Access to space and water for inland aquaculture

Background paper

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LIST OF ABBREVIATIONS

Term	Description
AA	Appropriate Assessment
AAC	Aquaculture Advisory Council
AAM	Aquaculture Assistance Mechanism
AMA	Aquaculture Management Area
APROMAR	Asociación Empresarial de Acuicultura Española (Aquaculture Business Association of Spain)
CIE	Combined intensive-extensive
CFP	Common Fisheries Policy
DMA	Disease Management Area
DSS	Decision Support Software
EC	European Commission
EAA	Ecosystem Approach to Aquaculture
EAS	European Aquaculture Society
EATIP	European Aquaculture Technology and Innovation Platform
EMFAF	European Maritime, Fisheries and Aquaculture Fund
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GIAHS	Globally Important Agricultural Heritage System
GIS	Geographic Information System
HUNATIP	Hungarian Aquaculture Technology and Innovation Platform
IMTA	Integrated Multitrophic Aquaculture
ISA	Infectious Salmon Anaemia
MS	Member State
MNSPA	Multiannual National Strategic Plan for Aquaculture
MSP	Maritime Spatial Planning
PGI	Protected Geographical Indication
RAMPS	Recirculating Aquaculture Multi-trophic Pond systems
RAS	Recirculating Aquaculture System
RBMPs	River Basin Management Plans
TAPAS	Tools for the Assessment and Planning of Aquaculture Sustainability
UK	United Kingdom
WFD	Water Framework Directive

1 INTRODUCTION

1.1 Policy Context

Access to space and water is of key importance for the sustainable growth of inland aquaculture in Europe. Inland aquaculture planning represents a cross-cutting strategic instrument for public authorities and stakeholders to apply a coordinated approach, allowing for a better use of space, reducing conflicts, as well as enhancing co-existence and synergies.

The European Union's (EU) "Strategic Guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030"[1] identifies access to 'space and water' as a factor contributing to building resilience and competitiveness for the aquaculture sector, especially through coordinated planning based on the designation of areas suitable for its activity. According to these guidelines, spatial planning should be based on the coordination between the relevant authorities at different levels, starting with the mapping of existing and potential aquaculture areas. Such mapping should include a process to identify the potential to restore abandoned aquaculture facilities or convert existing industrial facilities to aquaculture. It should also seek to promote synergies between different activities and multiple uses of space, such as encouraging aquaculture development in combination with other economic activities. Finally, the various effects of climate change must be taken into account in inland aquaculture planning.

In the EU, inland aquaculture is governed by national rather than EU legislation. However, there are EU legal instruments that have implications for the sector, such as the Birds[2] and Habitats[3] Directives. These directives have created the Natura 2000 network – which is now the largest coordinated network of protected areas in the world[4]. It is also worth mentioning the directive on Environmental Impact Assessment (EIA)[5] (EIA 2011/92/EU) and the Water Framework Directive (WFD 2000/60/EC)[6].

Furthermore, the Commission Staff Working Document on the application of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) in relation to aquaculture[7] provides guidance for Authorities including relevant information for decision making regarding inland aquaculture.

River Basin Management Plans (RBMPs), as key tools for implementing the WFD, have been suggested by O'Hagan et al., (2017) to integrate both objectives and measures for areas of aquaculture production so that the possible impacts of the sector and its future requirements can be considered in the context of the whole river basin[8].

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[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030 (COM/2021/236)

[2] The Birds Directive 79/409/EEC was adopted in 1979. It is one of the first pieces of environmental legislation to be adopted by the EU. It was amended in 2009 (Directive 2009/147/EC)

[3] The Habitats Directive (Council Directive 92/43/EEC) was adopted in 1992, thirteen years after the Birds Directive. Like the Birds Directive, the Habitats Directive requires all Member States to establish a strict protection regime for species listed in Annex IV, both inside and outside Natura 2000 sites.

[4] Natura 2000 is a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right. It stretches across all 27 EU countries, both on land and at sea. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive.

[5] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (Directive 2011/92/EU)

[6] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02000L0060-20141120&qid=1693405114480

[7] SWD (2016) 178 final https://aquaculture.ec.europa.eu/system/files/2023-06/Guidance_WFD_MSFD.pdf

[8] In Spain, the River Ebro RBMP , which also sees the fish farm as a pressure, reports in its annexes data on inland aquaculture. However, aquaculture occupies only the 5th position, the River Ebrothe RBMP considers aquaculture as an economic activity. In this sense, it reports 30 inland aquaculture establishments in the river Ebro basin. According to its annex, in 2019 inland production amounted to 5,754 tonnes, with a value of 28,753,243€, thus standing out from the rest of the river basins in

1.2 Scope of the background paper

Developed under the EU Aquaculture Assistance Mechanism (AAM) (see Annex I), this background paper has been designed to present Good Practices in different EU and non-EU countries (i.e., Norway and UK) that can provide Member States' authorities and policy makers with potential solutions to the challenges they face in inland aquaculture planning.

This background paper considers inland aquaculture as the production of aquatic organisms carried out in wetlands, lakes, ponds, and land-based facilities using freshwaters or located in the proximity of rivers. Within this scope this background paper considers:

- **Floating cages in lakes** for MS that can be interested in the sustainable growth of the inland aquaculture in this kind of environments.
- **Extensive aquaculture and manmade wetlands modelled by pond aquaculture,** important ecosystem services providers and their capacity to preserve water quality and availability.
- **Sustainable intensification of ponds,** by combined intensive-extensive (**CIE**) systems that optimise space and reduce manure applications keeping high water quality[9].
- Freshwater **RAS**[10], allowing food production almost anywhere, regardless of local conditions.
- **Aquaponic**[11], which allows to produce plants without soil thanks to the nutrient-reach effluents from fish farming.
- **Recirculating Aquaculture Multi-trophic Pond Systems** (**RAMPS**), an innovative freshwater **IMTA** combining RAS, IMTA and pond farming techniques, producing complementary species from different levels of the food chain[12].
- **Earthen ponds** and **raceways using flow-through systems** in rivers. This kind of aquaculture is considered in this background paper especially for its susceptibility to climate change's effects (e.g. water scarcity and deterioration).

The State of World Aquaculture and Fisheries (SOFIA) 2022[13], reported that there are places in the world where aquaculture in constructed ponds on seashores is classified as "inland aquaculture". However, this background document, with the exception of the example in estuaries, considers fish farming in ponds on the seashore as "coastal aquaculture"; and consequently, these systems are under the scope of the Guidance document on Access to Space for Marine Aquaculture[14].

This background paper is structured as follows: Chapter 2 describes the methodology employed and sources consulted to gather information for the elaboration of this document. Chapter 3 describes the key topics addressed, as well as the main challenges and solutions for inland aquaculture. Then, Chapter 4 compiles in seven factsheets Good

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Spain. The farms account for approximately 20% of the inland aquaculture facilities in Spain. These are mainly dedicated to the production of rainbow trout and, to a lesser extent, to the production of native trout for fish restocking, as well as sturgeon for caviar. Moreover, the document describes the impact of the sector on the local community, reporting the fact that aquaculture employs 233 people.

[9] In CIE systems, while a small unit increases farm productivity by implementing intensive techniques, a large pond takes advantage of the effluents operating polyculture and providing new space for other activities (multifunctional approach).

