12.August 2024


# Welcome to IAD Scientific Summer School in the Danube Delta

We welcome you to the Danube Delta Scientific Summer School, which aims to create a friendly and open atmosphere for students and lecturers, sharing scientific practice in the floodplain and scientific discussions at "round tables". Our goal is to foster a space for scientific collaboration and mutual exchange. The International Association for Danube Research (IAD) is a scientific network dedicated to a better understanding and protection of the Danube River and its catchment. By connecting with fellow participants and experts during our summer school, we strengthen a better understanding of the many vital Danube Delta ecosystems, a unique area of 6,264.03 km$^2$ biosphere reserve established in 1998 under UNESCO's Programme on Man and the Biosphere and shared by Romania and Ukraine.

Our lecturers bring in their broad and deep expertise in aquatic sciences, while our students, many of whom are PhD candidates, also offer specialized knowledge backgrounds. This diverse mix of participants from various Danubian countries promises a rich learning experience. We look forward to meaningful and stimulating discussions, joint projects, and shared discoveries as we explore the fascinating world of the Danube Delta together.

Our expertise of the IAD lecturers span ranges from aquatic microbiology to terrestrial observations in floodplains. Floodplain ecosystems are often influenced by "human life" that can alter or even threaten their existence through increasing urbanization, eutrophication, the introduction of pollutants (e.g. microplastics), the spread of invasive species, and - not to forget - the overarching effects of global warming, to name just a few. Today, we, lecturers in the summer school, share our collective expertise, which often overlaps due to our work across various water bodies in the Danube region and research fields. In addition to our broad scientific background in aquatic sciences, we will highlight a specific issue of focus.

Our summer school is organized into three main groups, and you, the students, are welcome to share join and contribute to the activities of one or more of these groups. We will refer to the groups as follows:

**1. Terrestrial group**: Diversity of floodplain habitats in the Danube Delta, with focus on terrestrial systems.

> Discussions and hands-on techniques will focus on: ● *Floodplain protection and restoration,* ● *Floodplain vegetation and insects diversity,* ● *Spead of invasive species,* ● *Conservation of native wetland plant species,* ● *Hydrological connectivity,* ● *Long-term scenarios of ecosystem succession and degradation,* ●*Mitigating climate change impact,* ● *Reed and land use sustainable management,* ● *Nature conservation to foster public awareness,* ● *Wetland ecosystem services, food-water-energy nexus, eco-tourism concepts,* ● *Choromatic Focus Maps used to visualize integrated management.*

**2. Water group:** Diversity of floodplain habitats in the Danube Delta, focusing on channels and lakes.

Discussions and hands-on techniques will focus on: ● *Current threads to aquatic systems from eutrophication and global warming;* ● *Phosphate reduction measures;* ● *Sustainable lake restoration;* ● *Water transparency as signature for ecosystem health;* ● *Biodiversity of natural assemblages;* ● *Spead of invasive species along water bodies;* ● *Appearance and disappearance of saline lakes and soda pans;* ● *Long-term monitoring needed to analyze trends;* ● *Lakes as sentinels of climate change;* ● *Mitigation of climate change impacts;* ● *The role of littoral zones for shallow water ecosystems;* ● *Protection of littoral reed zone;* ● *Shallow lakes vs deeper lakes, what makes here the difference;* ● *Reed and land use management;* ● *Nature conservation to foster public awareness of freshwater recourses;* ● *Sustainable tourism concepts in lakes and river of Danube floodplain.*

**3. Microplastic group**: Detecting microplastic and effective strategies to prevent and mitigate this pollution.

Discussions and hands-on techniques will focus on: ● *Detecting and quantifying microplastics in water bodies, sediments, and aquatic organisms;* ● *Sources and pathways of microplastic contamination;* ● *Impact of microplastic on aquatic ecosystems and human health;* ● *Best practices for reducing microplastic pollution, including policy measures, public awareness campaigns, and innovative technological solutions;* ● *Safeguarding initiatives against microplastic pollution in the unique ecosystem of the Danube Delta.*

As part of the funding program, instead of writing "traditional "reports, we are required to write four publications related to this 2024 summer school. Encouraged by this, we will also have a stimulating "round table" discussion about **scientific publishing** – presenting research results in scientific journals, at conferences, and using other science platforms.

Discussions will focus on: ● *Why scientific publishing?;* ● *Common structure of research articles;* ● *Novel original research vs incremental scientific publishing;* ● *Peer review process – do we need peer review?;* ● *Advantages and disadvantages of main stream publishing;* ● *What references might be/cant be cited;* ● *Authorship: who is first author, who is co-author;* ● *Ethical aspects of plagiarism, data fabrication, authorship disputes, and the transparency of the research process;* ● *Research article vs review article vs scientific assay;* ● *Journal article vs book chapter;* ● *Open access publishing vs. subscription-based journals;* ● *Recent publishing by industry policies;* ● *Use of preprint servers, digital tools and other research platforms.*

We are **13 lecturers participating in this IAD summer school**, mostly from Romania and Austria, but also from Hungary and Serbia. In the following section, we introduce ourselves, with related publications cited in the reference list on pages 25-27. Each lecturer will give a five-to-ten-minute stimulating talk discussing terrestrial, water, or microplastics issues at round tables. The topics for these talks, summarized in 3 to 5 slides as **outlines**, are listed below alongside each lecturer's introduction.

Dr. Eng. Iulian Nichersu, iulian.nichersu@ddni.ro

**Comprehensive approach to a better understanding and managing the Danube Delta's unique ecosystem** integrates various aspects of ecological, geographical, and hydrological aspects, such as (1) Ecological restoration & Biodiversity conservation, (2) Geospatial analysis & Cartography and (3) Hydro-Morphology and Flood risk management.

**Both vertical and horizontal hydrological connectivity** are vital for the Danube Delta's ecological health and functionality. *Vertical hydrological connectivity* refers to the movement of water between the surface and subsurface layers of an ecosystem along Danube River, thus involves infiltration, percolation, and groundwater recharge. Loss of vertical connectivity, often due to human activities such as groundwater extraction or land drainage, can lead to the desiccation of wetlands, loss of wetland habitat, and altered water quality. Restoring vertical connectivity involves measures such as controlled flooding, re-establishing natural water levels, and protecting groundwater recharge areas. *Horizontal hydrological connectivity*, which enables the lateral movement of water across the landscape, is connecting different water bodies such as Danube River bed & channels, lakes, wetlands (areas where water covers the soil, permanently or seasonally saturated with water), and floodplains (flat or nearly flat land adjacent to the Danube River that experiences occasional or periodic flooding). In the Danube Delta, horizontal connectivity helps mitigate flood risks, and enhances the resilience of ecosystems to climate change. Human activities like dam construction, levee building, and land reclamation can disrupt horizontal connectivity, leading to habitat fragmentation and reduced biodiversity. Restoring horizontal connectivity may involve removing or modifying barriers, re-creating floodplain dynamics, and implementing integrated water management practices that consider the entire watershed. Vertical and horizontal hydrological connectivity **together**, support a dynamic hydrological regime that sustains diverse habitats, promotes nutrient cycling, and enhances the resilience of the ecosystem to environmental changes. Effective management and restoration efforts must address both types of connectivity to ensure the long-term sustainability of the delta's unique and complex aquatic ecosystems, including. engineering solutions, policy measures, and community engagement to restore natural hydrological processes and improve the overall health of the Danube Delta.

