in the region centuries later. However, his bitter lesson was never quite forgotten and early Islamic civilisations used of water-raising technology wisely. It is salutary to note that many great civilisations fell through salinization, with Rome and Egypt being classical examples- but the spectre of salinization remains with us today (11), (12).

### **Fossil plant fuel**

Modern agriculture depends on inputs - fertilisers, fuel and pesticides, all of which are energy rich, a phenomenon referred to as the 'energy subsidy' (13). What most people do not release is that the phosphate in the fertiliser comes from a finite source – fossilised guano deposits in Morocco, China, Algeria and Syria (14) and on remote pacific islands (15). There has been considerable debate concerning the timing of 'peak phosphorus' the global peak of phosphorus extraction (16). This poses two challenges to sustainability: firstly, an energy subsidy in the form of fossil fuel is required to extract and support the material and secondly the resource is itself a fossilized, finite and non-renewable (17).

Once again, history provides clues to a possible solution, as before 18<sup>th</sup>C CE trans-global sea trade, phosphate fertiliser was principally organic in nature. In Isfahan, Iran, ancient towers predating Islam were frequently built in identical pairs, acting as granary and giant pigeon lofts respectively (18). A secured tower would be the granary, whilst that with openings would be home to pigeons who whilst roosting would produce faeces that could be collected and used to fertilise crops and process leather.



**Figure 2.** Pigeon tower and granary on the Iranian plateau. (muslimheritage.com)

The keeping of pigeons for food, fertiliser, carrying messages and objects was commonplace in the Middle East and the Mediterranean Basin. These, and other agricultural practices, were documented by Ibn Al-Awwam his book *Kitab Al-Falahat* (book of agriculture), an 12<sup>th</sup>C CE

Andalusian scholar who spent much of his academic life researching contemporary and historical agricultural practices of Arabia, Egypt, Greece, Persia and Rome (19).

The tradition of a multipurpose pigeon loft spread throughout Europe and beyond, but fell out of fashion in the 18<sup>th</sup>C CE when in revolutionary France the Second Article of the August Decree on the 4<sup>th</sup> August 1789 declared...

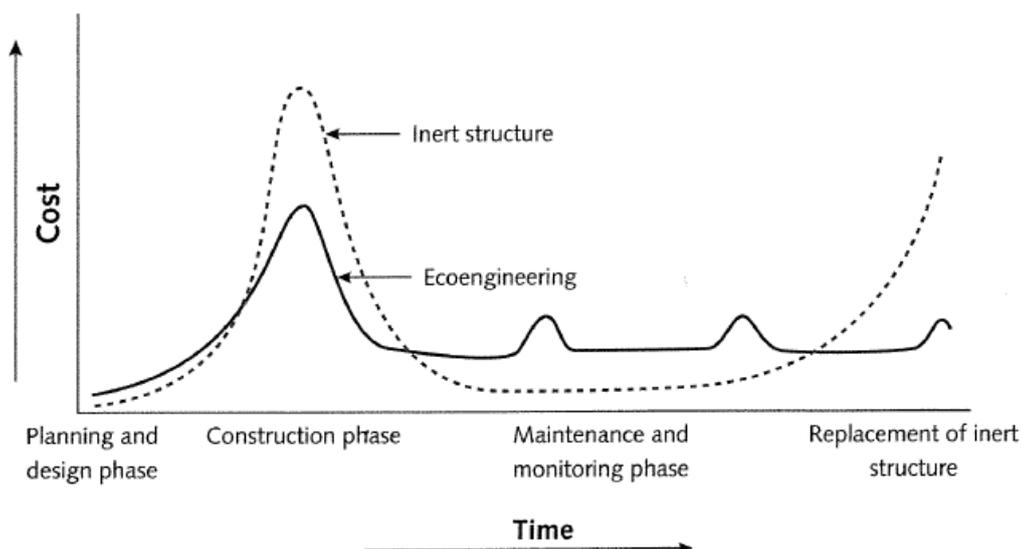
*“The exclusive right of fuites [allowing birds to graze] and dovecotes is abolished. The pigeons will be locked up during times determined by the communities. During these periods, they will be considered prey, and anyone will be allowed to kill them on their properties”* (20)

As we approach peak phosphorus and prioritize renewable over finite resources, such historic methods will prove a valuable source of more sustainable agricultural practices. Along with this will be the development of new technologies to realize the potential of the many secondary sources of phosphorus that are as yet unexploited (21).

### Ecoengineering

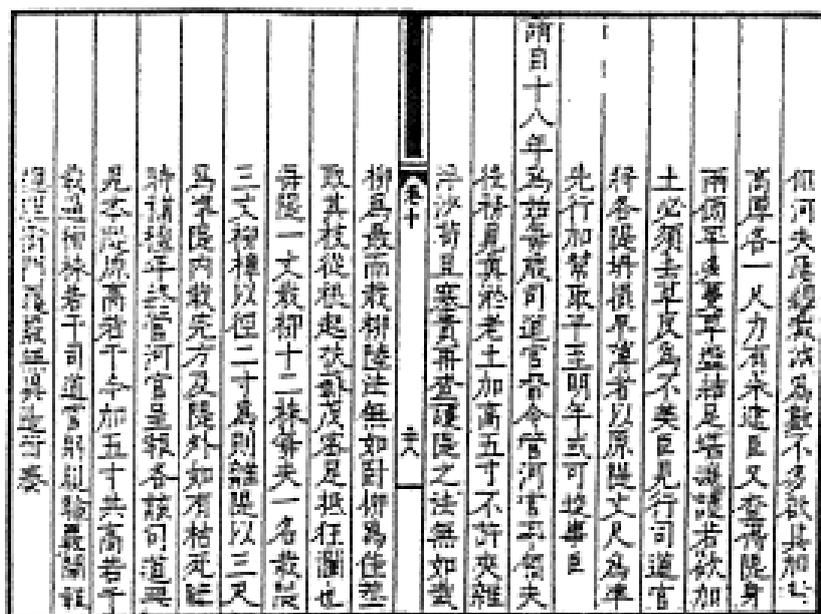
Ancient civil engineering techniques are also undergoing something of renaissance. Banks and cuttings for road and rail are increasingly making use of vegetation to assist in their stabilization (22).

