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Saltworks and health: Medical use of salt and halotherapy – from productive landscapes to multifunctional cultural valorization

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Abstract

Saltworks have historically constituted landscapes of production and economic activity, which in the contemporary era are being redefined as multifunctional spaces for health, wellness, culture, and sustainable entrepreneurship. The medical use of salt, rooted in ancient Greek and Roman traditions, evolved into organized forms of halotherapy, particularly in Central and Eastern Europe, where salt mines and salt pans were transformed into therapeutic environments. Inhalation of salt microparticles, saline baths, and the exploitation of the unique microclimate of saltworks have been associated with supporting respiratory function and overall well-being.

In the contemporary framework of sustainable development, saltworks are transformed from mono-functional extraction sites into complex experience hubs where health, culture, ecology, and tourism coexist. Examples such as Croatia's Solana Nin and Solana Pag illustrate a model that integrates traditional knowledge, the natural environment, and modern wellness practices, generating added value for local communities.

This study examines the transition of saltworks from production sites to multidimensional landscapes of therapeutic experience and cultural entrepreneurship, highlighting the role of salt as a natural resource, a carrier of historical memory, and a tool for sustainable regional development.

Keywords: Saltworks; Salt; Halotherapy; Health; Cultural entrepreneurship; Sustainable development

1. Introduction- Medical Use of Salt and Halotherapy in European Tradition

The therapeutic use of salt is a consistent element of European medical history, reflecting the deep relationship between the natural environment and healing practices. In ancient Greece, Hippocratic medicine incorporated the use of seawater, saline baths, and inhalation of sea air to address respiratory and dermatological conditions. This therapeutic approach was based on the belief that natural elements—air, water, and earth—significantly influence bodily balance (Maniou et al., 2025g).

The association between salt and health continued during the Roman period, where bath complexes (thermae salinae) combined hydrotherapy with social interaction. Saline pools and mineral-rich vapors were considered beneficial for the respiratory system and musculoskeletal rehabilitation (Rudenko, 2024). The Roman experience demonstrates the transition from empirical knowledge to organized therapeutic structures.

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During the Middle Ages and early modern period, areas such as Hallstatt (Austria) and Wieliczka (Poland) developed into significant salt extraction centers. It was observed that mine workers exhibited improved respiratory health compared to other populations, which led to the creation of the first underground halotherapy chambers. The stable temperature and salt-enriched air of these environments were used to support patients with asthma and chronic bronchitis (Roos, 2007).

In modern Europe, halotherapy has been systematized as a complementary therapeutic practice. Specially designed spaces ("salt caves") replicate the microclimate of salt mines or saltworks, while technology allows precise control of salt aerosol concentrations. In Croatia, Solana Nin and Solana Pag use high-purity salt in respiratory therapy and wellness programs, combining local tradition with health tourism (Valentine, 2016; Solana Nin, 2025).

The therapeutic experience extends beyond physiological effects. The microclimate of saltworks—rich in ions, sea breeze, and solar radiation—creates conditions for relaxation and psychophysical recovery. Engagement with the coastal landscape and the sense of open horizons enhance perceived well-being, embedding halotherapy within a holistic health model that bridges nature and science (Maniou et al., 2025; Maniou et al., 2025g).

2. From Productive Landscapes to Cultural and Therapeutic Spaces

Saltworks are emblematic cultural landscapes, shaped by human labor over centuries. The transition from mono-functional salt production to multifunctional uses represents a strategic adaptation to contemporary socio-economic conditions (Mitoula, 2023).

The concept of cultural entrepreneurship refers to the creative use of cultural and natural resources to generate social and economic value (Maniou, 2023). In saltworks, salt is transformed from a simple commercial commodity into a symbol of local identity and an experiential resource. Educational programs, harvest festivals, culinary activities, and wellness workshops integrate the production process into a broader narrative of culture and sustainable development (Pagkalos et al., 2025e).

Experiences from Spanish and Mediterranean saltworks show that linking culture and innovation strengthens local resilience (Maniou et al., 2025c). Similarly, Greek saltworks in Mytilene and Messolonghi possess significant cultural capital, which can be leveraged through low-impact tourism and health programs (Mitoula, 2023).