CIE systems have the same capacity to save both space and water such as recirculating aquaculture systems (RAS), Aquaponics and freshwater Integrated Multitrophic Aquaculture (IMTA), that are also considered in this background paper.

[10] RAS facilities are generally sophisticated closed systems (equipped with filters, aeration, etc.) that reuse water at high rates According to EUFOMA December 2020 – Recirculating Aquaculture facilities, conventionally, fully recirculating RAS are typically defined as systems with a recycle ratio above 90%.

[11] Aquaponics is the combination of aquaculture and hydroponics culture.

[12] In IMTA, the uneaten feed, wastes, nutrients, and by-products of one species are recaptured and converted into fertiliser, feed, and energy for the growth of the other species

[13] SOFIA, The State of World Aquaculture and Fisheries 2022

[14] The Guidance document on Access to space for marine aquaculture reports Good Practices from spatial planning from Andalusia (Spain) where specific zones for coastal earthen ponds are considered by the Regional Government in marine spatial planning.

Practices examples on access to space and water for inland aquaculture for MS, organised according to the topics presented in Chapter 3. Finally, this document provides further information about the AAM (Annex I) and good practices for the inland aquaculture industry (Annex II).

2 METHODOLOGY AND RESOURCES

In the preparation of this background document, several data collection activities (detailed below) were conducted to gather relevant and updated information on challenges, solutions, and good practices related to the access to space and water for inland aquaculture.

The literature review and desk research brought together numerous documents and studies from Europe, including guidelines from the European Commission (EC), handbooks from FAO, peer-reviewed scientific publications, case studies, deliverables from EU-funded projects, and recommendations from the Aquaculture Advisory Council (AAC), as well as Multiannual National Strategic Plans for Aquaculture (MNSPAs), RBMPs among others.

The outcomes of EU-funded projects, specifically of the "Ecosystem Approach to making Space for Aquaculture" (Aquaspace[15]) project, were used as a key source of information on the main issues on access to space. In addition, the "Tools for the Assessment and Planning of Aquaculture Sustainability" project (TAPAS[16]) was analysed to gather knowledge about site selection. Regarding key issues about climate change adaptation, "Climate change and European aquatic resources" project (CERES[17]) and "Co-creating a decision support framework to ensure sustainable fish production in Europe under climate change" (ClimeFish[18]) projects were considered in order to identify good practices on adapting the inland sector to temperature rise and extreme events occurrence.

An **online survey** was launched in April 2023, targeting authorities and policy makers working in the aquaculture sector in Member States. In consideration of the cross-cutting nature of inland aquaculture planning, authorities/policy makers in spatial planning or environmental departments were also invited to contribute to the survey. Overall, the key objective of this consultation was to identify the main challenges and solutions regarding access to space and water for inland aquaculture in Europe. Information about the phases and key elements pertaining to aquaculture planning, focusing on the specifics of inland aquaculture was also gathered from the survey. A total of 13 participants contributed to the survey, which was created and shared through the EU Survey tool.

To fill some gaps after the analysis of the survey responses, different rounds of consultations with experts and associations were held. In this sense, national experts and scientists, as well as TAPAS and AquaSpace projects representatives, were interviewed by e-mail or bilateral meetings. In addition, Spain farmers association APROMAR was consulted about RBMPs and WFD implementation in Spain, and the Hungarian Aquaculture Technology and Innovation Platform (HUNATIP, Hungary) was contacted regarding inland aquaculture techniques with lower or positive impact on the environment. These interviews provided core information for the validation of good practices.

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[15] Aquaspace project http://www.aquaspace-h2020.eu/

[16] TAPAS project https://www.youtube.com/watch?v=BLRbajmThVA

[17] CERES project https://ceresproject.eu/

[18] ClimeFish project http://136.144.228.39:8080/climefish/decision-support-framework

3 KEY ISSUES ADDRESSED

Changing conditions due to climate change, complex legal issues and coherence with other legislation (e.g., environmental/water management) have been identified as the main challenges for access to space and water for inland aquaculture.

In addition, the scarcity of freshwater resources, water quality and availability as well as the cost of the space and site availability were also highlighted by MS, together with subjective reservations among non-governmental organisations and/or the population about the siting of aquaculture facilities.

To provide solutions to these challenges for access to space and water for the inland aquaculture sector, the different topics addressed in this document are:

#	Key challenge	Related topics
3.1	**Access to space**	• Integrated spatial planning • Mapping systems • Site selection • Synergies and conflicts of interest with other activities • Consistency with environmental planning and aquaculture in Protected Areas
3.2	**Access to water**	• Water quality and availability & climate change
3.3	**Other issues relevant to space and water conservation**	

3.1 Access to Space

Multiple Levels of Authority

Countries can have **several levels of authority** for inland aquaculture administrative procedures having impact on spatial planning, especially when various activities coexist in the same ecosystem.

The Guidance Document on Regulatory and Administrative Procedures in Aquaculture reviewed the Licencing Process for aquaculture facilities and reported Good Practices for this issue.

Integrated Spatial Planning

Integrated spatial planning refers to a comprehensive and data-driven approach for the development that takes into account spatial or geographical considerations where policymakers identify, plan, and implement various policies, with a particular focus on nature conservation and local communities' needs[19].

For integrated spatial planning in inland aquaculture there is also the need to define which **method of production is suitable for each zone**. Thus, coordination and integrated spatial planning should be strengthened to address these challenges, and countries should adopt an approach that considers the concerns of local communities, among others (Cavallo et al., 2021).

This approach, which considers economic and social factors at multiple levels when allocating inland aquaculture should involve all relevant stakeholders and seek to understand their perspectives. Therefore, conflicts with other activities can be minimised, and a more harmonious coexistence can be achieved (Ross et al., 2013).

[19] Further information regarding Integrated Spatial Planning can be found here: https://www.undp.org/publications/integrated-spatial-planning-workbook

When aquaculture is completely new to a region, authorities, and other stakeholders, might want to start with scoping; while in areas where aquaculture is well established, it is suggested to begin with the definition of aquaculture management areas (AMAs) and management plans. AMAs are defined as zones that contain more than one farms.

Aguilar-Manjarrez (2017a, b) provided a schematic representation of an inland aquaculture zone. It represented individual land-based farms operating in earthen ponds where different companies where already established. With these parameters in mind, the author suggested three main steps for assigning the space to each one of the farms: 1) the identification of the type of farming according to species and technique (scoping and zoning); 2) the selection of farm sites within zones; and 3) the grouping into AMAs.

Regarding the order of these steps, the above-mentioned author reported that the sequence depends on the grade of the activity's development at the local level.

The designation of AMAs should depend on the mutual and exclusive use of incoming and outgoing water supplies by a given set of farmers. Consequently, it is recommended to identify the areas by establishing the common water sources and water flow as the priority criteria to address both fish health and environmental risks (Aguilar-Manjarrez et al., 2017a, b).

In the AMA, where different farms are next to each other and share water supply, if any issues arise (e.g. diseases), it can be more efficiently managed collectively than individually.

Mapping systems

Companies and entrepreneurs who want to open new farms need transparent information about spatial planning to verify site availability and suitability.

Geographic information system (GIS), which are also described in the Guidance Document on Access to Marine Space, are popular in marine spatial planning, showed great potential for inland aquaculture.

Certain MS, that have powerful GIS open to the public[20] present information regarding the inland aquaculture sector or are updating their public GIS systems to offer information useful for the growth of inland aquaculture (e.g. Spain and Portugal).

