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INTEGRATING THE ONE HEALTH APPROACH INTO THE DANUBE DELTA BIOSPHERE RESERVE

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Abstract. The Danube Delta Biosphere Reserve (DDBR), recognized as a UNESCO World Heritage Site and a Ramsar site of international importance, is a unique ecosystem in Europe, characterized by remarkable biodiversity, strong interaction between humans, animals, and the environment, as well as high vulnerability to climate change, emerging diseases, and anthropogenic pressures. In this complex context, the integration of the One Health concept — a transdisciplinary approach that recognizes the interdependence between human, animal, and ecological health — becomes essential to ensuring the environmental, social, and economic sustainability of the region. The article analyses the opportunities and challenges of applying the One Health concept in DDBR, based on an assessment of the local context: dominant economic activities (fishing, agriculture, tourism), public and veterinary health infrastructure, and the socio-cultural characteristics of local communities. It identifies the main risks associated with human-animal-environment interactions, such as the transmission of zoonoses, water pollution, and habitat loss, as well as ways in which integrated governance could contribute to their prevention. The paper proposes a framework for operationalizing the One Health concept in the Danube Delta, based on four main ideas: strengthening inter-institutional cooperation between public health, veterinary medicine, environmental protection, and local government officials; developing integrated systems for monitoring biological and environmental risks; promoting interdisciplinary research and data exchange between academic institutions and authorities; involving local communities in the decision-making process through education, awareness-raising, and active participation. By showing how important One Health is in a protected area that is strategic for both biodiversity and health and food security, the article helps shape a model of integrated governance that can be replicated in other vulnerable regions. In conclusion, implementing a One Health approach in the DDBR is not just an opportunity, but a necessity in the face of current challenges, with long-term benefits for collective health and ecosystem resilience.

Keywords: Danube Delta, One Health, biodiversity, ecology, environment, communities

1 INTRODUCTION

The One Health concept, internationally recognized as an integrated approach to human, animal, and environmental health, has gained increased importance in the current global context, characterized by intensifying climate change, the emergence of infectious diseases, and growing pressures on ecosystems. Its application is all the more relevant in areas of high biodiversity and intense interaction between humans, animals, and nature, such as the Danube Delta Biosphere Reserve (DDBR).

Located in southeastern Romania, the DDBR is one of the most valuable wetland regions in Europe, recognized for its biological diversity, unique natural landscapes, and essential role in regulating ecosystem services. (ARBDD 2022, UNEP & ILRI 2020) This article explores how the One Health approach could be integrated into conservation, governance, and sustainable development strategies for the Danube Delta, while identifying the challenges and opportunities specific to this context.

1.1 Theoretical basis of the One Health concept

One Health is a paradigm that asserts that human health, animal health, and environmental health are interdependent and must be managed through interdisciplinary collaboration. (fig. 1) (Mackenzie, Jeggo 2019). Its modern origins can be traced back to the efforts of the World Health Organization (WHO), the World Organization for Animal Health (WOAH), and the United Nations Environment Programme (UNEP), which promoted tripartite collaboration to combat zoonotic diseases and protect ecosystems. (Destoumieux-Garzón et al, 2018)

The concept has been consolidated through key documents such as the "*Tripartite+ Concept Note*" and the "*One Health Joint Plan of Action 2022–2026*" framework. (World Health Organisation 2022) Its application is fundamental to the prevention and control of zoonotic diseases, the fight against antimicrobial resistance, food safety, and environmental protection.

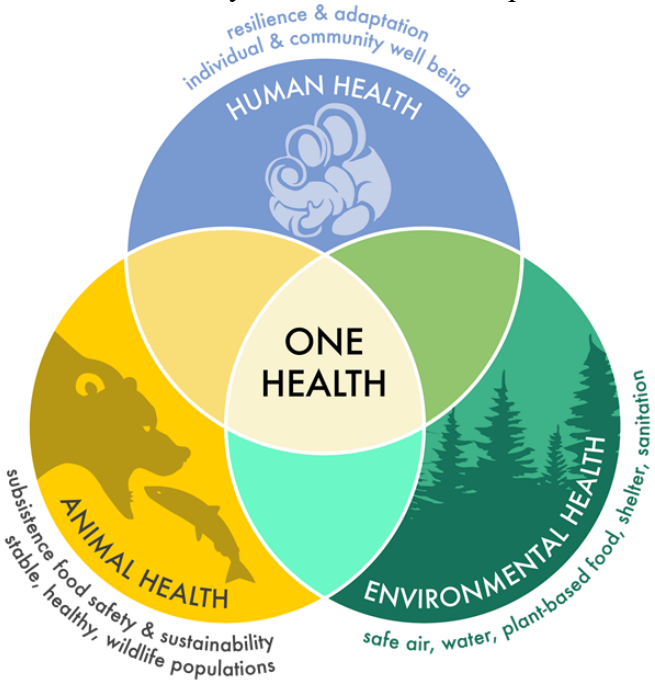

Figure 1. The One Health concept (https://www.uaf.edu/onehealth/)

1.2 Brief description of the Danube Delta Biosphere Reserve

The Danube Delta is one of the most important wetlands in Europe and a natural heritage site of global value, recognized by UNESCO. Located in southeastern Romania, at the mouth of the Danube River where it flows into the Black Sea, the reserve is home to impressive biodiversity: over

5,500 species of flora and fauna, many of which are rare or endemic, in 20 natural ecosystems. (Guvernul României 1993, 2000, 2023)

In addition to its natural wealth, the Delta is also home to approximately 15,000 inhabitants, spread over an area of 3,446 square kilometers, organized into fishing, agricultural, or tourist communities. Human activities such as fishing, agriculture, and tourism coexist with conservation efforts in a delicate balance.

