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Aquaculture: A Millenary History and a Sustainable Future Option

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Abstract
Aquaculture, understood as the set of techniques dedicated to the cultivation of aquatic organisms under controlled conditions, is a millenary practice that has evolved from sustainable traditional systems to global industrial models. This paper presents a historical and geographical overview of aquaculture, from its earliest records in China, Egypt, Australia, and South America to its consolidation as a food security strategy recognized by organizations such as the FAO. It also highlights its cultural value, especially in cases such as the Cistercian ponds of Central Europe or the Budj Bim landscape in Australia, which was declared a World Heritage site. Document and regulatory reviews confirm the potential of these systems to address contemporary challenges such as climate change, biodiversity loss, and sustainable food resources. The analysis emphasizes the importance of integrating traditional knowledge with technological innovation, promoting an aquaculture model that is culturally meaningful, environmentally responsible, and economically viable for future generations.

Keywords: Aquaculture, sustainability, cultural heritage, food security, biodiversity.

1. Aquaculture and its Historical Evolution
Aquaculture is defined as the set of techniques and knowledge intended to cultivate aquatic organisms—fish, crustaceans, molluscs, and algae—under controlled conditions. Today, it represents one of the key strategies for ensuring global food security. As recognized by the Food and Agriculture Organization of the United Nations (FAO), aquaculture is essential for increasing food availability, generating employment, and reducing pressure on marine ecosystems [1].
Although often associated with technological developments of the 20th century, aquaculture has millenary origins. Numerous archaeological findings on various continents show aquatic farming practices since prehistoric times, making it difficult to pinpoint a single time or place of origin.
In Australia, between 8000 and 6000 BCE, the Gunditjmara Aboriginal people of the Lake Condah floodplain managed a system of artificial ponds and canals to farm eels year-round. In 2019, UNESCO recognized the Budj Bim cultural landscape as a World Heritage Site [3], emphasizing that this ancestral aquaculture was the economic and social foundation of the Gunditjmara for over six millennia.



Fig. 1: Aquaculture canal and pond in the cultural landscape of Budj Bim (Australia), UNESCO World Heritage Site. © Corporación Aborigen de Propietarios Tradicionales Gunditj Mirring / © Gunditj Mirring Traditional Owners Aboriginal Corporation.

In South America, around 1 CE, the inhabitants of the Beni region (Bolivia) integrated irrigation canals and raised fields as fish reservoirs, ensuring food supply in flood-prone areas. This hydraulic system was declared a Biosphere Reserve in 1986 [4].
Meanwhile, in the Pacific, the Hawaiian people developed coastal pond aquaculture systems from the 3rd century CE—known as loko i‘as—where they farmed mullets, milkfish, crabs, and prawns. These systems were integrated with the cultivation of algae and taro, showcasing an early form of holistic and ecological aquaculture.



Fig. 2: Menehune fishpond in Hawaii, linked to ancestral indigenous knowledge. Image attributed to Menehune folklore

In Asia, aquaculture history dates back to the Early Neolithic. In China, around 8000 BCE, common carp (Cyprinus carpio) were already being raised under controlled conditions [2], and by 3500 BCE, aquaculture was integrated with rice farming and sericulture, using silkworm waste as fish feed. These practices evolved into highly efficient agro-aquaculture systems.
The first known treatise on aquaculture—"The Classic of Fish Farming" (Yǎngyú Jīng)—was written by Fan Li around 475 BCE. It includes guidelines on pond selection, male-to-female ratios, feeding, water quality, and intensive farming techniques [8]. Many of these methods are surprisingly similar to modern practices, positioning the text as a precursor to contemporary fish farming.
In Ancient Egypt, around 2500 BCE, scenes of tilapia harvesting in artificial ponds were depicted, among the earliest forms of traditional fish farming. Meanwhile, oyster farming, practiced over 2000 years ago in Japan, Greece, and Rome, represents the oldest form of coastal aquaculture.



Fig. 3: Fragment of funerary painting of the pond in Nebamun's estate. Tomb of Nebamun, Thebes. © The Trustees of the British Museum. https://www.britishmuseum.org/collection/image/244326001

Classical Rome developed vivaria piscium, domestic ponds where fish and seafood were kept alive for immediate consumption. Wealthy Roman citizens built these pools in their villas, even in inland regions, with moray eels and oysters being particularly prized.



Fig. 4: Roman bottle from Populonia, depicting maritime structures. © Corning Museum of Glass. https://glasscollection.cmog.org/objects/6551?image=0



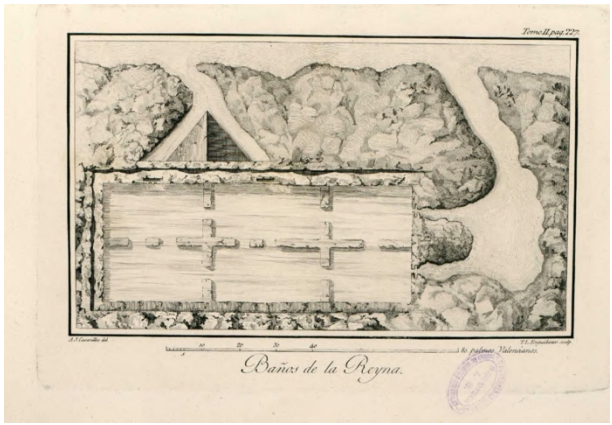

Fig. 5-6: Roman fish tanks carved into the coastal rock, known as piscinae, such as the Baños de la Reina in Calpe (165 m²), were used to raise fish in basins connected to the sea via canals. Species like turbot, sea bass, mullet, and eels were farmed. Public domain. Archaeological Museum of Alicante. Source: Antonio José de Cavanilles, Observations on Natural History, Vol. II, 1797.