GIS are a powerful tool to present the information that should be considered for spatial planning, and they can be used to generate models (known as GIS-based models) that can include data from the site, catchment, stakeholders, etc to identify the best space to allocate inland farms.

In this point, this background paper refers to GIS-based models as a good practice for inland aquaculture spatial planning in lakes (Falconer 2019a), since they can be useful for the MS that perform aquaculture in this kind of ecosystems such as Poland (O'Hagan et al., 2017), Scotland, and Sweden (Varadi et al., 2023).

Site selection

In order to perform **site selection**, the following two elements should be taken into consideration:

- Carrying capacity studies: On aquaculture these studies cannot be any longer be based solely on production. They have to be developed into a more

[20] Example of GIS web sites and their functions are showed in the section Further information of the Good Practice 4.1.1 of this background paper.

comprehensive study taking into account four categories: physical, production, ecological and social carrying capacity.

- Ecosystem Approach to Aquaculture (EAA): This is based on governance and environmental and socio-economic principles and emphasises the importance of minimizing negative impacts and maximizing benefits for society, involving all stakeholders in decision-making, and integrating with other sectors.

Taking into account the above, it is clear that data sets that can be used for site selection vary based on local priorities and circumstances. That means that key parameters (environmental, social, and economic) for inland facilities need to be established at the local level.

For site selection in ecosystems where there are no specific aquaculture zones and the waterbody needs to be assessed, the assessment of site availability and site suitability should focus on the entire system, using relevant parameters for stakeholders.

Synergies & conflicts of interest with other activities

In the implementation of inland spatial planning, conflicts can be avoided by creating **synergies between activities** that can coexist in the same ecosystem.

To avoid conflicts and promote sustainable growth, provisions such as tenders for public space use and consultations should be incorporated in the process that leads to the releasing of permits. These mechanisms allow for transparent and inclusive decision-making processes. (see Guidance Document on Regulatory and Administrative Procedures in Aquaculture)

The establishment of **multifunctional aquaculture sites**, which relates to spaces that are used to operate aquaculture and, at the same time, other economic activities (e.g. angling, touristic services, educational activity), is a way to **optimize the space** that could avoid conflicts between stakeholders from different sectors, recuperate space to produce food and, at the same time, valorise deteriorated wetlands, abandoned industrial soils and fields that are not suitable for agriculture.

Consistency with environmental planning & aquaculture in Protected Areas

Many suitable zones for inland aquaculture fall within protected zones. This is also a **challenge on access to space** given the restrictions imposed to the farms in **protected areas** (e.g. drainage of the pond, flora cutting and birds control).

Authorities should consider natural reserve as areas that can be used for aquaculture. The **reinforcement of positive interaction** within protected areas will harmonise the production with conservation objectives, contributing to biodiversity conservation and meeting aquaculture production goals.

The "Guidance document on aquaculture activities in the context of the Natura 2000 Network[21]" reports the procedure to follow to open aquaculture facilities. The latter can provide guidance to MS that are prohibiting aquaculture in Nature 2000 areas or other natural reserves.

[21]https://ec.europa.eu/environment/nature/natura2000/management/pdf/guidance_on_aquaculture_and_natura_2000_en.pdf

3.2 Access to Water

From the point of view of access to water for inland aquaculture, **water scarcity and deterioration**, as well as extreme water levels, pose significant challenges to inland aquaculture.

Note that there is a specific "Guidance Document on Climate-Change Adaptation in the Aquaculture Sector". Therefore, the present paper will include only good practices and examples related to climate-change adaptation when related to access to water for freshwater aquaculture in a way that can complement the latter and avoid any overlaps.

For these reasons, the Chapter 4 will consider **real-time water monitoring, water treatment, and the use of alternative water sources**, which can help to mitigate challenges faced by both extensive and intensive inland aquaculture facilities regarding access to water. Implementing these measures helps to ensure optimal water quality for the production and reduces the reliance on limited water resources.

Furthermore, **support** for inland farming during drought periods is an essential measure for enhancing the adaptive capacity of the sector to water scarcity or deterioration and it has been considered in the Chapter 4.

3.3 Other issues relevant to Space & Water conservation

Although traditional extensive and semi-extensive freshwater aquaculture is an important ecosystem services provider, which preserves both space and water and contributes to wetland habitat maintenance and water management, it may suffer economic losses due to **environmental restrictions**.

As the wetlands modelled by extensive ponds are manmade, if the aquaculture activity loses economic feasibility, the producers will abandon the ponds, and then the biodiversity associated to the wetland is lost and the space degrade.

A potential solution to this challenging scenario should be that the MS take care of the maintenance of the wetland.

Instead, if the role of extensive and semi-extensive farming is recognised and integrated into the overall value chain of the industry, it can improve the feasibility of the inland aquaculture industry avoiding the abandonment of the ponds by the farmers.

Therefore, authorities should promote the modernization of the monitoring. Data will show if the facilities are operating in a sustainable way, a condition that should also be reflected in certifications. The latter can be provided by public organizations or developed as Technical Standards or Codes of Conduct.

Furthermore, MS should provide access to space and water to innovative techniques such as **RAS**, **Aquaponics**, **CIE** and **IMTA** systems.

It should be noted that the upcoming "Guidance Document on Environmental Performance" will include in its second delivery aquaculture practices with lower environmental impact as well as ecosystem services and nature-based solutions. Therefore, the present document will include in the Chapter 4 only good practices and examples related to access to water for freshwater aquaculture in a way that can complement the latter and avoid any overlaps.

4 Good Practices

This Chapter presents the seven good practices selected to provide guidance to the Authorities on how to implement the solutions described in Chapter 3, including:

#	Key challenge	Good Practice
4.1	**Access to space**	4.1.1. Developing GIS-based tools & models for spatial planning 4.1.2. Restoration of abandoned facilities 4.1.3. Adopting multifunctional approach & special provisions 4.1.4. Reinforce positive interactions within protected areas
4.2	**Access to water**	4.2.1 Develop measures and tools to inform on water quality and availability
4.3	**Other issues relevant to space and water conservation**	4.3.1. Providing access to space to types of aquacultures that have lower or positive impact in nature 4.3.2 Strengthening space & water saving innovative technologies

4.1 Access to space

4.1.1 Developing GIS-based tools and models for spatial planning

Access to space
Developing GIS-based tools & models for spatial planning
Description: With the help of Online Geographical Information Systems (**GIS**) stakeholders (such as investors, private companies, researchers, and the public in general) can find where inland aquaculture facilities are located by consulting websites or application programs (app). These **GIS tools offer information** such as aquaculture facilities status (active/inactive), the technology employed and the species that are cultivated there. They also should include available sites for inland aquaculture in spaces such as lakes, rivers, and estuaries as well as land-based. GIS should also include facilities that have been closed or abandoned. Further information about the reason (socio-economic or environmental) for the closing would be also interesting to know, both for investors and citizens, to avoid conflict. Using GIS, maps can be enriched with relevant data for inland aquaculture (hydrographic information, water quality, location of other activities, etc.) for a specific case study. These enriched maps, which are known as **GIS-based models can offer alternative scenarios** that can be explored interactively, and they are very powerful to identifying potential and new areas to allocate inland aquaculture facilities. GIS-based models could also be supported by **carrying capacity assessments**, an important approach for ecosystem-based management, which helps to set the threshold of aquaculture production given the environmental limits and social acceptability of aquaculture, thus avoiding “unacceptable change” to both the natural ecosystem and the social functions and structures.
Relevant aspects to consider when developing GIS-based tools & models for inland aquaculture(1)
1. **Identifying project requirements**