These characteristics generate a complex human-animal-environment relationship, with a high potential for the transmission of zoonotic diseases, contamination of water resources, and habitat degradation. (INSP 2023; UNEP & ILRI 2020) At the same time, limited access to medical and veterinary services, poor infrastructure, and economic pressures accentuate the socio-ecological vulnerability of the area.

The DDBR begins at the confluence of the Danube and the Black Sea, at Cotul Pisicii and Sulina, with its western boundary being the contact between the Dobrogea Plateau and the wetlands, and its southern boundary being the Razim-Sinoe lagoon complex and Cape Midia. (fig. 2)

Geographical limits:

- Northern limit: The Chilia branch.
- Southern limit: The Razim-Sinoe lagoon complex and Cape Midia.
- Eastern limit: The town of Sulina and the bend in the Danube known as Cotul Pisicii.
- Western limit: Contact between the Dobrogea Plateau and the wetlands.

This area extends over the counties of Tulcea, Constanța, and Galați.

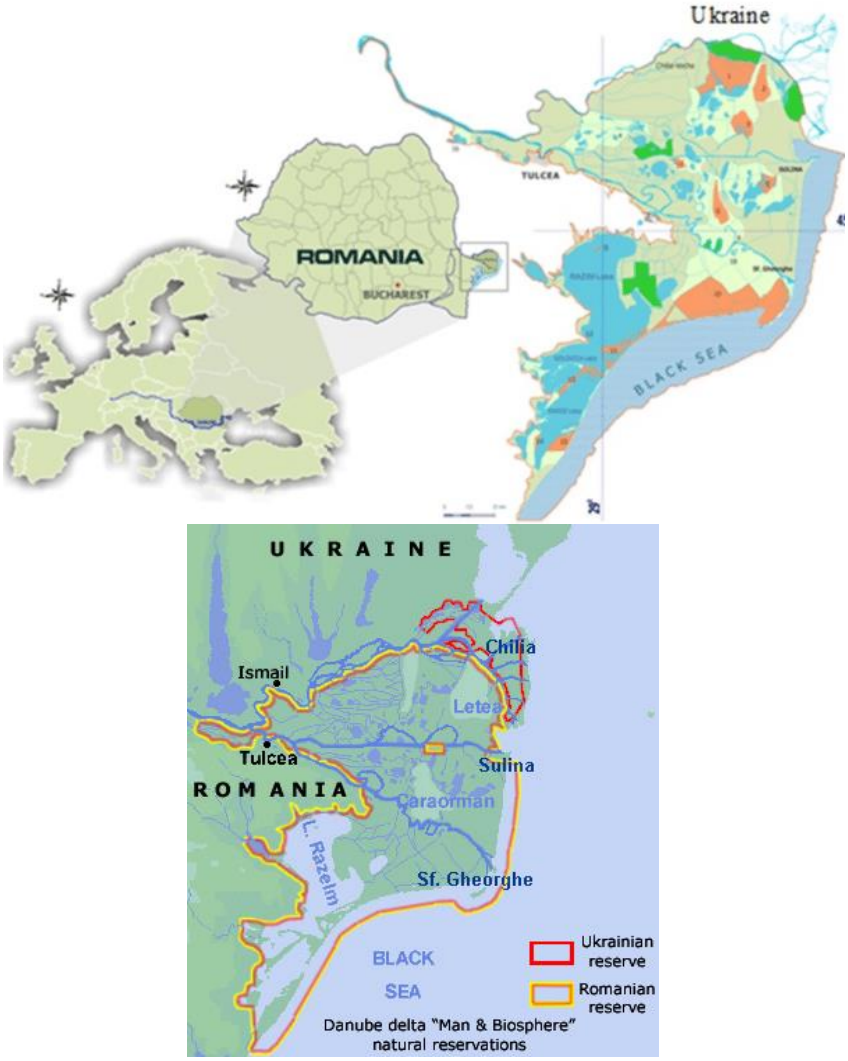

Figure 2. DDRB – geographical position and limits (www.researchgate.net)

2 METHODS

This research uses a mixed approach, combining qualitative and quantitative methods, to analyze the potential of integrating the One Health concept in the specific context of the DDBR. The aim is to understand the connections between human, animal, and environmental health, as well as the barriers and opportunities for implementing this approach in the region.

The documentary analysis was based on DDRB management plans, biodiversity reports, national public health and veterinary strategies, and documents relevant to One Health, and aimed to identify the current political and institutional framework, as well as any gaps or overlaps between sectors.

The "*One Health Joint Plan of Action 2022–2026*" aims to prevent, detect, and combat health threats that arise at the intersection of humans, animals, plants, and the environment. It is a collective plan by the Quadripartite to integrate the One Health approach at all levels. It contains six areas of action, three intervention pathways, and a step-by-step framework for implementation. It promotes global collaboration and provides strategic and technical guidance for nations and organizations. The "*One Health Joint Plan of Action 2022–2026*" provides a valuable framework for:

- developing integrated One Health policies in line with national and EU strategies;
- foundations for national One Health plans, in line with EU & UN requirements;
- focus on surveillance capabilities, response to zoonoses, AMR, food safety, and the environment—exactly the critical areas for the Danube Delta Biosphere Reserve.

The secondary data analysis took into account official statistics from the Tulcea Public Health Directorate, National Sanitary Veterinary and Food Safety Authority, Danube Delta Biosphere Reserve Administration, and the National Institute of Statistics, but especially the national strategies that create the reference framework.