**Iulian** will mainly contribute to the "**Terrestrial group**" and will present a short outline about "Floodplain Reconnection & Delta Wetland Conservation".

Dr. Thomas Zechmeister, Thomas.Zechmeister@bgld.gv.at

**Wetland monitoring & conservation, Reed management, Saline lakes and soda pans, Biodiversity of Moths and Butterflies**

**Wetland monitoring & conservation** strategies are used to preserve and restore wetlands, ensuring the continuation of their vital ecological services. It includes establishing "hands-off zones" of protected areas in a biosphere reserve, nature-based management, implementing buffer zones, and restoring degraded wetlands with support from policies like, e.g., the Ramsar Convention. Community involvement means here in Lake Neusiedl wetland, engaging local communities of wine growing area applying sustainable land-use practices of irrigation and developing eco-tourism concepts (area attracts bird watching holiday maker). Challenges cover aspects such as increasingly widespread urbanization and fragmentation of the wetland, drainage, agricultural expansion, pollution, and above all mitigating impact of global warming.

**Reed Management** for maintaining the ecological health and functionality of reed beds in Lake Neusiedl wetland, balancing growth, and habitat diversity. Ecological Benefits of reed for this shallow soda lake is supporting biodiversity, nutrient cycling, and water purification and above all providing habitat for wildlife in the wetland area – discussed as ecosystem services. Reed management techniques involve cutting, grazing, burning, and water level manipulation to prevent overgrowth and promote diverse plant communities.

**Soda Pans and Soda Lakes** are unique alkaline ecosystems with high pH, salinity, and carbonate minerals, common at National Park “Neusiedlersee-Seewinkel”, a wetland area close to Vienna. Known for their distinctive chemistry and diverse saline biota, these lakes face threats from global warming. Rising temperatures and decreased precipitation can stress saline-specialized species, alter species composition, and reduce biodiversity. Many soda pans have been lost during the recent decades due to the loss of vertical connectivity to the groundwater table. This disrupts the salinization mechanism on the soil surface, the soda pan surface, causing these sites to "freshen." As a result, they undergo natural succession to a non-saline habitat, turning into meadow-steppe landscapes and quickly becoming overgrown with shrubs.

**Moth and Butterfly Diversity in Floodplain Wetlands** serve as indicators of environmental health in floodplain wetlands. They contribute to pollination, serve as a food source, and play thus an important role in food webs. Conservation strategies focus on regular surveys of monitoring, habitat protection, invasive species management, and mitigating habitat fragmentation and climate change.

**Thomas** will mainly contribute to the “**Terrestrial group**” and will present a short outline about “Moths and Butterflies & Wetland Conservation”.

Dr. Alexandru Cătălin Doroşencu, alexandru.dorosencu@ddni.ro

**Ornithology and Biodiversity in the Danube Delta: Monitoring and Conservation Strategies:** The Danube Delta is one of Europe's most significant wetlands, hosting a diverse range of flora and fauna and thus is a biodiversity hotspot. It is a critical habitat for many bird species, some of which are endangered or of significant conservation interest. Birds are often indicators of environmental health, and therefore understanding these species and their habitats will contribute to effective conservation strategies. This way, monitoring of bird populations provides insights into the overall condition of the ecosystem, helping to detect and address ecological imbalances. Specifically here, an overview about Natura 2000 Sites and Conservation Priorities, on bird species of conservation interest and the selection of criteria and monitoring methods for Important Bird Areas (IBA) and Special Protection Areas (SPA) will be discussed.

**Ecological Impact Assessments in the Danube Delta: Methods and Case Studies:** Ecological Impact Assessments (EIAs) are essential for ensuring that development projects, like wind farms and industrial facilities, do not harm the fragile ecosystems in Danube Delta. They help balance the economic development with environmental protection. Informed Decision-Making (EIAs) provide here critical data that inform policymakers, helping them make decisions that protect biodiversity while allowing for sustainable development. Strategies are developed - through EIAs - that potential environmental impacts can be identified and mitigated before they cause a significant damage. This pro-active approach is important for maintaining the health of the Danube Delta ecosystems. Public awareness and engagement are further relevant here as EIAs often involve public consultation processes, raising awareness about environmental issues and engaging local communities in conservation efforts.

**Advanced Technologies in Biodiversity Monitoring**, such as Unmanned Aerial Vehicles (UAVs) and remote sensing, offer precise and accurate methods for monitoring biodiversity. They enable detailed mapping and data collection that traditional methods may not achieve. Technologies of real-time data can be used for critical timely decision-making, identifying a response to environmental changes. While initial investments may be high, the long-term use of advanced technologies can be more cost-effective than extensive ground surveys. They cover larger areas and provide comprehensive data with fewer resources. In addition, such techniques can be also applied for monitoring bird colonies. Here a detailed discussion on how UAVs and other technologies are used to monitor bird populations will refer on both, their benefits, and limitations.

**Bird Migration and Ecology: Insights from the Danube Delta:** Understanding Migration Patterns provides insights into the needs and behaviors of migratory birds, which is essential for their conservation. They help to assess the impacts of climate change on bird populations. Changes in migration timing, routes, and habitat availability are critical indicators of broader environmental shifts. This way, monitoring bird migration focuses on climate change and habitat alteration. Identifying significant stopover sites and breeding grounds helps prioritize areas for protection, ensuring that migratory birds have the habitats they need throughout their life cycles. Migratory birds cross international borders, making their conservation a global issue. Studies in the Danube Delta contribute to international conservation efforts and collaborations.

**Alexandru** will mainly contribute to the "**Terrestrial group**" and will present a short outline about "Bird Monitoring & Conservation Strategies in the Danube Delta".

Dr. Dušanka Cvijanović, dusanka.cvijanovic@dbe.uns.ac.rs,

**Wetland monitoring & conservation**

**Plant invasions in riparian areas of the Middle Danube Basin in Serbia** is studied by Monitoring invasive plant species in riparian zones, as riparian areas provide mainly pathways for plant invasions. Focusing on the Middle Danube Basin; provides insights into the challenges of managing invasive species and maintaining native biodiversity, relevant to the Danube Delta's riparian areas.