Access to space	
Developing GIS-based tools & models for spatial planning	
To align on the inland spatial planning project basics, known as a multiple stakeholder decision-making situation, it is essential to develop a common understanding of decision support needs, project goals, GIS functionality. **2. Identifying data sources and gathering information** For inland integrated spatial planning consider data from satellite (e.g. images), economic and social factors from local authorities reports, and infrastructures. Environmental data can be gathered on the field such as i) administrative authorities, ii) hydrographic information (including the ecological status of the water body), and iii) protected areas.	
Examples of Applications in European and non-EU countries	
Austria	*In the AQUAZOOM project [(2)], 17 land-based and 17 water-based spatial criteria were identified in terms of suitability for trout production and combined in an integrative GIS-based modelling approach. The result was a zoning of suitable areas for aquaculture. Out of a total of 8113 sub-catchments (TEZG) with a mean size of 10 km^2, 1295 TEZG were thus classified as suitable. This approach will be translated into an online tool to support the decision-making to avoid conflicts.*
Hungary	*In the AquaSpace project [(3)] a combination of a multi-layer GIS study and multiple stakeholder feedback surveys were done in Békés County. The overlay of the different land uses, the public use and opinions of the general population highlighted the importance of consultation and participatory processes for different stakeholder groups (face-to-face meetings). This is an example shows that communication can eliminate false assumptions and increase awareness of aquaculture industry efforts.*
Norway	*Online GIS app Kart i Fiskeridirektoratet[(4)] maps facilities in freshwater areas. The data that are uploaded to the systems comes from the municipalities that play a crucial role in spatial planning in this country. Abandoned or closed facilities can also be identified by the GIS app.*
Portugal	*The integration of the inland aquaculture sector is still in progress in the online GIS app Geo Portal da Acuicultura[(5)]. However, it is possible to observe by the GIS available aquaculture sites for aquaculture in estuaries.*
United Kingdom	*In Scotland, a spatial management strategy aimed at limiting the spread of infectious salmon anaemia (ISA) has been established in the Final Report of the Joint Government/Industry Working Group on Infectious Salmon Anaemia in January 2000[(6)].* *A GIS app is available in Scotland and integrates relevant information on the environment and the aquaculture sector. This GIS tool allows the visualisation of the Disease Management Areas (DMAs) that were based on separation distances around active farms to limit the spread of ISA. The app, which is integrated with water classification and water body status, shows that DMAs are also in transitional environments that are in good status [(7)].*

Access to space	
Developing GIS-based tools & models for spatial planning	
	The Loch Shin study from the TAPAS Project [8] carried out site selection to grow juvenile Atlantic salmon in cages. The whole freshwater system of this lake was considered by the development of an integrated loch-catchment model. A carrying capacity assessment was also performed using predictive models.
Spain	*Online GIS app Acuivisor[9] maps existing inland aquaculture facilities and it has a tool that allow the identification of new site for the development of freshwater aquaculture. It shows 56 freshwater inland facilities in Natura 2000 areas.*
Further information	

1. Applications of geographical information systems (GIS) for spatial decision support in aquaculture https://doi.org/10.1016/S0144-8609(00)00051-0
2. AquaZoom – eine integrative Methode zur Bewertung des Fischzuchtpotenzials entlang österreichischer Fließgewässer https://link.springer.com/article/10.1007/s00506-022-00894-1
3. http://www.aquaspace-h2020.eu/ Deliverable 2.1
4. https://open-data-fiskeridirektoratet-fiskeridir.hub.arcgis.com/
5. https://www.dgrm.mm.gov.pt/pt/web/guest/aquicultura
6. https://marine.gov.scot/information/disease-management-areas
7. https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=500
8. https://tapas-h2020.eu/results/ Deliverables 5.6 and 5.8
9. https://www.mapa.gob.es/es/pesca/temas/acuicultura/visor-de-instalaciones/

4.1.2 Restoration of abandoned facilities.

Access to Space
Restoration of abandoned facilities

Description:

In this practice, the access to space refers to areas that are already existing but not in use any longer such as ponds or old industrial facilities. This approach also contributes to revitalising social development by creating new jobs.

- Restoration of abandoned ponds regenerates degraded wetlands and recovers biodiversity.
- Restoration of old industrial facilities generates new suitable sites for aquaculture. This land revaluation practice can be used to rehabilitate industrial areas where companies are no longer operating or where the land is not suitable for agriculture, and to avoid conflicts between these two sectors.

MS could develop projects focused on identifying available spaces as well as carry out activities to offer and share with citizens a catalogue with information about them. Promotion of the opportunities offered by these spaces should also be foreseen in such projects.

Access to Space	
Restoration of abandoned facilities	
Main steps to prepare a strategy to support the re-opening of abandoned facilities [1].	
• Identify and assess inland abandoned facilities to determine their status and potential for restoration. This may involve conducting site visits, reviewing historical records, consulting experts and assessing the status (quality and availability) of water resources in the zone. • Address legal and administrative issues that may be hindering restoration efforts. This may involve obtaining permits, resolving property ownership disputes, or addressing environmental concerns. • Develop a restoration plan that includes specific actions to be taken, timelines, and funding sources. The plan should be based on the assessment of the abandoned facility and should consider environmental and regulatory standards. • Identify funding opportunities to support investors and the implementation of the restoration plan and give assistance on how to obtain the permit. • Monitor the restored facility to ensure that it is functioning properly and meeting environmental and regulatory standards. This may involve conducting regular inspections, collecting data on water quality and fish populations, as well as addressing any issues that may arise.	
Examples of Applications in European and non-EU Countries	
Czechia	*In the last three decades, the country invested in the creation and restoration of small water reservoirs . This initiative, which includes ponds for fish farming, is supported by subsidy programmes such as the river network revitalisation programme.* *Among the most important phases of the initiative, two of them are the most relevant: i) the identification of historic pond areas through military maps, and ii) their interpretation, which is aimed to determine the connection with watercourses revitalisation and restoration projects that are in course in the country since 1992[2].* *An example of such pond restoration was carried out at the 40 ha Vajgar fish pond in South Bohemia where 330,000 m3 of black sediment were pumped and moved to settling ponds at 2.5 In km. 40,000 m3 of eutrophic sediment was directly applied on an agriculture field, while sediment containing oil products was decontaminated by using a biocatalyst and bacterial culture[3].*
Spain	*In the Autonomous Community of Extremadura, a farm for tench production has been built in a former gravel mine. The company in charge breeds fingerlings for authorised sport fishing restocking. There is also a recreational fishing activity in two ponds within the facility. The production method used is semi-extensive and is made up of nineteen production ponds with a unit surface area of 20x10m covered with nets. In total, 1 million larvae of which 200,000 fish reach the minimum saleable size (15 cm)[4].*

Access to Space
Restoration of abandoned facilities
Further information

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2. Reservoirs, Ponds and Wetlands' Restoration at the Abandoned Pond Areas. In: Assessment and Protection of Water Resources in the Czech Republic. Springer Water. Springer, Cham. https://doi.org/10.1007/978-3-030-18363-9_5
3. The restoration of fish ponds in agricultural landscapes, Ecological Engineering, https://doi.org/10.1016/S0925-8574(02)00020-4.
4. Private aquaculture farms: http://pescayrios.juntaextremadura.es/pescayrios/web/guest/explotaciones-privadas

4.1.3 Adopting multifunctional approach & special provisions

Access to space
Adopting multifunctional approach & special provisions

Description:

There are examples in MS where space for inland aquaculture has been optimised creating synergies with other activities.