The strategies below clearly reflect the One Health principles:

- Romania's National Strategy for Sustainable Development (until 2030) promotes: international cooperation with Danube countries to improve water quality and reduce the impact of pollution flowing into the Black Sea; sustainable management of living aquatic resources through an ecosystem approach and control of illegal fishing; support for research in protected areas and living aquatic resources;
- The Danube River Basin Integration Strategy – EU (EUSDR) supports: restoring water quality by modernizing wastewater treatment plants, reducing diffuse pollution, and managing nutrients in agricultural areas; adaptation to climate change: promoting drinking water and retention systems, supporting fish migration through hydraulic connectivity; transnational cooperation for risk prevention and wetland restoration, including in the Danube Delta;
- Integrated Sustainable Development Strategy for the Danube Delta (2014) establishes an integrated framework for sustainable development: biodiversity conservation and improvement of the quality of life of residents and organizes strict zoning of the DDRB: 16 strictly protected areas, buffer corridors, and regulated economic zones (e.g., sustainable tourism, controlled fishing);
- Strategies related to biodiversity and fisheries (national and EU policies) through: aligning national policies with the EU Biodiversity Strategy (post-2020); sustainable use of fish resources and conservation of the marine environment (e.g., waste reduction, selective fishing, rigorous inspections against illegal fishing); control of invasive species and rehabilitation of affected wetlands; (Finlayson, Horwitz 2015)
- Local strategies: Danube Delta Local Action Groups – Local Development (2021–2027) with financial support and projects for local communities in rural tourism, sustainable fishing, and

organic farming; focus on know-how transfer and strengthening administrative capacity at the local level;

- National scientific programs implemented through The Danube Delta National Institute for Research and Development (DDNI) which leads important projects, as: MORFDD, COMADUREP, DANSTUR – sturgeon conservation, aquatic environment compliance assessment, mathematical models for wetland reconstruction; or, PN3, HADIT CHANGE, IASON, DNAqua Net, CERES programs – biodiversity, climate change, invasive species, and genetic bioassessment.

Field observations formed the basis for understanding the interaction between people, animals, and the environment in the context of daily activities in the Delta (e.g., fishing, tourism, agriculture, transportation).

3 RESULTS

3.1 Local context

The assessment of the local context highlights the need for an integrated and multisectoral approach, in line with the One Health principles. The Danube Delta is an area where human, animal, and ecosystem health are deeply interconnected. (Rewilding Europe 2021) Any effective intervention must take into account the specific socio-cultural context, economic vulnerabilities, and existing infrastructure limitations. Implementing a One Health strategy in the DDBR will require inter-institutional cooperation, government support, adequate funding, and the active involvement of local communities.

- Socio-cultural characteristics of local communities

a. Ethnic diversity and cultural identity

o ethnic composition:

The Danube Delta is one of the most ethnically diverse regions in Romania. According to the 2021 census, the population consists of:

- Romanians (majority, approx. 65%);
- Lipovan Russians (20–25%);
- Ukrainians, Greeks, Turks, and Tatars, in smaller proportions.

o vultural value:

- the communities preserve distinct traditions in food, folk medicine, spirituality, and their relationship with nature;
- in Lipovan villages (e.g., Mila 23, Sfântu Gheorghe), the old Orthodox rite is observed and Russian is used in everyday conversation;
- in some Ukrainian communities (e.g., Chilia Veche, Periprava), popular culture is influenced by myths and archaic practices of coexistence with nature.

o One Health implications:

- health communication approaches must be multilingual and culturally adapted to be effective;
- traditional healing or self-medication practices may interfere with modern treatments (e.g., the use of plants or empirical ointments instead of medical intervention);
- perceptions of wild and domestic animals are often shaped by orally transmitted beliefs, which can influence attitudes toward vaccination, sterilization, or vector control.

b. Social structure and living conditions

o standard of living:

- many households in the Danube Delta live below the poverty line. According to the official data, almost 40% of the Delta's inhabitants have incomes below the minimum guaranteed income;
- basic public services (drinking water, sewage, stable electricity, internet) are lacking in more than a third of the localities in the DDRB.

o access to infrastructure:

- unpaved roads or complete lack of land access in certain villages;

- transportation during the cold season becomes impossible in some areas, completely isolating communities.

o risk behaviors:

- in the absence of drinking water, many residents use water from the Danube or unprotected wells, exposing themselves to intestinal infections and liver disease;
- practices such as dumping household waste into canals or letting animals roam free are common and exacerbate public health problems.

o One Health implications:

- poor housing and hygiene conditions are factors that favor the emergence of emerging and re-emerging diseases;
- in the absence of integrated socio-medical interventions, the risks to collective health (human and animal) remain high;
- community participation in decision-making is limited by a lack of social capital and trust in state institutions.

c. Level of education, awareness, and access to information

o relevant statistics:

- the school dropout rate in Tulcea County is 15.3%, above the national average (13%);
- only 7% of adults in isolated areas have higher education, and access to continuing education is almost non-existent in communities such as Caraorman, Letea, or Pardina.

o lack of functional literacy:

- in some villages, the level of understanding of public messages (including health or environmental messages) is low;
- terms such as "zoonosis", "antimicrobial", "vector", or "biosecurity" are not understood by the majority of the population without further explanation.

o One Health implications:

- the need to develop adapted educational materials (visual, audio, interactive) and translate them into minority languages;
- promoting health education in schools, but also in churches, local associations, or community workshops;
- without a minimum level of awareness among the population, health prevention or environmental protection strategies are ineffective.