Medieval Aquaculture in Europe Between the 5th and 15th centuries, aquaculture in Europe acquired a new dimension thanks to the monastic orders, particularly the Cistercians. These monks not only refined techniques inherited from the Roman Empire but also promoted a comprehensive territorial management model where fishponds became part of the productive and spiritual landscape.

Throughout feudal Europe, religious orders and aristocracy controlled land, forests, and watercourses, allowing them to develop vivaria or freshwater fish ponds. This practice became a crucial protein source, especially during religious fasting periods when meat consumption was forbidden. Carp (Cyprinus carpio) became the most farmed species and was fully domesticated during this period. Mussel farming also began, a technique that remained largely unchanged until the 20th century.



Fig. 7: Medieval scene of pond or vivarium fishing, featuring nets and vegetation, illustrating the technical knowledge of aquaculture in the 14th century. La pêche au vivier, Palais des Papes, Aviñón (1343–1344). © RMN-Grand Palais / Martine Beck-Coppola.

Between the 14th and 16th centuries, treatises were published on fish farming detailing pond construction, species selection, disease management, and feeding, demonstrating a high level of specialization. Emperor Charles IV, for example, promoted pond creation in Bohemia (now the Czech Republic), consolidating a fish farming tradition that still exists.

One of the most documented cases is the Cistercian monastery of Waldsassen in Upper Palatinate (now Bavaria, Germany). From the 12th century, the monks developed a network of over 150 interconnected ponds for carp farming, known as "sky ponds" as they were fed exclusively by rainwater. By the 16th century, this system provided enough fish to supply the monastery and local trade, becoming one of Europe's most advanced aquaculture facilities of the time [5].

The transnational project Cisterscapes[i] connects 17 former Cistercian sites via hiking trails and promotes recognition of the cultural landscape shaped by these practices. This network highlights the historical role of aquaculture in shaping the European landscape and its potential to offer solutions to contemporary challenges like climate change and food security.

2. FAO and Contemporary Recognition

The FAO considers aquaculture a key component of global food security. Traditional systems such as the mulberry-dyke and fishpond system of Huzhou, in Zhejiang—originating over 2,500 years ago—and the carp ponds in Waldviertel, Austria—with a history of more than 900 years—have been designated as Globally Important Agricultural Heritage Systems (GIAHS)[ii] in recognition of their sustainability, biodiversity, and cultural significance. These systems are characterized by environmentally responsible practices that support biodiverse aquatic ecosystems closely connected to surrounding forests. In addition to producing high-quality carp, they contribute to water conservation, biodiversity preservation, and the safeguarding of local cultural heritage.



Fig. 8: The mulberry-dyke and fishpond system of Huzhou, in Zhejiang, integrates several types of symbiotic agricultural production, such as mulberry dyke cultivation, silkworm farming, and aquaculture. © Photo courtesy of GIAHS: Zhejiang Huzhou Mulberry-dyke and Fishpond System.



Fig. 9: Carp pond farming in the Waldviertel region of Lower Austria. Photo courtesy of GIAHS/ Carp Pond farming in the Waldviertel region of Lower Austria. Editorial use only. https://www.flickr.com/photos/giahs/53965517113/in/album-72177720320012444

These ecosystems not only produce food but also provide ecological services such as water regulation, carbon retention, and habitats for numerous species. Furthermore, they foster agritourism and local innovation.

3. Conclusions

With a history spanning over 8,000 years, aquaculture has become essential for sustainable development, food security, and the conservation of aquatic ecosystems. From its beginnings in Asia, Oceania, America, and Europe, this practice has evolved from traditional water resource management to advanced production systems adapted to 21st-century challenges.
Today, aquaculture represents a real opportunity to tackle major contemporary issues: feeding a growing global population, reducing pressure on wild species, generating employment in rural areas, and promoting a circular economy based on efficiency and sustainability. When well managed, it can ensure a stable supply of nutritious aquatic food with a lower environmental impact than other forms of animal production.
The integration of historical principles into modern aquaculture—such as polyculture, agriculture-fish symbiosis, and use of local resources—offers a resilient, environment-adapted production model. Traditional knowledge, properly documented and updated, can inspire new solutions to climate change and environmental degradation.

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[i] Cisterscapes is a European cultural project that connects former Cistercian monasteries through heritage hiking routes, with the aim of preserving the cultural landscape shaped by the agricultural, hydraulic, and aquacultural practices of this medieval monastic order. https://cisterscapes.eu

[ii] The FAO's GIAHS program (Globally Important Agricultural Heritage Systems) recognizes traditional agricultural systems that integrate sustainability, biodiversity, and cultural value. Among them is the carp pond system of Waldviertel (Austria), valued for its ecological management, historical legacy, and contribution to sustainable rural development.
Source: FAO – Globally Important Agricultural Heritage Systems (GIAHS). Available at: https://www.fao.org/giahs