This is the case of the multifunctional approach, where synergies between different sectors are developed allowing companies to develop their economic activity while people can use the same space for other scopes. For instance, tourism services (tours, visits to the farms, fishing, or angling) or learning and educational activities have been successfully integrated within fish farms, adding value to the companies, and providing benefits to society.

MS should provide guidance to advance in the multifunctional approach. For instance, they could implement a strategy aimed at promoting activities (e.g. training, information regarding permits, etc.) targeting investors from other sectors with the aim of transferring knowledge on how to include inland aquaculture in their activities. This approach can also allow to diversify inland aquaculture.

In the case of public space (National, regional, or local authorities), special provisions to ensure the transparency of the process that led to the permit must be established to prevent conflicts. For instance, tenders and consultations should be granted. Furthermore, the quantity, timing, and quality of water necessary to support freshwater and estuarine ecosystems, as well as the human livelihoods dependent on these ecosystems, should be determined through ecological considerations (ecological flows). These considerations should be regarded as essential criteria that MS should employ to.

Long-term objectives of multifunctional use of inland aquaculture sites according to an EU-funded experience [(1)]:

- Offer to the investor a new vision for the inland aquaculture business.
- Promoting a new strategy based on diversifying farms' sources of revenue.
- Increase profitability and competitiveness of both aquaculture production and local tourism.
- Lifelong learning and job creation in aquaculture areas.

Access to space	
Adopting multifunctional approach & special provisions	
Examples of Applications in European and non-EU countries	
Multifunctional fish farming	
Austria	*Fish farm visits, gastronomic experiences like cooking fresh fish, fishing in lakes and ponds and access to shops to buy directly from the farm are offered to tourists. These services, which have been integrated in some trout, carp, and sturgeon-producing facilities, are an example of diversification that provides extra profits to companies and, at the same time, encourages local fish consumption [2].*
France	*The Aqua-tourisme website[3] allows to find a great number of national aquaculture facilities which tourists can visit, go fishing or buy fresh fish and delicatessen directly from the farm. The offer includes educational content to learn about the role of fish farms in restocking aquatic environments, aquatic plant diversity and water quality, wetland conservation and small fish reproduction. Some facilities also offer special training for children to learn the stages of a freshwater fish's life from the fertilisation that occurs in the hatchery to the rearing of fingerling in the nursery.*
Germany	*In Aischgrund, Franconia[4], the pond complex has a museum that provides information about carp and pond farming. Moreover, tours through the Aischgrund are offered to learn about carp breeding as well as catfish, pike and zander breeding. In the country inn with guest rooms, particular carp dishes from the ponds are offered to the visitors.*
Hungary	*In Rétimajor[5] there is an example of pond farm diversification. Besides carp production, which is the company's main source of income, farm activities include tourism services. The favourable natural conditions and the management's innovative planning have led to a centre where protection and exploitation sustainably coexist. Traditional crafts (extensive culture) are combined with modern technologies (hatchery and breeding) and research activities that favour environment-friendly solutions. The farm cooperates with Hungarian universities and is also involved in the training and education of fishing experts.*
Poland	*An example of business transformation was accomplished in 2012[6]. A carp fish farm was turned into a thriving tourism and recreation centre offering angling, recreation, conference, hotel and restaurant services, creating five new jobs and helping to maintain another. It also increased the profitability and competitiveness of the fish farm and contributes to the economic development of the area.*

Access to space	
Adopting multifunctional approach & special provisions	
	In the Baryc River Valley, the Ramsar site Milicz Fishponds Nature Reserve is one of the biggest pond complexes in Europe with opportunities also for bird watching(7,8). *Przemków Fish Ponds(9), that is also a Ramsar site, plays a valuable role in flood control and soil formation, as well as provides recreational, educational and scientific opportunities, together with other environmental services and biodiversity conservation.*
Special provisions to ensure consistency with environmental planning and water management	
Spain	*Public Hydraulic Domain Regulations(10) establish tenders through which several stakeholders (companies or entrepreneurs) can opt for a permit. Consultations with the managers on potentially affected public spaces and citizens are developed to avoid potential conflicts. At the same time, the establishment of an ecological flow regime(11) according to a proper WFD implementation secures water quantity and dynamics, supports aquatic ecosystems and the achievement of environmental objectives.*

Further information

1. https://webgate.ec.europa.eu/fpfis/cms/farnet2/on-the-ground/good-practice/projects/fish-farm-transforms-tourism-and-recreation-centre_en.html
2. https://www.austria.info/en/food-and-drink/culinary-tips/the-fish-experience#3-cooking-trout-with-farmer-anna-peraus
3. https://www.aqua-tourisme.fr/
4. https://bavaria.travel/listicles/franconia-aischgrund-carp/
5. https://www.ecsb.org/wp-content/uploads/casestudies/49/Aranyponty%20(Golden%20Carp)%20Fish%20Pond_english_4da7034f290100.pdf; http://www.aranyponty.com/
6. https://webgate.ec.europa.eu/fpfis/cms/farnet2/on-the-ground/good-practice/projects/fish-farm-transforms-tourism-and-recreation-centre_en.html
7. https://dolnyslask.travel/stawy-milickie-2/?lang=en
8. https://rsis.ramsar.org/ris/758
9. https://rsis.ramsar.org/ris/2320
10. Real Decreto 849/1986, de 11 de abril, por el que se aprueba el Reglamento del Dominio Público Hidráulico, que desarrolla los títulos preliminar I, IV, V, VI y VII de la Ley 29/1985, de 2 de agosto, de Aguas. https://www.boe.es/eli/es/rd/1986/04/11/849/con
11. Ecological flows in the implementation of the Water Framework Directive. Guidance Document No. 31. 2015. https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20%28final%20version%29.pdf

4.1.4 Reinforce positive interaction within protected areas.

Access to space
Reinforce positive interactions within protected areas

Description

The "Guidance document on aquaculture activities in the context of the Natura 2000 Network" [2], promotes sustainable aquaculture practices that are compatible with the conservation objectives of Natura 2000 sites. It recognises aquaculture as an