✓ Dominant economic activities in the DDRB

a. Fishing

o current context:

Fishing is the traditional economic activity fundamental to communities in the DDRB, with a history stretching back thousands of years. According to official data, around 70% of households in the Danube Delta derive direct or indirect income from fishing.

o characteristics and risks:

- the vast majority of the activity is carried out by artisanal fishermen, who use small boats without refrigeration and adequate processing infrastructure;
- overfishing, especially during closed seasons, has led to a considerable reduction in fish stocks, particularly for important commercial species (pike, catfish, carp, zander);
- the introduction of invasive species (e.g., dwarf catfish) contributes to ecosystem imbalances.

o One Health implications:

- poor hygiene in fish handling (lack of gutting, transport in improper conditions) can generate food risks (*Salmonella spp*., *Vibrio cholerae non-O1/O139*);
- fishing activities without sanitary-veterinary control (e.g., informal processing in households) contribute to the transmission of zoonotic diseases;
- frequent exposure to contaminated water promotes the development of dermatitis, leptospirosis infections, and acute diarrheal diseases.

b. Agriculture

o general characteristics:

- it is mainly practiced in villages located near consolidated sandbanks and agricultural terraces (Murighiol, Beștepe, Dunavățu de Jos);
- peasant households practice subsistence farming, with limited resources and minimal inputs;
- in addition to corn, sunflower, and vegetable crops, livestock farming (sheep, cattle, pigs) is still an important component.

o challenges and risks:

- the irrational use of pesticides and herbicides, without protective equipment, poses health risks to farmers and risks of soil and water contamination;
- in the absence of fences or protective perimeters, domestic animals frequently enter wild areas, increasing the risk of disease transmission between wildlife and domestic herds (e.g., African swine fever);
- agricultural waste management (manure, plastics) is inadequate and uncontrolled in many cases.

o One Health implications:

- poor water quality in wells due to nitrate and nitrite infiltration poses a public health hazard, especially for children and pregnant women;
- unreported organic and chemical fertilizers contribute to water eutrophication, affecting aquatic ecosystems and fish life;
- uncontrolled herds can become vectors for the spread of parasites and pathogenic bacteria (*Cryptosporidium*, *Campylobacter*).

c. Tourism

o context and trends:

- the rapid development of tourism over the last 10 years has brought significant economic benefits, but has not been accompanied by coherent environmental protection policies;
- there has been an increase in uncontrolled mass tourism, alongside ecotourism promoted by NGOs and some local guesthouses.

o negative impacts:

- recreational activities (motorboats, unauthorized trips to strictly protected areas) affect bird and aquatic mammal colonies;
- the large number of visitors, in the absence of adequate waste management infrastructure, generates solid and liquid pollution (e.g., excessive phosphates from domestic wastewater);
- health risks: the lack of sewage systems in most localities favors water and soil contamination, with the potential for outbreaks of enterovirus or hepatitis A.

o One Health implications:

- frequent interaction between tourists and wildlife (especially birds and rodents) can promote contact with zoonotic pathogens;
- tourist transport can contribute to the spread of vectors (mosquitoes, ticks) between endemic and non-endemic areas (e.g., West Nile virus);
- increased exposure to mosquito bites or blood-sucking insects in unprotected wetlands raises the risk of vector-borne disease transmission. (Horwitz, Finlayson 2011)

✓ Public and veterinary health infrastructure

a. Public health

o structure and resources:

- Tulcea County Hospital is the main medical center for the entire county and the DDRB area, but the long distance and lack of fast transportation make it difficult for residents of isolated villages (Sulina, Letea, Periprava) to access it;
- most localities in the DDRB have only a temporary medical assistance point or a family doctor who is present only a few days a week.

o key vulnerabilities:

- lack of emergency medical services, especially in cases of accidents, childbirth, or severe infections;

- the medical transport network is dependent on weather conditions (transport by water or Mobile Emergency, Resuscitation, and Extrication Service/SMURD helicopter);
- prevention campaigns (vaccination, testing for infectious diseases, screenings) are implemented sporadically, without continuity.

o One Health implications:

- the lack of early diagnosis means that many cases of zoonotic or infectious diseases are discovered late, with epidemic potential;
- the geographical isolation of localities limits the ability to respond quickly to outbreaks of diseases transmitted by water, vectors, or animals;
- the weak epidemiological surveillance system in the territory makes it difficult to accurately monitor public health indicators.

b. Veterinary health

o current capacity:

- veterinary services are poorly represented in the DDRB. Most localities do not have a permanent veterinarian, but only occasional collaborations with specialists from Tulcea or neighboring municipalities;
- the lack of quarantine centers, veterinary diagnostic laboratories, and emergency veterinary services complicates the management of disease outbreaks.

o major deficiencies:

- non-compliance with national vaccination plans for domestic animals;
- non-registration of animals and lack of regular checks in households;
- presence of stray or semi-feral dogs, with risk of rabies or parasitic diseases (echinococcosis, toxocariasis).

o One Health implications:

- lack of veterinary surveillance in the field favors the emergence and spread of zoonoses, which can quickly cross the interspecies barrier;
- the lack of a coherent biosecurity system in households (e.g., confinement, disinfection, quarantine) is a high epidemiological risk factor;
- reactive interventions (only in the event of outbreaks) are not sufficient for integrated disease control.

3.2 The interconnection between human, animal, and environmental health in the Danube Delta: an integrated approach

The Danube Delta, the largest natural wetland system in Europe, is an ideal model for analyzing the complex relationships between human, animal, and environmental health. With its exceptional biodiversity and significant cultural diversity, the region is also exposed to risks generated by ecological imbalances, anthropogenic pressures, and climate change. In this context, the One Health concept becomes essential for understanding and managing these interdependent interactions.