So-called ‘soft’ engineering had advantages over conventional ‘hard’ engineering as the structures have a potentially longer life time and have the advantages sustainable management and maintenance rather than costly replacement (Figure 3).



**Figure 3** The cost vs benefit between ‘hard’ and ‘soft’ engineering. (23)

Historic evidence continues to emerge from the along the ancient ‘Silk Road’ demonstrating that ecoengineering has a long and respected tradition. Throughout the Middle Ages the Chinese made use of vegetation in the form of fast growing willow trees (*Salix* spp.) as figure below shows (Figure 4).



**Figure 4 Advice from Pan (Minister for Flood Control) Ming Dynasty 1591 CE.**

*“It is observed that both sides of the earth dam embankment surfaces are covered with creeping sage grasses, which provide sufficient surface protection. If it is intended to raise and thicken the embankment, the grasses have to be removed and the surface protection condition could become worse ... It is revealed that the best method for protecting the embankment is planting willows. Among the six planting methods of willow, the lateral planting is best. Since this method permits the willow’s branches to grow much closer from the root system, thus it allows the willow to have much blooming branches to resist the impact of impounding water. Every 1 zhang (320 cm) of embankment should be planted with 12 willows ... The willow should have a minimum girth of 2 cun (3.2 cm) and stick out from the embankment for 3 chi (96 cm). The planting should start from the inner to the outer portion of the embankment. Any dead willows found should be replaced immediately...”* (24)

The benefits of such techniques on both ecosystem and human health are well recognised. Recovery from disease and injury is known to be affected by the presence of greener surroundings (25). Meanwhile, research from the United Kingdom has shown that those in England living in proximity to green space had lower death rates compared to others, with 1,300 extra deaths in low income areas where the provision of greenspace was poor (26). This indicates that the land management plays a key role in both planetary and human health.

### **The historic roots of protected landscapes**

Al Hima has its roots in pre-Islamic land management which was later refined by custom and codified by Islamic law. The concept applied to both nomadic and settled communities and served the function of ensuring sustainable land-use.

At its heart lay the idea of reserved pasture, where trees and grazing lands are protected from indiscriminate harvest on a temporary or permanent basis, in which, as the name suggests, certain activities were forbidden. Its origins are thought to have been the actions of nomadic chiefs who sought to protect their flocks from drought and starvation. In ancient Mesopotamia, Egypt, India and China and throughout the ‘Silk Road’, rangelands, hunting grounds, parks and gardens received legal protection. Hunting was restricted by ‘closed

seasons’ to allow game to breed, restrictions were placed on the amount of timber that could be felled and species were protected by royal decrees. With the emergence of Islam, the function of Al Himā changed. The underlying philosophy and responsibility of humans to manage land sustainably was viewed as essential civic and religious duty. These areas were formally defined, subject to restrictions on development, used for not-for-profit communal activities, and subject to land management protocols (27).

This type of land management is a global human imperative, as protected areas are found in traditions worldwide from the Incas, first nation Americans and Aboriginals *etc.* However, it is the subsequent evolution of Al Himā in the Islamic Golden Age and its prevalence along the Silk Road and around the Mediterranean Basin which has had a lasting influence on today’s landscape conservation.

Al Himā embodied the idea of conservation within a human-managed landscape and this idea was the prevalent landscape management system within Europe due to historic land use and population distributions. As a result of this, when the concept of ‘national parks’ arose in the late 19<sup>th</sup>C CE there was a subtle difference between the first national parks, typified by Yellowstone in the United States of America and what emerged as national parks in the United Kingdom. Whilst the former involved the separation of nature and human activity in seeking to preserve wilderness, those of the latter were inextricably linked with semi-natural habitats and human activity (28), (29). The similarities and differences are shown in Table 1 below and evidence the influence of earlier land-use traditions such as Al Himā.

<b><i>Al Himā</i></b>	<b><i>UK/European National Parks</i></b>	<b><i>Other National Parks</i></b>
Community-based	Government/community-based	Governmentally-based
Natural/Semi-natural	Natural/Semi-natural	Wilderness
Managed for sustainable use	Managed for sustainable use	Managed for conservation
Controlled human use	Controlled human use	Minimal human use
Benefit to local community	Benefit to local and wider community	Limited community benefit

**Table 1      Attributes of the principal national parks compared with Al Himā**

### **Conclusion**

There has always been a need for sustainable environmental management. However, during periods when global climatic disasters are increasing in frequency and geopolitical and socio-economic changes are occurring, there is a concomitant requirement to enshrine sustainability in policy and practice at a global, national and local level. The Rockefeller-*Lancet* Commission on planetary health uncovered substantial gaps in our knowledge of both planetary health and its impact on human health and wellbeing. In response to this they recommend that more transdisciplinary research is required to address this shortfall (30).

The persistence of traditional environmental practices suggests their capacity for intrinsic resilience, and research into the underlying mechanisms promises to reveal the secrets of their success which can potentially lead to new and more sophisticated techniques. Part of this research should include systematic studies of historic sources, such as those produced during the Islamic Golden Age, not least that they represent cross cultural collaborations that sustained a civilisation for more than a millennium.

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