Access to space	
Reinforce positive interactions within protected areas	
important economic activity if it is carried out in a sustainable manner. The latter provides guidance to minimise aquaculture activities' impacts as well as recommendations to avoid or mitigate them. The steps presented below can be useful for MS to know how inland aquaculture can be regulated in protected areas, natural parks, and natural reserves. This approach will allow MS to take advantage of these spaces to produce food while protecting the environment.	
Main elements that MS should consider regarding establish inland aquaculture projects in protected areas.	
• Consider that belonging to a protected area is not a reason to prohibit aquaculture activities in a certain region. • Offer a catalogue or an online tool (e.g. web sites with public access to GIS), to show suitable sites where inland aquaculture can be performed in protected areas. • Provide guidance about the prohibitions in these sites as well as information regarding how the inland aquaculture can be compatible with these restrictions. • Conduct environmental assessments according to the space and the technology that will be used in the aquaculture project.	
Examples of Applications in European and non-EU countries	
Czechia	*The Nesyt Fishpond[4] which is part of the Natura 2000 site "Lednice fishponds" and hosts fish farming activities, has integrated summer drainage as a management measure to create suitable environmental conditions for halophilous plants of exposed pond substrates and for some threatened wetland birds.*
France	*The Natural Park of La Brenne[5,6] is made up of nearly 4.000 ponds created by man since the High Middle Ages. Nowadays, they play a key role in the preservation of flora and fauna, especially for waterfowl nesting and migratory birds. In the Park, aqua-environmental measures to the fishponds are applied with the objective to develop aquaculture production methods that contribute to the improvement of the environment and preservation of nature. Some of these measures aim to recreate or maintain favourable conditions for insects, amphibians, birds, and fish to maintain vegetation belts, avoid fertilisation, and manage alien species like coypu, muskrats, and crayfish (shooting, trapping, use of filters). The species reared are carp, roach and pike. However, more recent species such as blackbass and pikeperch are also farmed in the ponds.*
Italy	*Some of the best-preserved freshwater wetlands of the Region Friuli Venezia Giulia[2] have survived the simplification of the hydrographic network and drainage that have affected the Friuli plain during the last century thanks to the fish farm activity. In some aquaculture ponds in the Veneto Plain, the largest wintering colony of the Cormorant and one of the last colonies of yellow belly*

Access to space	
Reinforce positive interactions within protected areas	
	toad in the plain are found nearby the existing aquaculture areas. Friuli Venezia Giulia's aquaculture in wetlands can be both freshwater (carps, tench, northern pike) and brackish (mullets, seabass, Seabream, and eels)[7].
Slovakia	*A common practice in some farms[2] is to prevent the removal of aquatic vegetation, which has led to patches of Typha and Phragmites in a considerable part of the fishpond system. These ponds serve as breeding sites for heron-like birds (Purple Heron, Spoonbill, Night Heron), the Marsh Harrier, the Bittern, Little Bittern, Red-necked Grebe, Black-necked Grebe (now rare) and the Ferruginous Duck.*
Spain	*Veta la Palma[8] is located within the Doñana Natural Park and is also part of the Natura 2000 network. It has extensive aquaculture operations in 2,500ha flooded under brackish water. The farm has 45 reservoirs, covering 70 hectares each, interconnected with the Guadalquivir and Guadiamar rivers through an extensive network of irrigation and drainage channels for over 300km. Mullets and the indigenous shrimp Palaemon variants are the species cultivated. The marshes and careful water management support a diverse bird population.*

Further information

1. http://www.aquaspace-h2020.eu/ Deliverable 2.1
2. Guidance on Aquaculture and Natura 2000 https://oceans-and-fisheries.ec.europa.eu/system/files/2016-09/guidance-aquaculture-natura2000.pdf
3. Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02011L0092-20140515
   a. ANNEX III "Selection criteria referred to in article 4(3) (Criteria to determine whether the projects listed in annex II should be subject to an environmental impact assessment)"
4. The summer drainage of Nesyt Fishpond in 2007: a successful conservation measure or ecological catastrophe? pp 10-11, In: European Pond Conservation Network, Newsletter No. 3, Spring 2010 http://campus.hesge.ch/epcn/pdf_files/newsletters/EPCN_Newsletter_3.pd
5. «Cahiers d'habitats » Natura 2000. Connaissance et gestion des habitats et des espèces d'intérêt communautaire. Tome 3 - Habitats humides. MATE/MAP/ MNHN. https://inpn.mnhn.fr/docs/cahab/tome3.pdf
6. Fauna (parc-naturel-brenne.fr)
7. acquacoltura.pdf (izsvenezie.it)
8. https://www.vetalapalma.es/acuicultura-sostenible/

4.2 Access to water

4.2.1 Developing measures and tools to inform on water quality and availability

Access to water	
Developing measures and tools to inform on water quality and availability	
Description: Climate change is compromising the **availability of good quality water,** which is a decisive factor for the establishment of new inland aquaculture facilities. In this regard, the implementation at the national level of **public websites with up-to-date information on water quality and quantity** could be a very powerful tool that the authority can offer to companies, entrepreneurs and the citizen in general. The value of these tools for the access to water for inland aquaculture relies in the fact that reliable data can support decision-making in the opening of new facilities as well as in the management of running aquaculture facilities. At the same time, Internet could be also used for the dissemination of **water treatment solutions.** On these websites, farmers could access information on how to **recycle water**, and fish producers could learn about how to take advantage of alternative sources of water.	
Main steps that led to a dynamic and flexible management of surface water at National Level(1)	
• Develop a network of sensors that can measure water indicators in real time (e.g. acidity, salinity and temperature). • Carefully chose locations to locate sensors. MS should consider not only streams, canals, rivers etc. but also the subsoil near sewerage and water treatment plants. • Use self-learning algorithms to analyse the data from the sensors and combine it with other sources of information (e.g., measurement from other networks aimed at environmental control). • Use the outputs to produce hydrological models that can support inland aquaculture, as well as all kind of water-related decisions**.**	
Examples of Applications in European and non-EU Countries	
Belgium	*The Internet of Water(1) is a public website from Flanders that provides real-time water monitoring by an extensive network of sensors. It can assist fish farming stakeholders in searching for available sources of water and information regarding conditions for discharges.* *The Inagro Water Knowledge Centre(2) offers the public a website which provides information to farmers that choose alternative water (e.g. rainwater, surface water and recovery water for their facilities in Flanders). The website indicates proper water treatments to make these alternative sources of water suitable for farming.* *Alternative sources of water, such as the waste streams from industries, were studied for aquaculture in the HaLAVla project(3). As a result, ten new feasible sites were identified for land-based aquaculture in Flanders focusing on waste stream*

Access to water	
Developing measures and tools to inform on water quality and availability	
	quality and logistical possibilities; and legal framework issues were addressed.
Hungary	*In the ClimeFish project, a Decision Support Software was developed for the Hungarian Ponds regarding Carp farming(4). It is available online on the project's website and could be used by carp farmers who will face water quality deterioration, a decrease in water availability, and, consequently, a price increase.*
Spain	*NABIA is the information system on the status and quality of inland waters that must be completed annually as set out in Royal Decree 817/2015, of 11 September which establishes the criteria for the monitoring and assessment of surface waters and environmental quality standards according to the Water Frame Directive. NABIA is mainly used to monitor the obligation to obtain good status of water bodies.* *The NABIA application has been designed to obtain, load, and integrate data on the quality and status of surface water mainly, but also groundwater, from the different water administrations, including the regional administrations, into a single database.* *The Directorate General for Water of the Ministry of Ecological Transition of Spain has carried out a series of works aimed at establishing quality assurance and guaranteeing mechanisms throughout the data generation process. These activities ensure a certain degree of coordination as the network is based on a homogeneous criterion. Likewise, this application must perform the necessary calculations to assess the status of water bodies, in accordance with the WFD, together with the generation of the corresponding reports(5).* *The Spanish Water Observatory project consists of the creation of a web portal that collects, analyses, and disseminates hydrological information and information on the main uses and users of water in the country. Its main objective is to improve water management, promote transparency and citizen participation, and adapt to climate change. The web portal will contain different sections for the characterisation and visualisation of hydrological data and water uses, both static and in real-time, resulting in a powerful tool for decision-making to ease access to water for inland companies and entrepreneurs(6).* *Both NABIA and the Spanish Water Observatory can provide data-driven support for decision-making for the inland aquaculture sector in terms of water quality and availability.*
Further information	