- Environmental health as a determinant of human and animal health

The quality of water, air, and soil in the Danube Delta directly influences the health of human communities and local wildlife. Contamination of water with toxic substances from agriculture or uncontrolled discharges leads to the accumulation of pollutants in the food chain, affecting fish species and, implicitly, human health through the consumption of contaminated fish. At the same time, the degradation of natural habitats – such as the disappearance of reed beds or temporary wetlands – reduces the ecosystem's ability to filter and regenerate resources, amplifying vulnerability to communicable diseases. (Dale, Connelly 2012)

- Zoonoses and human–animal–environment dynamics

The Danube Delta is a natural hotspot for several zoonotic diseases, such as leptospirosis, trichinellosis, avian influenza, and West Nile virus infection. (INSP 2023) These diseases arise as a result of direct or indirect interaction between humans and animals (wild or domestic), facilitated by

high humidity, high density of biological vectors (mosquitoes, rodents), and the lack of effective veterinary and sanitary control systems. An illustrative example is the transmission of the West Nile virus, in which migratory birds act as reservoirs, mosquitoes as vectors, and humans as accidental hosts. This tripartite relationship clearly highlights the interdependence between the health of wildlife, the environment, and the human population.

- The impact of human practices on ecosystem health

Human activities—overfishing, uncontrolled tourism, intensive agriculture—affect the ecological balance and can lead to biodiversity loss, the emergence of invasive species, and trophic imbalances. These processes influence the ecosystem's ability to provide essential services: drinking water, clean air, food, and protection against communicable diseases. Thus, human health cannot be maintained without protecting the health of the environment. At the same time, the decline in the quality of life in local communities—through lack of access to medical services, safe water, or sanitation—favors the development of infection hotspots and increases the population's exposure to zoonotic risks.

- Community resilience: an intersection between health and sustainability

The health of communities in the delta depends not only on ecological conditions, but also on their ability to adopt sustainable practices: legal fishing, proper hygiene, vaccination of domestic animals, and participation in conservation programs. Therefore, strengthening social resilience is an essential component of the One Health strategy in the region. Environmental education, epidemiological monitoring, and participatory conservation programs can help strengthen the positive relationship between humans, animals, and the environment, benefiting all components of the ecosystem. (Guvernul României 2023; Ministerul Mediului 2016)

3.2.1 The interdependence of biotic and abiotic components in the Danube Delta ecosystem: an integrative approach

The Danube Delta ecosystem is an emblematic example of a complex ecological network, in which the interaction between biotic, abiotic, and anthropogenic components generates a fragile but essential balance for the functioning of the system. This interdependence is a fundamental aspect of the One Health approach, which proposes an integrated perspective on human, animal, and environmental health.

- Piscivorous birds and aquatic resources

Piscivorous bird species, such as the great white pelican (*Pelecanus onocrotalus*), the great cormorant (*Phalacrocorax carbo*) and herons (*Ardeidae*), depend on the presence of stable fish populations in the delta's waters. These trophic relationships are vulnerable to changes in the hydrological regime and anthropogenic pressures. For example, the decrease in water level during the dry season negatively affects the diversity and abundance of fish fauna, with direct implications for the reproductive success of waterbirds.

- Reed beds as multifunctional ecological habitats

Reeds (*Phragmites australis*) play a key role in maintaining nesting, shelter, and breeding habitats for a variety of species—from birds (egrets, herons) to amphibians and invertebrates. The degradation of reed beds, through burning or intensive exploitation, leads to the loss of local biodiversity and affects the ecosystem's ability to naturally filter water. In addition, this type of aquatic vegetation supports biofiltration processes, which has implications for the quality of water consumed by human communities.

- Biological vectors and interspecies relationships

The Danube Delta offers ideal conditions for the development of biological vectors, especially mosquitoes of the *Culex genus*, which can transmit the West Nile virus. Wild birds are natural hosts for the virus, while humans are accidental hosts. This complex relationship between vector, natural reservoir, and human host is a classic example of interdependence with direct implications for public health, illustrating the need to apply a One Health framework in monitoring emerging diseases.

- The relationship between agricultural activities and protected fauna

Protected species, such as the red-footed falcon (*Falco vespertinus*), depend on the abundance of insects in the agricultural areas surrounding the delta. Intensive pesticide use reduces insect populations, limiting the main food source for this migratory predator. Thus, unsustainable agricultural practices can have knock-on effects on a species on the European conservation list, demonstrating the subtle connections between agriculture, biodiversity, and wildlife conservation.

- Traditional fishing and ecosystem balance

Human communities in the delta practice fishing as a subsistence activity, being deeply dependent on local fish resources. At the same time, fish-eating species, such as otters (*Lutra lutra*) or herons, compete for the same resource. Overfishing or illegal fishing creates imbalances in food chains, affecting both wildlife and human well-being. This tripartite relationship between humans, animals, and the environment constitutes a critical interdependence that requires sustainable regulation.

- The impact of invasive species

The accidental introduction of invasive species, such as the fish *Pseudorasbora parva* or the aquatic plant *Elodea canadensis*, disrupts local ecological dynamics. These species compete for resources with native species, altering the structure of the food web and reducing biological diversity. This process also affects resources exploited by humans, such as native fish, illustrating an indirect but significant interdependence between biodiversity and local food security.

3.2.2 Risks and challenges

The DDRB is a unique ecosystem in Europe, characterized by exceptional biodiversity, but also by a high degree of vulnerability to anthropogenic and climatic pressures. The interaction between humans, animals (domestic and wild) and the environment is complex and dynamic, generating a number of major risks that can affect human health, animal welfare and ecosystem balance. These risks can be analyzed from the perspective of the One Health concept, which promotes health as the result of a balance between ecological systems, human health, and animal health.