**The critical role of vegetation in the Danube ecosystem**: Getting deeper insights here, will address both native and invasive species, and utilizing modern technologies for monitoring and conservation. Floodplain forests subjected to drought are more susceptible to invasive species. The stress from reduced moisture levels weakens native vegetation, providing an opportunity for invasive species to establish and spread more easily. The Copernicus Normalized Difference Moisture Index (NDMI) is used to assess the effects of drought on forests by measuring the moisture content in vegetation. This index helps identify areas experiencing moisture stress, aiding in the monitoring and management of forest health. Ground-truthing vegetation surveys along the drought gradient allow us to explore the effects of drought on herbaceous invasive species in the Danube Delta floodplain forests using the NDMI values obtained from the open-access Copernicus platform.

**Duska** will mainly contribute to the "**Terrestrial group**" and will present short outline about "Environmental Monitoring & Wetland Conservation".


Dr. Werner Lazowski, werner.lazowski@chello.at

**Botanical surveys, Floodplain vegetation, wetland conservation,**

**Vegetation of Water-Influenced Sites**: Understanding vegetation in water-influenced environments is importnant for wetland management and restoration, i.e. focusing on species adapted to fluctuating water levels.

**Restoration in Nature Conservation Biosphere Reserves**: Restoration in biosphere reserves aims to return ecosystems to their natural state, enhancing biodiversity and ecosystem services through re-establishing water flow, replanting native vegetation, and monitoring wildlife.

**Sustainable Development – the Comparison of the Danube Floodplains in Vienna and the Danube Delta**: Comparing sustainable development practices in the Danube floodplains near Vienna and the Danube Delta provides insights on best practice of habitat protection and restoration. Oxbow lakes are here critical habitats in floodplain areas. They serve as biodiversity hotspots and play a significant role in nutrient cycling and flood mitigation. Their ecological importance is key for conservation and restoration efforts. Floodplains are formations building up new lakes, whereas in other landscapes, lakes usually disappear through natural succession.

**Werner** will mainly contribute to the "**Terrestrial group**" and will present a short outline about "Floodplain Vegetation (Floodplain landscapes) & Delta Ecosystems".


Mag. Dragos Balaican, dragos.balaican@ddni.ro

**Utilizing Choromatic Focus Maps (CFMs)** offers an innovative way to visualize the complexities of the Water, Energy, and Food (WEF) nexus in the Danube Delta. Through a methodological approach that involves stakeholder engagement, and the integration of advanced technologies like machine learning, CFMs can significantly enhance resource management and decision-making processes, ensuring sustainable and practical strategies for the region.

**Adopting the food-water-energy (FWE) nexus approach** can transform resource management in the Danube Delta by integrating water, food, and energy systems to enhance climate resilience and sustainable development. The FWE case study from Tulcea, a city located in Danube Delta, highlights the importance of a participatory process, when focusing on local vegetable markets and their connections to water and energy. Engaging local communities in participatory research fosters effective, context-specific solutions, empowering residents and ensuring sustainable practices tailored to the Delta's unique environment.

**Dragos** will mainly contribute to the "**Terrestrial group**" and will present a short outline about "Water Energy Food Nexus in urbanizing wetlands in Danube Delta".

Prof. Martin Dokulil, martin.dokulil@zell-net.at

**Phytoplankton, Freshwater Ecology, Impact of global warming on aquatic systems**

**Climate signals, as e.g. NAO**: The North Atlantic Oscillation (NAO) is a significant climatic phenomenon that influences weather patterns in the North Atlantic region, including the Danube Delta. Understanding the NAO's impact on local climate conditions, such as temperature, precipitation, and wind patterns, is important for predicting and managing ecological changes driven by global warming in the region.

**Impact of global warming on aquatic ecosystems**: Global warming is causing significant alterations in aquatic ecosystems worldwide, including the Danube Delta. Rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events are driving changes in water quality, habitat structure, and species interactions. Highlighting adaptive management strategies mitigating global warming impact, such as enhancing riparian buffers, restoring wetlands, and implementing sustainable water use practices to maintain ecosystem function and biodiversity.

**Phytoplankton, the primary producers**: Phytoplankton are microscopic diverse algae and cyanobacteria and play an important role in aquatic food webs. Their ecological significance is linked to nutrient cycling, carbon sequestration, and supporting aquatic biodiversity. The topic on phytoplankton also covers factors influencing phytoplankton growth and distribution, such as light availability, nutrient concentrations, and water temperature, relate among others to harmful algal blooms (HABs) caused by nutrient pollution and climate change.

**Long-term sustainable restoration of oxbow lake, case study Alte Donau, Vienna, Austria:** This case study explores the multi-faceted approach to restore and sustain this urban aquatic ecosystem, Restoration techniques used, such as phosphate precipitation to reduce eutrophication, re-establishing natural water flows, and enhancing light availability for submerged macrophyte growth, can be discussed. The role of community involvement and public awareness in supporting restoration efforts is also highlighted.

**Martin** will mainly contribute to the "**Water group**" and will present a short outline about "Global warming & Delta Ecosystems".

Prof. Vera Istvánovics, istvanovics.vera@gmail.com

**Eutrophication is the enrichment of water by nutrients** causing an accelerated growth of algae and/or higher forms of plant life, and produces an undesirable disturbance to the balance of organisms and to the water quality. **Nutrient** enrichment is a necessary but not sufficient condition to cause accelerated plant growth. Among the auxiliary conditions, we will discuss the presence of species adapted to eutrophic conditions and water residence times. The latter is particularly important for river eutrophication and highly relevant for the eutrophication of the Danube Delta lakes.

**Today's transient climate can cause ecological surprises and regime shifts, which greatly complicate lake management.** After 25 years of apparently successful eutrophication management, a record-breaking mixed algal bloom with a "strange" taxonomic composition developed unexpectedly in 2019 in Lake Balaton. The external nutrient load was too low to support this bloom. Climate change seems to accelerate nutrient recycling from the sediments, and increased internal load may shift the system from externally driven to internal eutrophication. Intensive long-term monitoring is needed to understand the mechanisms of such regime shifts and to develop effective management strategies.

**Constructed Wetlands as a Tool for Integrated Phosphorus Management - the Kis-Balaton Case Study**. The Kis-Balaton wetlands were reconstructed to retain phosphorus from diffuse sources as part of the comprehensive eutrophication management strategy of Lake Balaton. Despite huge investments and huge efforts put in monitoring and modeling, the sequence of decisions during the 30-year implementation period was far from optimal. Changes in the political framework and the sectoral authorities left their mark on the implementation process. Due to the complexity of the system, science has mostly excelled at finding explanations for observed changes rather than predicting the impacts of management measures. Despite efforts to manage the system based on scientific knowledge and predictions, most management actions were futile and did not result in improved nutrient retention. The high degree of autonomy of the system throughout its history suggests that a less proactive management could operate the system in a more natural (and less managed) manner with roughly the same efficiency but with significantly less effort and operating costs. As an unanticipated benefit, the Kis-Balaton wetlands became a huge ecological asset, that was worth the price. The lessons learned from this large and complex wetland system can facilitate the management of other large wetlands, including the Danube Delta.