1. https://www.internetofwater.be/
2. https://www.watertool.be/interface/index.aspx
3. https://lv.vlaanderen.be/sites/default/files/attachments/haalbaarheidsstudie_landbased_aquacultuur_vlaanderen.pdf
4. https://climefish.eu/2019/04/10/hungarian-ponds/

Access to water
Developing measures and tools to inform on water quality and availability
5. https://acrobat.adobe.com/link/track?uri=urn:aaid:scds:US:f8c1ac1e-ecb3-4d18-8731-c6b3173de8ec 6. https://contrataciondelestado.es/wps/poc?uri=deeplink%3Adetalle_licitacion&idEvl=QaPFIbi%2Fr%2F8uf4aBO%2BvQlQ%3D%3D

4.3 Other issues relevant to space & water conservation

4.3.1 Providing access to space to types of aquaculture that have lower or positive impact in nature

Other issues relevant to space & water conservation	
Providing access to space to types of aquaculture that have lower or positive impact in nature	
Description The overwhelming majority of inland freshwater aquaculture facilities performed in ponds applies extensive (<500 kg/ha) or semi-intensive (<2000 kg/ha) technologies[1] and takes place in harmony with nature. The manmade wetland for pond farming are among the most ecologically valuable and species-rich cultural landscapes due to their sustainable and nature-friendly management. Development over long periods of time has led to very stable ecosystems without the need for any major alterations that contribute to the improvement of water management and maintenance of biodiversity. Ponds play an irreplaceable role in water retention, groundwater regulation, and flood control as well as other ecosystem services that ensure the good status of water bodies and the conservation of wetlands. Their management prevents the deterioration of this valuable area.	
What can authorities do to valorise these valuable spaces?	
Environmental protection can be combined with inland aquaculture by providing access to space for types of aquaculture that have a minor or positive impact on nature. This can also be a tool in the restoration of nature, that also provides food supply, as described above (Good Practice 4.1.2). It is for this reason that MS should consider the promotion of the implementation of data-driven practices in the inland sector to share the knowledge about the benefits that the facilities bring to nature. Data analysis can offer also valuable insights into the farm's performance, allowing authorities to provide targeted support to those farms exhibiting best practices and results. The development of public certification, technical standards, and codes of conduct that farms can adopt to demonstrate their adherence to best practices, should be also promoted.	
Examples of Applications in EU Member States	
Austria	*To safeguard and support its agri-cultural heritage, carp pond farming in the Waldviertel Region has been recently proposed as a Globally Important Agricultural Heritage System (GIAHS). This FAO recognition would foster an integrated approach to sustainable aquaculture and rural development, and promote public understanding of the*

Other issues relevant to space & water conservation	
Providing access to space to types of aquaculture that have lower or positive impact in nature	
	services that these systems provide to the environment and to local communities[2]*.* *There is also a special funding scheme in place for the promotion of extensive and organic management of ponds. The new scheme compensates farmers for this particularly environmentally friendly and resource-saving management of carp ponds. For organically managed ponds, extra compensation is granted*[3]*.*
Germany	*Fish from regions such as Northern Bavaria were assigned the EU label "Protected Geographical Indication" (PGI) and, since 2021, the Bavarian carp pond farming (Bayerische Karpfenteichwirtschaft) has the "Intangible Cultural Heritage" seal of UNESCO* [3, 4]*.*
Hungary	*Measures assist in the improvement of water management within the pond fish farm. Limits exist in the fee for the use of water resources (there are no fees below 25.000 m*^{3}*ha) and in the water supply (1500 HUF/ha). However, no fees are paid for water supply during draught periods.*

Further information

1. http://www.aquaspace-h2020.eu/ Deliverable 2.1
2. https://www.fao.org/giahs/giahsaroundtheworld/designated-sites/europe-and-central-asia/en/
3. https://info.bml.gv.at/themen/landwirtschaft/landwirtschaft-in-oesterreich/tierische-produktion/fischzucht-oe/sonderrichtlinieteichwirtschaft.html
4. https://www.unesco.de/en/node/2392 https://karpfenteichwirtschaft-bayern.de/

4.3.2 Strengthening space & water saving innovative technologies

Other issues relevant to space & water conservation
Strengthening space & water saving innovative technologies

Description:

Effluents from **RAS** can be directed to hydroponics systems allowing **Aquaponic.** These kinds of systems allow the production of both fish and edible plants in the same facility, occupying the same space and water[1]. This technology allows to perform Horticulture, taking advantage of the fertilization provided by the fish farming. It can also contribute to reducing the conflicts between aquaculture and agriculture in their competition for water and soil.

Freshwater IMTA systems are becoming popular on lands and allow food production in spaces that are not suitable for agricultural scope.

Both technologies can provide two different kinds of products using the same space and water. That is especially relevant for landlocked countries that can produce fish or shellfish along with vegetable, avoiding conflicts with agriculture and being more self-sufficient in the production of food.

Other issues relevant to space & water conservation

Strengthening space & water saving innovative technologies

What are the authorities doing to support these innovative techniques?

In some countries, authorities support certain types of aquaculture. Austria, for example, is strengthening innovative technologies and practices, such as Combined Intensive-Extensive (CIE) systems (see Annex II), RAS, and the production of new species (e.g. pike-perch and African catfish).

Germany has designated areas that may be well-suited for RAS, including commercial areas mainly. Transport links (especially for feed delivery) were often considered. Some municipalities offer special support conditions (e.g. tax relief is granted for the settlement of generally all types of businesses); and fewer requirements are expected for settlement projects that will produce less than 1000 metric tonnes per year

Examples of Applications in European and non-EU countries

Ireland	*Recirculating Aquaculture Multi-trophic Pond systems (RAMPS) combine RAS, IMTA and pond farming techniques. It has been employed to combine fish and macroalgae production(2) on marginalised agricultural land and cutaway peatlands. The resulting paludiculture included a trout and perk rearing pond and algae and duckweed canals for effluent remediation. The system achieved marketable size for both fish species and no discharges for nine months.*
Spain	*An international study produced under the frame of HortiMED H2020 PRIMA Project (Grant Number 1915) was presented at the first International Electronic Conference of Horticulture. The study presented the combination of IMTA with hydroponic horticultural production. Nutrients from cultured tilapia, mullets, crayfish, clams, and silver carp were successfully used to produce green leaf lettuce, chili and bell peppers, cucumber, eggplant, mallow, watercress and celery(3). A total system biomass (crop and aquatic species) of 1017.30 kg was produced.*

Further information

1. Effects of climate and environmental variance on the performance of a novel peatland-based integrated multi-trophic aquaculture (IMTA) system: Implications and opportunities for advancing research and disruptive innovation post COVID-19 era https://doi.org/10.1016/j.scitotenv.2022.153073
2. Integrated Multitrophic Aquaponics—A Promising Strategy for Cycling Plant Nutrients and Minimizing Water Consumption https://doi.org/10.3390/IECHo2022-12493