The main risks identified would be:

a) Epidemiological risk: emerging and re-emerging zoonoses

The DDRB is a convergence area for migratory birds, wild animals, and human populations, favoring the emergence and transmission of zoonotic diseases. Among the most relevant are:

- West Nile virus, transmitted by infected mosquito bites, with human cases reported annually in the region;
- Leptospirosis, associated with contaminated water, common in wetlands;
- Avian influenza, favored by contact between wild and domestic birds;
- Trichinellosis, originating from the consumption of game meat (especially wild boar) that has not been inspected by health authorities.

The presence of biological vectors (mosquitoes, ticks) is accentuated by favorable climatic conditions (humidity, high temperatures), increasing the risk of interspecies transmission of pathogens.

b) Environmental pollution and contamination of the food chain

Human activities in the area – discharge of wastewater, use of pesticides in agriculture, waste disposal – lead to contamination of water, soil, and aquatic fauna. Toxic substances (heavy metals, persistent organic compounds) can enter the food chain, bioaccumulating in fish organisms and subsequently in human food. Thus, environmental pollution becomes a threat not only to biodiversity, but also to food safety and public health. (Sørensen, D'Amico, Popescu 2021)

c) Ecological imbalances caused by human pressure

The uncontrolled growth of certain wildlife populations (wild boar, jackal) as a result of habitat change or the reduction of natural predators generates tensions in the human-animal relationship. These imbalances can lead to:

- an increase in the number of accidents or human-animal conflicts;
- the destruction of agricultural crops and damage to livelihoods;

- the spread of zoonotic diseases in human communities and among domestic animals.

d) Unsustainable economic practices

Poaching, illegal fishing, uncontrolled tourism, and other economic activities with a negative impact on biodiversity contribute to habitat degradation and ecological imbalance. Disturbing sensitive species can lead to lower reproduction rates, altered animal behavior, and changes in wild population dynamics. Thus, human pressure has cumulative effects on the ecosystem. (Simon, Andrei 2021)

e) Antimicrobial resistance

The uncontrolled use of antibiotics in households and small farms can promote the emergence of antimicrobial resistance, with serious implications for public health.

f) Contamination of water and natural resources

Discharges of waste, fertilizers, and untreated sewage pollute aquatic ecosystems, affecting fauna, flora, and human populations.

g) The effects of climate change

The Danube Delta is particularly vulnerable to the effects of climate change, such as:

- sea level rise and soil salinisation;
- changes in the hydrological regime;
- frequent droughts and declining water quality.

These phenomena affect the distribution and behavior of species, while also favoring the proliferation of disease vectors and the emergence of new epidemiological risks. Climate change also puts pressure on natural resources, amplifying competition between species and between humans and the environment.

h) Invasive species

The accidental or deliberate introduction of invasive species, such as *Pseudorasbora parva* fish or certain aquatic plant species, affects the delta ecosystem by competing for resources and altering habitats. These species can change the trophic structure and have indirect consequences on the health of the ecosystem and the human populations that depend on the services it provides.

Sustainable management of DDRB requires a transdisciplinary approach that integrates human, animal, and environmental health. The identification and monitoring of risks arising from human-animal-environment interactions must be carried out through collaboration between public health specialists, veterinarians, ecologists, local authorities, and local communities. The implementation of One Health principles can contribute to protecting the ecosystem and ensuring harmonious coexistence between humans and nature. (FAO, OIE, UNEP, & WHO 2019)

4 DISCUSSION

4.1 The benefits of a One Health approach in the Danube Delta Biosphere Reserve

Implementing the One Health concept in the Danube Delta brings a number of significant benefits for the ecosystem, public health, and the socio-economic development of the region. Given the specific nature of the Delta as a wetland of international importance, with high biodiversity and a significant density of human-animal-environment interactions, the integrative One Health approach becomes not only timely but essential to ensuring long-term sustainability. In a territory at the intersection of nature and culture, conservation and development, One Health provides an essential framework for sustainable, integrative, and resilient governance.

- Preventing zoonotic diseases and strengthening public health

The One Health approach enables early detection and effective control of diseases transmitted from animals to humans, such as avian influenza, leptospirosis, trichinellosis, and West Nile virus. By integrating veterinary, human, and environmental epidemiological surveillance, major health crises can be prevented, thereby reducing:

- the risk of epidemics and pandemics;
- pressure on the regional healthcare system;
- the costs associated with treatments and reactive measures.

The integrated approach also supports the development of early warning systems, which are essential in the context of climate change that favors the spread of biological vectors (mosquitoes, ticks).

- Protecting biodiversity and conserving ecosystems

By linking the health of fauna and flora to human health, One Health contributes to the conservation of natural habitats that are essential for maintaining ecological balance. The Danube Delta is home to hundreds of species of rare birds, mammals, fish, and plants, and their conservation has direct beneficial effects on:

- water and air quality;
- the stability of food chains;
- ecosystem services (water filtration, carbon storage, flood protection).

Thus, protecting nature becomes a direct investment in the health and well-being of local human communities.

- Food security and natural resource quality

By preventing ecosystem contamination and controlling the bioaccumulation of toxic substances, One Health supports the safety of locally sourced food – fish, game meat, and agricultural products. This is particularly important in a region where food is often obtained directly from nature. (Andrei, Lianu, Gudei 2016)

Benefits include:

- reducing the population's exposure to heavy metals, pesticides, and pathogens;
- maintaining fisheries and agricultural productivity;
- supporting short supply chains and the local economy.