**Vera** will mainly contribute to the "**Water group**" and will present a short outline about "Eutrophication & Delta Ecosystems".

Dr. Adrian Burada, adrian.burada@ddni.ro

**Environmental Impact Assessments and Water Quality Classifications** The integration of laboratory analysis results into comprehensive reports and environmental impact assessments is important for understanding the health of the Danube Delta's ecosystems. Advanced statistical analysis techniques, allow a detailed environmental impact assessments and water quality classifications to ensure compliance with environmental regulations and sustainable water management practices.

**Evaluation of Industrial Environmental Impacts** A key area of water quality study in Danube Delta is the evaluation of potential environmental impacts of industrial facilities, with a particular focus on those involved in heavy water tritium removal. Industrial activities can affect the Danube Delta and thus a rigorous environmental assessment to mitigate potential environmental risks is fundamental.

**Traceability of Pharmaceutical Residues and Chemical Carcinogens** Understanding the traceability of pharmaceutical residues and chemical carcinogens in aquatic ecosystems is critical for preventing risk factors in the Danube Delta. This topic will delve into the processes and research methods used to trace these substances, assess their impact on the environment, and develop strategies to mitigate their presence.

**Transfer of Hazardous Substances in Aquatic Food Chains** An understanding of the transfer of priority and priority hazardous substances in the aquatic food chains of the Danube Delta is essential for the protection and sustainable use of these ecosystems. Hazardous Substances are identified at various trophic levels. Controlling hazardous substances to protect the Delta's complex and sensitive ecological networks will finally protect biodiversity and human health.

**Adrian** will mainly contribute to the "**Water group**" and will present a short outline about "Environmental Impact Assessments and Water Quality in the Danube Delta".

Eng. Matei Simionov, matei.simionov@ddni.ro

**Morpho-Hydrographic Changes and their impacts:** A comprehensive understanding of the morpho-hydrographic changes in the Danube Delta involves analyzing the complex processes of sedimentation and erosion. These processes lead to the formation or obstruction of secondary arms, streams, and other features, as well as alterations in submersion relief, sedimentation of inner lakes, and depression areas. The Fluvial Delta, the oldest part of the Danube Delta, has undergone significant evolution, with fluvial waters reaching an altitude of 3 meters. The depression zones, characterized by high-intensity sedimentation, are shrinking, and dotted with numerous small lakes.

**Human Impact and Hydrological Data:** Post-1970, the construction of the Iron Gates Dam reduced the Danube's sediment flow to 30-40% of its previous values. Consequently, the Danube Delta has seen a reduction in activity, influenced by human interventions. Hydrological data are important for understanding the water circulation system, especially in the context of the accelerated dynamics of the delta's hydro-morphology. The reduction in sediment flow has led to noticeable changes in the delta's landscape and ecological balance, necessitating continuous monitoring and study.

**Climate Change and Hydrological Modelling:** Climate change further complicates this scenario by altering the high-water and low-water cycles and intensifying extreme hydrological phenomena. This necessitates the continuous updating of hydrological models and databases to accurately reflect the current state of the deltaic ecosystem. The integration of new techniques for collecting water circulation data (discharge and water level) enhances the precision of hydraulic models. Currently, discharge calculations rely on rating curves, but real-time updates of these data series across different water levels improve the accuracy of model outcomes. Given the high sedimentation rates and increased investment in unclogging works, an updated hydraulic model of the Danube Delta is a vital tool for managing the dynamic deltaic system. Accurate and timely data collection and model updates are essential for effective management and preservation of this unique ecosystem.

**Matei** will mainly contribute to the "**Water group**" and will present a short outline about "Hydraulic parameters measurements & Hydraulic Modeling in the Danube Delta".

PD Dr. Katrin Teubner, katrin.teubner@univie.ac.at

**Sustainable Lake Restoration - reducing Phosphorus to Control Phytoplankton Growth:** The goal of successful lake restoration is to shift a lake from algal turbidity to a clear-water ecosystem controlled by underwater vegetation. Sustainable lake restoration involves a holistic and long-term approach that balances ecological health, social needs, and economic viability. A case study of this approach is about Alte Donau, a former branch of the Danube River used for recreation by Viennese, Austria. The restoration process began with phosphorus reduction through phosphate precipitation, followed by the re-establishment of submerged macrophytes.

**Water Clarity as Socio-Ecological Indicator in Urban Lakes**: Water clarity is a key indicator of aquatic ecosystem health and restoration success, with significant socio-ecological implications. It reflects water quality, ecosystem function, and human perceptions of environmental quality. *Ecological Significance*: Clear water indicates low levels of suspended sediments and algal biomass, associated with good water quality and healthy ecosystems. It supports diverse biological communities and enhances habitat quality. *Social benefit*: High water clarity improves recreational opportunities, aesthetic value, and public health. It fosters a connection between people and water bodies, promoting environmental awareness. Urban hotspots combining lakes and parks create blue-green spaces that are more valuable for urban living than green spaces alone.

**Role of Light Availability in Macrophyte Restoration in the Danube Delta:** Optimal underwater light availability is vital for macrophyte growth and for sustaining the clear-water state. For monitoring purposes, the euphotic depth (where more than 1% of ambient surface light penetrates) is typically measured, focusing on the minimum light requirement for growth of primary producers, algae and macrophytes. However, for sustained lake restoration, it is more effective to focus on optimum light availability (where more than 12% of ambient surface light penetrates). Large photic sediment areas receiving optimum light conditions will favor flourishing macrophyte growth and thus prevent algal growth in the water column (phosphorus is mainly utilized by macrophytes and not planktonic algae), which is essential for maintaining the clear-water state after restoration.

**Macrophyte Habitat Architecture and Its Ecological Impact:** Mature macrophyte stands are the third component in a shallow lake, bridging between benthic (lake bottom) and pelagic (lake water) zones. Their role is mainly seen in retaining nutrients (phosphorus which is bounded in plant tissue, is thus not available for phytoplankton growth during growing season) and habitat provision. Bio-mass and bio-surface are therefore the two main parameters describing ecological relevant aspects of macrophyte habitat architecture. In marine systems, the submerged macrophyte zone beside benthic and pelagic zone are described as underwater forest, a term that is equally applicable to freshwater systems.

**Capturing Eco-physiological background** of algae and macrophytes, e.g., as their species-specific pigment composition or nutrient acquisition, is important for interpreting consequences in lake ecosystems due to eutrophication and global warming, as it provides insights into species-specific responses to nutrient availability, light conditions, and temperature shifts, ultimately important for effective management and conservation strategies. Such knowledge is also important for categorizing algae based on their occurrence in waters with varying quality levels as defined by the Water Framework Directive.