The transformation of saltworks into "living laboratories" of cultural production requires collaboration among local authorities, academic institutions, and private stakeholders. Experiences from literary parks and culinary routes demonstrate that connecting culture and entrepreneurship can create sustainable development networks (Maniou et al., 2025f; Maniou et al., 2025d).

3. Tourism, Ecology, and Research in Contemporary Saltworks

Tourism in saltworks has evolved significantly over the past decades, engaging visitors in immersive experiences that combine authenticity, participation, and connection with the natural and cultural environment (Kortekaas, 2004). Guided tours, educational programs, and themed routes interpret the productive landscape, highlighting the salt production process, the importance of natural factors such as sunlight and wind, and the connection to local economies and social life (Bacon, 1987; Calvo et al., 2009). Through experiential activities, visitors participate in salt harvesting workshops, culinary events, and wellness programs, enhancing understanding of the complex relationship between production, culture, and the natural environment (Cirillo et al., 1994).

Saltworks are also important wetland ecosystems with high biodiversity. Traditional salt production, when applied with sustainable techniques, supports habitats for migratory birds such as herons and flamingos, and for halophilic vegetation, while fostering micro-ecosystems of ecological significance (Luković & Stevanović, 2020; Florín & Montes, 1999). Protection and management of these ecosystems are essential for the long-term sustainability of both production and wellness tourism activities, creating a comprehensive framework for ecotourism and environmental education (Daniele et al., 2011).

Scientific research enhances saltworks sustainability through multi-level studies. Analyses of salt composition, monitoring of trace elements, and assessment of climate impacts contribute to product quality improvement and natural resource conservation (Townend et al., 2011; Jones et al., 2018). Continuous monitoring of salinity, temperature,

water levels, and biodiversity enables adaptive production practices, enhancing ecosystem resilience (Frey & Basan, 1985; Martín et al., 2017).

Multidisciplinary approaches that integrate ecology, geochemistry, tourism, and economics play a key role. Scientific data inform protection policies, optimize production processes, and create environmental education programs for visitors and local communities (Calvo et al., 2009; Daniele et al., 2011). The combination of research and experiential tourism enhances social acceptance of conservation actions and raises awareness of environmental challenges, positioning saltworks as models of sustainable management of cultural and natural resources.

This integrated model, in which tourism, health, ecology, and scientific research coexist, strengthens local community resilience and transforms saltworks into examples of sustainable regional development (Cirillo et al., 1994; Luković & Stevanović, 2020; Jones et al., 2018; Calvo et al., 2009). It allows the preservation of natural and cultural characteristics of saltworks while generating new opportunities for wellness tourism, environmental education, and cultural entrepreneurship, establishing salt as a strategic resource at multiple levels.

4. Cross-Sectoral Collaboration and the International Economic Dimension of Saltworks

The modern dynamics of Croatian saltworks cannot be understood solely through the lens of primary salt production. Their sustainability relies on a complex network of cross-sectoral collaborations that extend beyond traditional salt production, integrating gastronomy, pharmaceuticals, wellness, tourism, and international trade. This transition marks a shift from isolated production units to a collaborative development model, in which saltworks function as nodes connecting different economic and cultural sectors (Pandža et al., 2007).

In gastronomy, salt is elevated from a basic dietary component to a high-value product with distinct organoleptic characteristics and clear geographical identity. Collaborations with high-quality restaurants, chefs, and local food producers highlight the unique taste of each region. Salt from Solana Pag, for instance, is incorporated into dishes showcasing local cuisine and traditional products, reinforcing the connection between product and place of origin (Solana Pag, 2025). Participation in culinary festivals and gourmet networks increases visibility in markets emphasizing quality and authenticity, establishing salt as a marker of cultural identity and a differentiating factor in the tourism product.

Collaboration with the pharmaceutical and wellness sectors is equally significant. Natural sea salt, due to its purity and trace element content, is used in halotherapy, inhalation treatments, and personal care products. Saltworks supply raw materials to spa centers, therapeutic tourism facilities, and cosmetic and wellness product manufacturers, broadening their economic scope (Roos, 2007). Shifting from raw material sales to branded high-value wellness products enhances competitiveness in markets linked to preventive and holistic health.