- Increasing resilience to climate change

The Danube Delta is particularly vulnerable to climate change: rising sea levels, soil salinisation, frequent droughts and changes in the hydrological regime are affecting the structure and functioning of the ecosystem. One Health provides a coherent framework for:

- integrated adaptation to new climatic conditions;
- prevention of ecosystem collapse and forced migration of species and human communities;
- maintenance of ecological functions essential for public health (e.g., freshwater storage, vector-borne disease control).

- Improving governance and inter-institutional collaboration

One Health involves cooperation between multiple institutions and fields: public health, environment, agriculture, veterinary medicine, education, local administration. Implementing this approach in the Danube Delta has the following effects:

- improved institutional coordination;
- reduced duplication of efforts and more efficient use of public resources;
- increased efficiency in managing complex risks.

This contributes to strengthening the capacity for an integrated response to health and environmental crises.

- Supporting the sustainable development of local communities

A well-implemented One Health strategy supports local communities by:

- promoting sustainable economic activities (ecotourism, responsible fishing, organic farming);
- increasing access to health and education services;
- protecting the region's natural and cultural heritage.

In this way, development becomes inclusive and adapted to the unique ecological context of the Delta.

4.2 Integrated public policies for implementing the One Health concept in the Danube Delta Biosphere Reserve

The One Health concept, which promotes an integrated approach to human, animal, and environmental health, is increasingly relevant in the context of the health and ecological crises of the

21st century. In the case of the DDBR, the application of this concept requires a systemic vision and integrated public policies that transcend traditional sectoral boundaries.

- The need for cross-sectoral governance

One of the most significant obstacles to implementing the One Health concept is institutional fragmentation. Currently, public health, animal health, and environmental protection are managed by different entities with distinct objectives and budgets.

To overcome this obstacle, it is necessary to institutionalize intersectoral cooperation between:

- Danube Delta Biosphere Reserve Administration – for ecosystem conservation and regulation of human activities;
- Public Health Directorates and Sanitary-Veterinary Directorates – for disease prevention and control;
- local councils and municipalities – for the implementation of measures at community level;
- National Institute of Public Health and National Sanitary Veterinary and Food Safety Authority – for integrated epidemiological surveillance;
- universities and research institutes – for the provision of scientific data and multidisciplinary expertise.

- Integrating the One Health concept into strategic planning

Relevant legislation includes:

- Law no. 150/2023 on integrated wetland management;
- Law no. 350/2001 on land use and urban planning;
- Order no. 233/2016 approving the Guidelines for Management Plans for Protected Natural Areas;
- National Strategy for Adaptation to Climate Change (2023–2030).

Territorial planning and sustainable development frameworks must reflect One Health principles. (Law 350/2011) These include:

- the DDRB management plan – should be updated to include specific objectives on zoonotic disease surveillance, vector control, and the protection of habitats essential to public health;
- local mobility and infrastructure plans – should integrate sustainability and ecological health criteria (e.g., pollution control, sewerage networks, wastewater treatment);
- local development strategies – should support eco-tourism, sustainable agriculture, and responsible fishing, thereby reducing pressures on the environment and biodiversity. (Simon, Andrei 2023)

- Monitoring and rapid response mechanisms

The implementation of One Health requires integrated monitoring and early warning systems for zoonotic diseases, pollution, and climate change. The DDRB recommends:

- creating a data-sharing platform between institutions (human health, veterinary, environment);
- inter-institutional rapid response teams in case of zoonotic epidemics (e.g., avian influenza, West Nile);
- training medical, veterinary, and environmental personnel to recognize and report cross-cutting risks quickly;
- participatory community surveillance programs, involving locals and NGOs in observing environmental and health changes.

- Education, participation, and community responsibility

Effective public policies must include educational and participatory dimensions. (Ministerul Educației 2022) Communities in the Delta, especially fishermen, farmers, and tour guides, must be supported in adopting sustainable practices that contribute to the health of the ecosystem and, implicitly, to their own health.

The following are needed:

- information campaigns on communicable diseases, good hygiene practices, and biodiversity protection;
- educational programs in schools on the link between health and nature;

- economic incentives for sustainable practices (ecological fishing, ecotourism, pesticide-free agriculture);
- inclusion of local communities in decision-making processes regarding conservation and development.

Proposed strategic directions for integrated public policies could be:

✓ strengthening multisectoral governance:
- creating a Local One Health Committee within the DDRB, with the participation of DDRB Administration, Public Health Directorate, National Sanitary Veterinary and Food Safety Authority, municipalities, NGOs, and representatives of local communities;
- developing a regional One Health 2025–2030 strategy, adapted to the specific characteristics of the Delta.
- integrating One Health indicators into the DDRB Management Plan and the General Urban Plans of the localities in the reserve.

✓ improving health and biosecurity infrastructure by:
- developing mobile and floating medical centers for isolated communities;
- equipping Sanitary Veterinary and Food Safety Directorate Tulcea with regional laboratories capable of rapidly detecting zoonoses;
- creation of water, soil, and wildlife monitoring networks, with monthly reporting to decision-makers.

✓ prevention and control of zoonoses:
- free vaccination, sterilization, and registration campaigns for pets and farm animals;
- training local rapid response teams for emerging disease outbreaks (trained by competent authorities);
- monitoring the health of wildlife (migratory birds, wild boars, foxes) in collaboration with apiculture and hunting associations.

✓ community education and local involvement trough:
- One Health education programs in schools, supported by DDRB Administration and relevant NGOs;
- training religious and community leaders as vectors for promoting integrated health;
- launching a participatory digital platform for reporting animal health, pollution, or communicable disease issues (with a mobile app).