**Katrin** will mainly contribute to the "**Water group**" with short outline about "Water quality and macrophytes in Delta Ecosystems".

Dr. Markus Weinbauer, markus.weinbauer@imev-mer.fr

**Microbial Dynamics and Particle Interactions in the ocean, coastal and fresh water:** Viruses and microorganisms are the most abundant life forms on Earth, significantly influencing aquatic ecosystems. Present in all habitats, they affect ecosystem functions, nutrient cycles, and biodiversity. Organic and inorganic particles in water bodies host these microorganisms, with organic particles tending to release viruses and inorganic particles trapping organic matter to support bacterial growth. Thus, such floating particles are both, sink (host) and source (release) of viruses and microorganisms. The overall impact of these particles inhabited by microorganisms on ecosystems is determined by their chemical and three-dimensional architecture and their capacity to absorb organic matter.

**Reeds and aquatic plants in the littoral zone trap particles from the water column**, including nutrients, organic matter, and pollutants. Sediment accumulation in these zones can enhance nutrient cycling, which is supported by microbial processes, an interplay of viral and microbial activity on biogeochemical cycling of organic particles. Plants utilize available nutrients from sediment for growth, thereby retaining these nutrients in the littoral zone during the growing season. This process is important for improving water quality in lakes and delta river branches.

**Comprehensive view on microbial and viral dynamics** highlights the importance of microbial processes in carbon cycling and storage, and availability of other nutrients too, which are important for understanding carbon and nutrient dynamics in the Danube Delta's aquatic ecosystems (viral lysis can e.g. alter biological availability of dissolved organic matter derived from picocyanobacteria). Interactions between viruses, bacteria, and their environment are responding to global warming and play a significant role in the health and functioning of freshwater and coastal ecosystems like those in the Danube Delta.

**Markus** will mainly contribute to the "**Water group**" with short outline about "Viruses und microorganisms & Delta Ecosystems".


Dr. Eng. Cristina Despina, cristina.despina@ddni.ro

**Pollution by Microplastics:** Monitoring plastic particles, which are typically less than 5 millimeters in diameter, is important to find effective strategies to prevent and mitigate this pollutant. Microplastic sources refer to the degradation of larger plastics (fragment into smaller pieces from bottles or bags, break down due to weathering, UV radiation), or originate primarily from microplastic sources (as e.g. waste water with microbeads contamination by cosmetic care products and industrial abrasives) or synthetic fibers (synthetic fabrics like polyester and nylon shed tiny fibers when washing clothes). Microplastics are pervasive in both terrestrial and aquatic environments, from oceans and rivers to soils and even the air. They pose risks to wildlife, as animals can ingest them, leading to physical harm or toxic effects. Additionally, microplastics can absorb and concentrate pollutants from their surroundings, which can then be transferred through the food chain. Addressing microplastic pollution involves efforts to reduce plastic use, improve waste management, and develop better filtration systems to capture microplastics before they enter the environment.

**Monitoring pollutants in the Danube Delta** is essential for safeguarding the environment, protecting biodiversity, and ensuring the well-being of both the ecosystem and the human populations that rely on it. Pollutants in the Danube Delta are beside microplastics further due to (1) Nutrient runoff, mostly via agriculture and inadequate water treatment plants in rural area, (2) Pesticides and herbicides used in agriculture washed into the Delta, (3) Heavy Metals from industrial activities and mining operations upstream, and (4) Wastewater and sewage by inadequate treatment facilities and direct discharge.

**Cristina** will mainly contribute to the "**Microplastic group**" and will present a short outline about "Microplastic Pollution in the Danube Delta".

**The working titles of suggested six publications are as follows:**

**The Danube Delta and Its Ecosystem Diversity** (scientific documentation prepared as scientific assay) ● Exploration of the various ecosystems within the Danube Delta, ● Detailed surveys study of aquatic and terrestrial habitats, ● Examination of the flora and fauna, with a focus on unique and endemic species, ● Analysis of ecological interactions and biodiversity, ● Field trips to key locations within the Delta to observe and collect data.

**Threats to the Ecosystem Diversity in the Danube Delta** (scientific documentation prepared as scientific assay) ● Identification and discussion of the primary threats to the Delta's ecosystems, ● Impact of climate change on the region's biodiversity, ● Effects of human activities such as agriculture, fishing, and urban development, ● Conservation efforts and strategies to mitigate threats, ● Role of policy and international cooperation in protecting the Delta

**Modern Monitoring of Floodplain Forests Vegetation in the Danube: NDMI and Conservation Efforts** (DC et al.) ● In drought-affected floodplain forests, reduced moisture levels weaken native vegetation, making it more vulnerable to invasive species, ● Utilizing modern technologies like the Copernicus Normalized Difference Moisture Index (NDMI) is essential for monitoring these changes. NDMI assesses vegetation moisture content, highlighting areas under drought stress, ● Ground-truthing vegetation surveys along the drought gradient, combined with NDMI data, offer valuable insights into the spread of invasive species in the Danube Delta floodplain forests, guiding conservation efforts, ● practical relevance for summer school: (1) field protocol that can be completed within 3 hours in the field and 3-4 hours of desktop work. The topic is very modern, and students will gain valuable skills, including field techniques, manipulation of satellite images, and a basic framework for data processing. (2) The fieldwork will be conducted in the floodplain forest and will include 20 survey plots with varying cover values of herbaceous invasive species. For the same plots, students will extract the 5-years median values for NDMI (Copernicus moisture index). After that, students will process data and interpret results. Finlay, we will create the structure of the paper together.

**Tracing Pollution Pathways: Industrial, Agricultural, and Urban Impacts on the Coastal Area between Sulina and Sf. Gheorghe** (DB, AB, CD et al.) ● Discussion about what data in space and time are required: The coastal area between Sulina and Sf. Gheorghe in the Danube Delta is subject to various pollutants, including industrial discharges, agricultural runoff, and urban waste. These pollutants create complex patterns of contamination influenced by water flow, tides, and human activities. Key stressors in this region include chemical pollutants (e.g., heavy metals, pesticides), nutrient overload (leading to eutrophication), and physical disturbances (such as dredging and construction). Understanding these patterns and influences is most relevant for developing effective management strategies to mitigate pollution and protect the ecological integrity of the coastal zone. This involves identifying the sources of pollution, tracking their movement and concentration, and assessing their cumulative impacts on the ecosystem.

**Sustainable Food Systems: Addressing Microplastic Pollution in the Danube Delta's Aquatic Food Chain** (Prof. Stefan Petrea from Univ. Galati, DB & AB et al.) ● discussing the intersection of sustainability, food systems, and environmental pollution, ● defining microplastic pollution in Danube Delta ● searching for how microplastics enter and move through the aquatic food chain, ● assessing food safety in view of microplastics, ● reviewing the potential strategies to mitigate these effects to support a sustainable and healthy food system.