The tourism industry also plays a pivotal role, incorporating saltworks into comprehensive experience networks. Through partnerships with travel agencies, hotels, and local promotion agencies, visits to saltworks become part of broader narrative routes combining nature, culture, and gastronomy. Saltworks are no longer isolated destinations but are integrated into themed routes and experience packages targeting visitors seeking high-quality and authentic experiences. This strategy contributes to diversifying Croatia's tourism product, particularly in regions aiming to reduce dependence on mass seasonal tourism (Pandža et al., 2007).

Cross-sector networking directly relates to the international economic dimension of saltworks. Although Croatia is not among Europe's largest industrial salt exporters, its saltworks occupy a niche in specialized markets for natural and traditional products. Growing international demand for unprocessed, gourmet, and certified products presents opportunities for goods with strong cultural and geographical identity (Petanidou & Dalaka, 2009). In this context, Solana Pag and Solana Nin salt is exported as a branded product, accompanied by narratives highlighting its history and production landscape (Solana Nin, 2025).

Economic sustainability does not depend solely on export volume but on diversifying revenue sources. Beyond culinary salt, significant income derives from high-quality gastronomic products, wellness items, and raw materials for therapeutic applications. Linking production with tourism creates a feedback loop between experience and consumption, as visitors purchase local products as high-value souvenirs, supporting the local economy.

Saltworks also benefit from European and national funding programs for rural development, cultural landscape protection, and sustainable tourism. These policies recognize the value of connecting primary production with tourism and the creative economy, reinforcing long-term economic resilience (Petanidou & Dalaka, 2009; Rudenko, 2017).

Overall, Croatian saltworks exemplify an integrated development model, in which synergy between production, culture, and services generates mutual benefits. Integration with gastronomy, wellness, tourism, and international trade demonstrates that salt can function not only as a natural resource but also as a strategic tool for sustainable regional development, based on quality, identity, and cross-sector collaboration.

Finally, the significance of all digital technologies in the field of cross-sectoral education, as well as for training and education in cultural entrepreneurship, is emphasized. ICTs promote education for all, provide innovative ways to educate instructors effectively, enhance knowledge retention, foster teamwork, increase transparency, develop learner-centered approaches, develop new teaching strategies, and speed up learning. Additionally, offer new resources for representing knowledge and support educational initiatives and approaches through artificial intelligence, mobilization, virtualization, and new learning environments. With regard to cultural entrepreneurship training in particular, ICTs are highly effective and productive. They help and enhance the evaluation, intervention, and educational processes through mobile devices, which make learning activities accessible everywhere [31], as well as through a variety of ICT applications, which are the main force behind education [32-35]. The use of AI, STEM, and robotics elevates teaching methods to new heights of flexibility, creativity, and effectiveness [36-39], and games change learning into a multimodal, amiable, and joyful experience [40]. Furthermore, integrating ICTs with theories and models of well-being metacognition, mindfulness, meditation, and emotional intelligence development [41-45] enhances and accelerates educational practices and outcomes, particularly in training for cultural business owners and entrepreneurs [38-44]. This puts well-being and mental skills at the center of educational procedures and policies.

5. Conclusion

Today, saltworks are emerging as multifunctional landscapes of high value, where salt production, health, culture, ecology, and entrepreneurship form a cohesive and comprehensive development framework. Halotherapy and wellness practices, rooted in the long-standing European tradition, acquire modern relevance, while cultural entrepreneurship enhances the economic and social dynamics of local communities, creating new opportunities for employment and innovation.

The transition from mono-functional productive landscapes to a multidimensional model combining therapeutic experience, environmental protection, and cultural enhancement does not erase the historical identity of saltworks; instead, it strengthens and redefines it. Salt now functions as a bridge between nature, science, and culture, while offering a tool for sustainable development that integrates tradition with contemporary health, wellness, and environmental resilience needs.

Thus, saltworks become models of multifunctional landscapes capable of integrating production, tourism, research, ecological management, and cultural entrepreneurship, offering a framework of sustainable regional development that can serve as a guide for similar initiatives at European and global levels.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors proclaim no conflict of interest.

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