✓ supporting research and innovation based on:
- partnerships between DDRB Administration, Romanian Academy (One Health Commission, Center for Study and Research for AgroForestry Biodiversity), universities (e.g., Ovidius University of Constanța, University of Agronomic Sciences and Veterinary Medicine Bucharest) and research institutes (Danube Delta National Research and Development Institute Tulcea) for pilot studies;
- funding projects through, the LIFE Program, Horizon Europe, Interreg Europe pro the transnational programs, national and regional funding programs for innovative solutions in One Health risk management;
- creation of a regional One Health database, accessible to institutional actors and communities.

These proposed strategies, from national to regional and local levels,provide a solid framework for applying One Health in DDRB by conserving aquatic and terrestrial ecosystems to protect human health and wildlife; controlling zoonotic diseases and pollutants, including through automation and standardization in water and biodiversity monitoring; sustainable fisheries management, preventing contamination and reducing exposure to health risks; interdisciplinary cooperation: environmental authorities, public health, research, NGOs, and local communities; ecological restoration and climate resilience, contributing to reducing regional vulnerability. (Mattsson et al, 2019)

They can be integrated into One Health projects in different ways, as shown in the table 1:

Table 1. Proposed strategies for integrating One Health in the Danube Delta

One Health component	**Relevant strategies**
Human health	Reducing water pollution, access to health services, community awareness
Animal health	Fishing control, prevention of zoonoses, avoidance of invasive species
Ecosystem health	Wetland restoration, biodiversity conservation, adaptive management

The integration of One Health principles into the sustainable management of the Danube Delta Biosphere Reserve, through the correlation of human, animal, and ecosystem health, in alignment with relevant national and European strategies, can lead to the establishment of a Plan for implementing the One Health approach in the DDBR.

This implementation plan consists of six major components, each linked to concrete actions, result indicators, and relevant national and European strategies. Its structure aims to effectively integrate DDBR. Through a systemic and cross-sectoral approach, the plan seeks to strengthen the interconnection between human, animal, and environmental health, mitigate emerging risks, support local communities, and contribute to the conservation of biodiversity in this unique ecosystem. The coordinated implementation of these components will enable effective climate change adaptation and support the achievement of goals outlined in national sustainable development strategies and related European policies. (table 2)

Table 2. Components and concretes actions of implementing plan

Component	**Proposed Activities**	**Related Strategies**
Integrated Monitoring	Implementation of a GIS platform to centralize data on zoonotic diseases, water quality, and biodiversity	National Strategy for Sustainable Development 2030 EU Biodiversity Strategy Horizon EU/national/regional funding
Zoonoses Surveillance	Periodic testing for West Nile virus, leptospirosis, and avian influenza in key areas	Health Strategy EU/national/regional funding
Community Education	Campaigns in schools and villages on water hygiene risks, illegal fishing, and wild animal consumption	FLAG Delta Strategy National Strategy for Sustainable Development 2030 EU/national/regional funding
Sustainable Fisheries Management	Early warning systems for poaching Catch monitoring and fisher involvement in reporting Implementation of QR codes for traceability	Common Fisheries Policy Biodiversity Strategy EU/national/regional funding
Ecological Restoration	Reconnection of degraded wetland areas Invasive species control Reintroduction of key species (e.g., sturgeon, turbot)	EU Strategy for Danube Region Rewilding Europe LIFE Program Horizon

		EU/national/regional funding
Preventive Human Health	Improved access to potable water Mobile medical assistance for isolated communities Water testing and food hygiene assessments	Health Strategy National Strategy for Sustainable Development 2030 Horizon EU/national/regional funding

The implementation such an implementing plan represents a vital step toward strengthening the region's socio-ecological resilience. By aligning human, animal, and ecosystem health within a coherent framework of policy, monitoring, and education, this plan provides a clear strategic direction tailored to the local context. Its success relies on interinstitutional collaboration, community engagement, and the sustainable use of natural resources. In this way, the DDBR can become a replicable model of sustainable governance, where health, biodiversity, and economic development coexist harmoniously, in line with national and European commitments to environmental and public health.

5 CONCLUSION

The integration of the One Health approach into the sustainable management of the Danube Delta Biosphere Reserve is not only timely but imperative. The complex interdependencies between human health, animal health, and the environment in this unique ecosystem call for a strategic framework that transcends traditional disciplinary and institutional boundaries. This paper has demonstrated that One Health offers a valuable paradigm for addressing the interconnected challenges of zoonotic disease prevention, biodiversity conservation, public health, climate resilience, and sustainable livelihoods in the Delta.

The proposed implementation plan – structured around six major components: integrated monitoring, zoonotic surveillance, community education, sustainable fisheries management, ecological restoration, and preventive human health – is designed to translate One Health principles into concrete, measurable, and locally adapted actions. These actions are closely aligned with national and European strategic frameworks and leverage cross-sectoral cooperation, participatory governance, and the responsible use of natural resources.

By adopting a systemic and inclusive approach, the Danube Delta can become a model of resilient and integrated governance, where the long-term well-being of both human and natural communities is prioritized. The success of this endeavor will depend on sustained political will, institutional coordination, adequate funding, and – perhaps most importantly – the active engagement of local communities whose lives are deeply intertwined with the ecosystem.

In conclusion, the One Health approach in the Danube Delta is not merely an academic ideal, but a practical necessity for ensuring a healthy, biodiverse, and sustainable future – both for this unique region and as a replicable example for other vulnerable ecosystems worldwide.

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