**Structural Diversity of underwater vegetation habitats: Bio-Mass vs Bio-Surface Ratios of macrophyte species** (KT MW MD et al.) ● Discussing the role of macrophyte habitat architecture, ● Investigating the structural diversity of underwater vegetation by analyzing the bio-mass to bio-surface ratios of various macrophyte species, ● By assessing bio-mass, we can estimate how much phosphorus

is bound within the tissue and, therefore, not available for algae growth, ● Macrophyte biomass will be assessed as displacement (biovolume) of living plant material, ● Macrophyte bio-surface refers to the total surface area of the plants that is available for colonization by microorganisms, algae, and invertebrates. This can include leaves, stems, and roots that are submerged, ● Summer school offers hands-on experience in collecting and preparing plant material to measure biovolume and bio-surface to enhance our understanding of these critical ecological metrics.

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Introduction to the site "Bazinul Mic", nearby the accommodation Vila Alga (Fig1a, b). It will be our main site for surveys which take longer time, to bring out insect traps and doing depth profile measurements, used by all three groups the "**Terrestrial group**" "**Water group**" and "**Microplastic group**".


*Fig 1a, b: Two Google maps screen shots showing "**Bazinul Mic**", Small Sulina Coastal Bay, where we can do probe measurements, beside day-boat trips (see day 5, Thursday, and day 6, Friday), measurements will be discussed knowing how the bay looks like*

# Time schedule

1 First day (25.08.2024, **Saturday**): Students and lecturers arrive in Tulcea (most of them at 12:00 or 15:30 at Airport Bucharest, a four-hour bus transfer to Tulcea is organized), **Welcome dinner at 20.30 at Hotel Delta Tulcea** (https://hoteldelta.eu/ ) /overnight in Hotel Delta in Tulcea (Fig. 2)

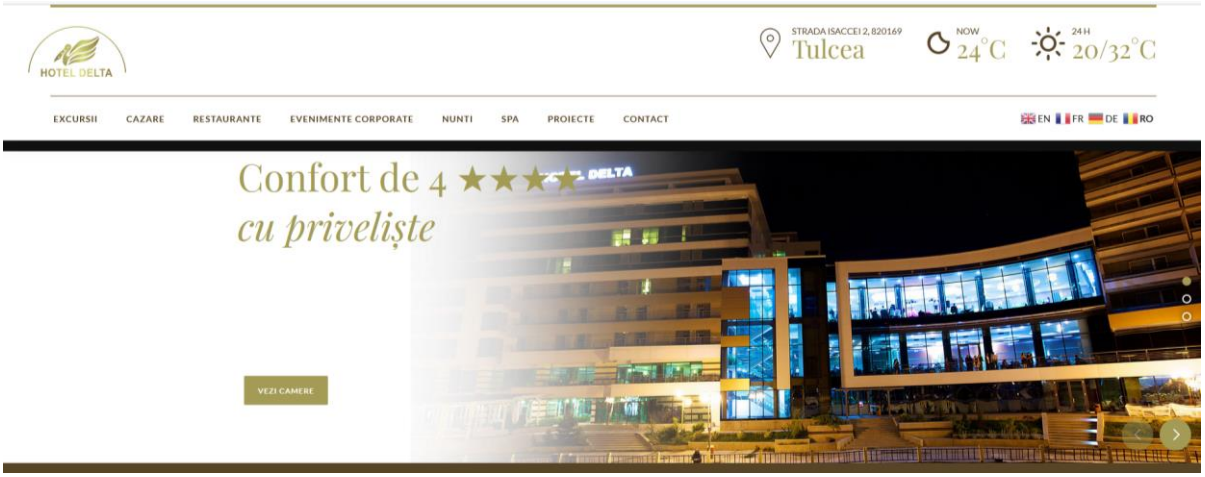


*Fig 2: Our accommodation in Hotel Delta in Tulcea, with welcome dinner in the evening, screenshot from https://hoteldelta.eu/*
*The day of arrival will be the only day to visit Tulcea, if one wishes to do so.*

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2 Second day (26.08.2024, **Monday**): **Visit to Danube Delta National Institute** (DDNI, https://ddni.ro/wps/) to learn about their research activity & expertise, the departments, and projects of the Institute.

- 9:30-9:45 Arrival and registration to the event(each participant will get an equipment set containing t-shirt, cap, summer jacket, agenda and pencil)
- 9:45-10:00 Welcome speech introducing to the Danube Delta Institute and biosphere reserve by **Dr. Eng. Iulian Nichersu**
- 10:00- 10:15 Welcome speech about mission and history of IAD, by IAD President **Prof. Bernd Cyffka** *15 minutes, online*
- *10:15- 10:20* Welcome Introducing lecturers and students to IAD summer school, by IAD General Secretary, PD **Dr. Katrin Teubner** *10 minutes*

- *10:20- 10:35* Welcome speech about scientific program of IAD summer school, by **Dr. Markus Weinbauer** *15 minutes*
- *10:35- 11:00* Welcome speech about funding of IAD summer school and short overview about recent EU projects, such as Dawetrest, by **Mag. Dragos Balaican** *15 minutes*
- 11:00-11:30 DDNI presentation, ongoing projects and future possible collaborations *30 minutes*
- 11:30-12: 00 Brunch at DDNI
- 13:30 Departure from Tulcea to Sulina

Around 4 hours trip with classic vessel


Photo from https://www.navromdelta.ro/galerie-foto/)

Two Presentations during trip by **Dr. Alexandru Dorosencu**:

- General presentation of Danube-Danube Delta-Black Sea (20-30 minutes after departure from Tulcea)
- Free flooding areas; Regulation and management activities on the Sulina Channel, focusing on enhancing navigability and effective water flow regulation (20-30 minutes in the area Obretin-Crisan)


*Fig 3: Our accommodation Vila Alga, located near the shore of Sulina's "Bazinul Mic", which means translated "The Small Basin" of Sulina Coastal area – screenshot from https://www.vila-alga.ro/*

17:30 check-in at **Vila Alga**, Fig. 3 ( https://www.vila-alga.ro/ )

18:00 -18:45 Dinner

18:45 – 19:00 Schedule for the upcoming days and safety rules (**Mag. Dragos Balaican**)

19:00-20:00

| Evening round table discussion about **Scientific publishing** |
|---|

3 Third day (27.08.2024, **Tuesday**): **Thematic excursion** to the **Periprava area** and **Letea Forest** /overnight in Sulina

07:30 – 08:30 Breakfast

09:00 Departure to **Letea Village** by speed boats, around 1 hour trip in inside channels

Letea is a beautiful village, with many traditional houses made of wood, adobe (a type of mudbrick house made of dirt and straw with mud used as mortar) and reed, painted in the traditional colors of green, blue and white. From here, the trip continues to Letea Forest with an all-terrain vehicle.