5 QUESTIONS FOR NATIONAL EXPERTS

- Are you aware of any **measure (e.g. administrative procedure)** to ease the allocation of space and access to water for inland aquaculture (e.g. ponds, flow-through, freshwater cages, CIE) and/or land-based freshwater aquaculture (RAS, Aquaponics, IMTA)?
- The information regarding the inland aquaculture industry in **RBMPs** is a very desirable element that other RBMPs should include Thus, in order to gather Good Practices examples to prepare a dedicated factsheet on RBMPs, please answer the following question: Are you aware of any RBMP that considers providing space and water to inland aquaculture as a tool in the implementation of the WFD in your country instead of just a pressure?
- Are you aware of any European **GIS** app that shows available sites for inland and/or land-based freshwater aquaculture? Does your country have information on a GIP app about new aquaculture site in **estuaries**? If so, can you explain what technology or technique your country foresees for these spaces?
- Are you aware of any **nature restoration activity** that directly involves inland aquaculture as an approach to achieving good environmental status?
- Are you aware of any **programme for the development of the multifunctional approach** that directly involves inland aquaculture?
- Do you have any examples of synergies **between inland aquaculture and agriculture**?
- Do you have any **special assessment** to allow inland and/or land-based aquaculture in protected areas (including but not only Natura 2000 sites)?
- Are you aware of any Good Practices for aquaculture practised in **lakes**, **water reservoirs** or **dams**?
- Are you aware of any **code, standard, certification, recognition** (a part of Organic Aquaculture) that can be adopted by inland farmers that would help to highlight the sustainability of their activity?
- Annex II of this background paper provides Good Practices examples on access to space and water for the inland aquaculture industry. Do you consider that the information provided in this Annex is relevant and should therefore remain in the final version of the document or should it be deleted?
- Do you know any projects for additional information on the main issues on access to space and water, site selection or to provide access to water in response to temperature rise and extreme events occurrence?

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7 ANNEXES

ANNEX I: About the Aquaculture Assistance Mechanism (AAM)

The EU Aquaculture Assistance Mechanism (AAM) is a service contract to support the Commission, Member States, the aquaculture industry and other stakeholders in the implementation of the "Strategic Guidelines for a more sustainable and competitive aquaculture for the period 2021-2030", through the provision of logistic, administrative, and technical assistance, as well as one-stop-shop for knowledge and good practices about sustainable aquaculture in the EU.

The AAM is jointly managed by the Directorate-General for Maritime Affairs and Fisheries of the European Commission (DG MARE) and the European Climate, Infrastructure and Environment Executive Agency (CINEA).

The consortium is coordinated by NTT DATA in partnership with Aristotle University of Thessaloniki, SCOPE - Intrasoft, the European Aquaculture Society (EAS) and the European Aquaculture Technology and Innovation Platform (EATIP). The Service Contract started in June 2022 and will run until May 2024.

The website https://aquaculture.ec.europa.eu/ is the portal of the AAM with an extensive knowledge base containing:

- EU legislation and relevant international instruments
- Guidelines
- Good practices and experiences
- Projects
- Reports
- Scientific papers and publications
- Learning material
- Materials developed by the AAM
- Member States area

It also has a funding section, which provides an overview of EU open calls for proposals and tenders in the field of aquaculture, as well as an area dedicated to aquaculture-related EU events. Finally, the AAM website also has a country information section.

ANNEX II: Good Practices examples on access to space and water for the inland aquaculture industry.

Access to water	
Develop measures and tools to ensure water quality and availability	
Examples of Applications in European and non-EU Countries	
Germany	*Measures that adapt fish farms to the challenges of climate change (especially temperature increase and water scarcity) have been identified as the conversion of flow-through to partial recirculation systems and the roofing of systems. In Baden-Württemberg, the Ministry of Food, Rural Areas and Consumer Protection is preparing a funding programme for such measures (1).*
Hungary	*According to ClimeFish, in the Hungarian Ponds(2), farmers can be assisted with measures to maintain water in good conditions by the DSS(2). These measures will include controlling environmental parameters, optimizing stocking and manuring strategies (extensive ponds), upgrading production infrastructure to withstand storms and floods, and using aeration techniques (intensive ponds).*
Italy	*From the point of view of access to water, water scarcity due to climate change may lead to increased aeration. Therefore, a shift towards partial recirculation systems and RAS should be performed in raceways that works as flowthrough (3). In fact, many rainbow trout farms in the Friuli Venezia Giulia region barely survived the dry summer of 2015 according to the Aquascape project.*
Further information	
1. https://acrobat.adobe.com/link/track?uri=urn:aaid:scds:US:f8c1ac1e-ecb3-4d18-8731-c6b3173de8ec 2. https://climefish.eu/2019/04/10/hungarian-ponds/ 3. http://www.aquaspace-h2020.eu/ Deliverable 2.1	

Other issues relevant to space & water conservation	
Strengthening space & water saving technology	
In the Combined Intensive-Extensive (**CIE**) systems fish are produced intensively in a separate unit next to the extensively cultivated main pond for polyculture. From the smaller unit, which can be a floating cage, a land-based outdoor system, or even another pond that is in the proximity of the main unit, effluents are released into the extensive pond. The latter provides fish and, at the same time, ecosystem services and space to develop other activities (see factsheet for GP7). CIE is also known as a tool for the sustainable intensification of pond farming and can provide by 0,5 ha the same amount of fish that can be extensively cultivated in a 2 ha pond(1).	
Examples of Applications in European and non-EU countries	
Hungary	*The "cage in pond system" is the simplest implementation of an intensive and extensive farming combination. Floating cages are put in a pod where the depth is suitable for the installation. An experiment was performed in a multifunctional fish farm, using 50m^3 of cages for each pond hectare. While European catfish was farmed in the cages, the pond was reared extensively using polyculture. At the end of the experiment, each cage unit provided*

Other issues relevant to space & water conservation	
Strengthening space & water saving technology	
	500kg or catfish; while ponds provided 500 kg of common carp and 200 kg of paddlefish [1]. *A financially viable "tank in pond system" was performed by a floating flow-through tank as the intensive unit. The tank was situated in an extensive fishpond. The CIE system was operated to produce hybrid striped bass fed on high-quality floating feed in the intensive unit and polyculture in the extensive pond. The total yield in the intensive system (3 tanks with 120m^3 volume each) was 4,800 kg feed, while the gross yield in the extensive pond (20 ha) supplemented with grain feed was 1,050 kg/ha[1].*
Romania	*A "cage in pond system" experiment in a 3,8 ha extensive pond was performed at the Fish Culture Research and Development Station in Nucet, where polyculture farming was reared of natural feed. Intensive carp farming in these ponds was performed employing eight cages (6x6x2 m each) where the fish were fed with formulated feed. After 175 days of production cages, the net yield was 3.267 kg, while the extensive pond had a production of 320 kg/ha [1].*
Slovenia	*An innovative "Tank by pond" system has been developed and successfully operated at a commercial scale. Large concrete circular tanks (about 6000 m^3) receive the water supply from a conventional fishpond. At the same time, effluent waters are realised back into the pond. In the tank, where continuous water circulation is maintained by airlift pumps, carp are fed using high-quality feed. More than 10 kg of carp can be produced in 1m^3 with this system. "Tank by pond" can also be operated with tilapia. Moreover, water saving can be increased by installing biological filters in the system as well as by implementing automation and digitalization[1].*
Further information	
1. Aquaculture Europe Vol 48(1) March 2023	