10:00 – 10:20 Departure to Letea Forest (Fig. 4)

The area is a rich combination of Mediterranean, subtropical and Balkan species. This diversity is due to its unique location. Here you can meet the *Dobrogean liana*, a liana with glossy green leaves and yellow flowers, which wraps around the trees. You can also admire the sandwort, a small white flower with a yellow center that blooms in the spring, and dog grass, a perennial plant with long green leaves and spikes of flowers that cover the forest floor. The biggest attraction, then when you take a trip to the Letea Forest, is the wild horses of the Danube Delta. The horses of Letea are an emblem of this area and are descendants of domestic horses abandoned in the 70s and 80s, which have adapted perfectly to the wild life of this region. The horses of the Letea Forest are medium-sized, with a brown or black coat, often with white spots on their muzzles and legs. Here is one of the few places where you can see wild horses in Romania. They are hardy and have strong hooves, adapted to the sandy ground of the gravel.

12:30- 14:00 Trip to **C.A.Rosetti village** and stop to the **Salt water Lake**

14:00- 15:00 Brunch in Letea

15:00- 16:00 trip back to Sulina

17:30 Dinner at Vila Alga

18:00 Presentation of schedule for tomorrow and after

| Evening round table discussion stimulated by **Terrestrial group** |
|---|


*Fig 4: Google maps screen shots showing Periprava above, Periprava & Letea Forest below.*

4 Fourth day (28.08.2024, **Wednesday**): **Thematic excursion** to the study areas of the project **DaWetRest** (Caraorman and Seaside Cordon) /overnight in Sulina

07:30 – 08:30 Breakfast

09:00 12:30 Departure to Caraorman fish pond (study case from Dawetrest)

The trip will have the following path (as presented in the map below with the red line, Fig. 5) **Barbosu-Imputita** channel- **Lakes Rosu-Rosulet** and **Lake Puiu**- **Caraorman Channel**; the trip normally takes around 1.5 hours only but we will go slower to discuss on the biodiversity and observe different species of birds, flora and so on (Fig. 6)

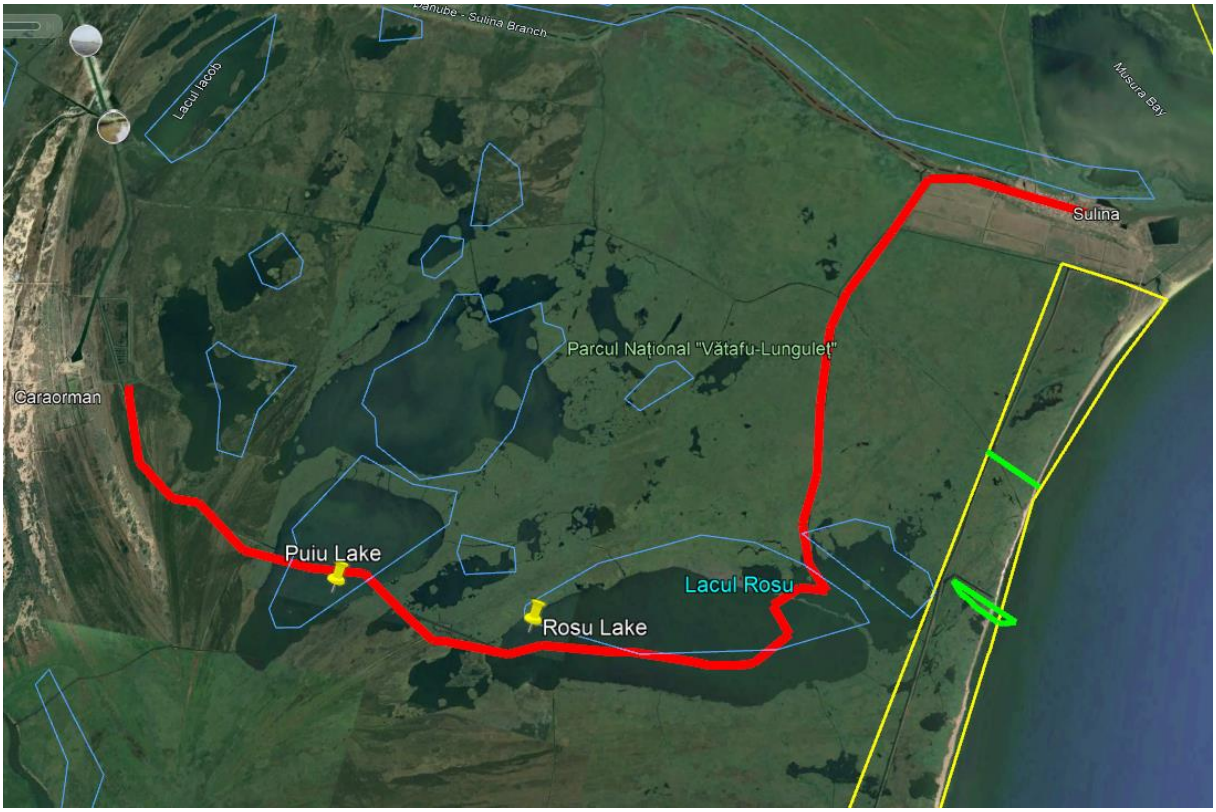


*Fig: Google maps screen shots showing the route map going to Caraorman.*

12:30-13:00 visiting DaWetRest study case in Caraorman fishpond

13:00- 14:00 Lunch at local restaurant next to Caraorman fishpond

14:00- 15:15 Trip by boat to Cordon Litoral, study case in DawetRest project

15:30 – 16:00 trip by boat back to Sulina

17:30- 18:30 dinner

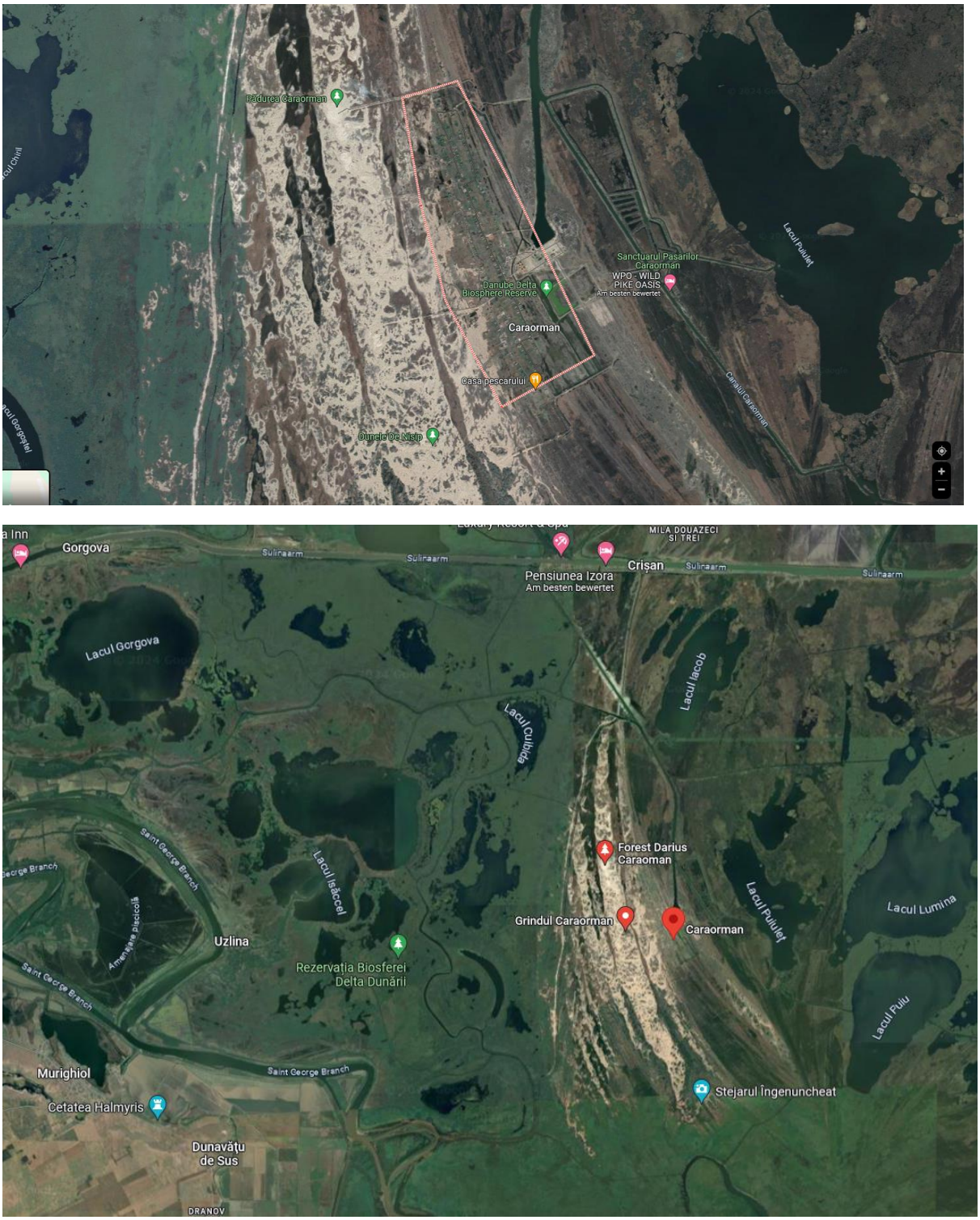


*Fig 6: Further Google maps screen shots showing Caraorman above and Caraorman & Seaside Cordon below.*

| Evening round table discussion stimulated by **Water group** |
|---|

5 Fifth day (29.08.2024, **Thursday**):**Thematic excursion** of **Microplastic group** to the Sulina coastal area with greening of an area and identification of types of pollutants

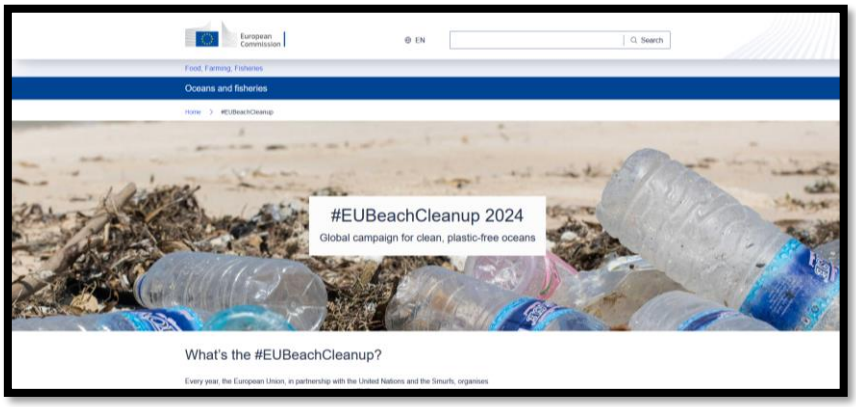


*Fig 7: Screen shots from [https://oceans-and-fisheries.ec.europa.eu/eu-beach-cleanup_en](https://oceans-and-fisheries.ec.europa.eu/eu-beach-cleanup_en) .*

07:30 – 08:30 Breakfast

9:00- 12:00 DaWetRest Premiere BeachCleanUp . This is also registered as an event on **#EU BeachCleanUp** (Fig. 7)

We will split in 5 groups at designated sites on the **coastal area of Sulina** and we gather and map the types of garbage identified (plastic, metal, other). We are using an app with the scope of realizing the pattern of the garbage brought by the currents to the coastal area. For sampling, we will use gloves, plastic bags, and water. We further will discuss microplastic pollution from the scientific experience by participants from other countries, as Bulgaria and Hungary. The results of sampling and collecting microplastics is aimed to be published further as scientifical article prepared by the microplastic group, and who else wants to contribute here.

12:00-14:00 relaxing time

14:00-15:00 lunch

15:00- 19:00 relaxing/discussion time

19:00- 20:00 dinner

This day also will offer the opportunity to work in the "terrestrial and water group" after lunch, as, e.g. doing surveys on reed vegetation, birds and insects, starting day-night cycle to measure depth profiles for dissolved oxygen (DO) and temperature (T), working on submerged macrophytes an so on. All these measure activities will be roughly speaking in front of accommodation or while enjoying at a picnic area at shore of the "**Bazinul Mic**", Small Sulina Coastal Bay.

| Evening round table discussion stimulated by **Microplastic group** |
|---|

6 Sixth day (30.08.2024, **Friday**) travel day / overnight in Sulina:

07:30 – 9:00 Breakfast

09:00- 14:00 free time

14:00-15:00 lunch

15:00-19:00 free time

19:00-20:00 Dinner

Day of individual planning of thematic groups:

**Terrestrial group,** if need locally by boat to reed

**Water group** by boat studying submerged macrophytes, continuing measuring day-night profiles of T and DO, measuring transects with probes

One possibility is to stay in Sulina, which is the most important port city on the western coast of the Sea Black in the past state, Porto-Franco, providing impetus for a thriving, driven economy trade and navigation. Now with less than 3,500 inhabitants.

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7 Seventh day (31.08.2024, **Saturday**): Return to Tulcea by early morning disembarkation of students & lecturers

**Departure at 05:30** (1.5 hours trip)

07:00 Tulcea

Trip to Bucharest around 4 hours by bus, means arriving Airport Bucharest at around 11 am – for few participants one overnight stay in Tulcea is planned (Hotel Insula, Tulcea, https://www.booking.com/hotel/ro/insula-tulcea.de.html), they leave to airport Bucharest on 1.Sept, Sunday

## Recommended Literature for IAD summer school:

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