DANUBIUS-PP

Preparatory Phase for the pan-European Research Infrastructure DANUBIUS–RI "The International Centre for advanced studies on river-sea systems"

DANUBIUS-RI Ontology reference document

Deliverable Nr. 9.2

Ontology for advanced studies on river-sea systems delivered through a distributed research infrastructure

European Commission

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Authors & Institutes Acronyms	THE NETHERLANDS ***Deltares*** Jos Brils, Henriette Otter IRELAND ***University College Cork*** Jeremy Gault GERMANY ***BfG*** Lars Duester, Marie Massmig, Ole Roessler ESTONIA ***Europportunities*** Franck Brottier UNITED KINGDOM ***Plymouth Marine Laboratory*** Mike Grant ***University of Birmingham*** Christopher Bradley (SPAIN		

	Universitat Politècnica de Catalunya Vicente Gracia	
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Executive summary / abstract

The International Centre for Advanced Studies on River-Sea Systems (DANUBIUS-RI) will be a distributed research infrastructure (RI) that serves as a one-stop shop that provides access to a range of experts, infrastructure, services and river-sea (RS) systems across Europe. It will provide a platform for interdisciplinary research, access to centres of excellence and harmonized data and, thus, enable knowledge transfer through direct between discourse between disciplines, scientists and policy-makers and through development and support for education and training programmes. It will, therefore, make a significant scientific contribution to our current understanding of the complexities of the entire extent of RS continuum and our capacity to manage and develop these resources in an environmentally sensitive and sustainable manner.

The capability and capacity for mutual understanding is critical in bridging the inter-disciplinary gap between scientists, the gap at the science-policy interface as well as the disconnect between the scientific community and water-course and environmental managers, industry and the general public. Ontologies provide a mechanism to bridge these gaps by defining a common vocabulary for those who, for example, need to converse on a common issue or share information in a domain.

This document represents the initial attempt at a DANUBIUS-RI ontology and should be seen as a living document that will be updated over the life-span of DANUBIUS-RI as it matures by interaction with stakeholders during the operational phase.

In the first instance the aim of a DANUBIUS-RI ontology is to define the shared domain of discourse, and then at different levels of hierarchy:

- Select the primary objects of relevance for this domain of discourse;
- Conceptualize the inter-relational links between these objects (conceptual model); and
- Define these objects in a representational vocabulary (common language).

The DANUBIUS-RI domain of discourse covers advanced studies on river-sea systems delivered through a distributed research infrastructure.

At the 1st level of hierarchy the following objects have been selected, interrelated in a conceptual model and defined in a common language: **river-sea (RS) systems** and the RS systems components **river basins** and **coastal seas**.

At the 2nd level the following objects have been selected, interrelated in a conceptual model and defined in a common language: **Supersites, Data Centre, Nodes, Technology Transfer Office (TTO), E-Learning Office, Hub** and **Science & Innovation Agenda (SIA).**

The objects of relevance at the 3rd level of hierarchy relate to the '**data-information-knowledge-impact' (DIKI) workflow** in DANUBIUS-RI. This 3rd level provides the highest level of detail regarding the DANUBIUS-RI ontology. At this level all relevant terms used and defined in the DANUBIUS-PP deliverables are related to this workflow and selected as objects.

Finally, there is a section added that does not so much relate to research and innovation facilitating activities as such but addresses the DANUBIUS-RI **governance** related ontology.

1. Introduction

1.1. About DANUBIUS-RI

Freshwater and marine systems are central to societal wellbeing, yet they face multiple and compounding pressures from climate change, eutrophication and other natural and anthropogenic influences at varying intensities at local and global scales.

The International Centre for Advanced Studies on River-Sea Systems (DANUBIUS-RI) will be a distributed research infrastructure (RI) that serves as a one-stop shop that provides access to a range of experts, infrastructure, services and river-sea (RS) systems across Europe. It will provide a platform for interdisciplinary research, access to expert support and harmonized data and enable knowledge transfer through early and direct discourse between disciplines, scientists and policy-makers as well as water managers and through development and support for education and training programmes. It will, therefore, make a significant scientific contribution to our current understanding of the complexities of the continuum of RS systems and our capacity to manage and develop these resources in a sustainable manner.

There is a widely recognized need to consider the RS system as a single continuum, spanning traditional disciplinary silos (including JPI Water and JPI Oceans) and overcoming the gaps between the existing European environmental policies such as the Water Framework Directive (EC 2000); Floods Directive (EC 2007); Marine Strategy Framework Directive (EC 2008a) and NATURA 2000 (EC 2008b). DANUBIUS-RI will have the capability to provide the evidence base required for a more comprehensive framework for future European environmental policy making.

A fundamentally new approach to research is needed to advance the goal of better-informed and holistically engaged environmental management of RS systems, particularly at the freshwater-marine interface. This requires world-leading science, comprising research that has immediate societal relevance and impact in facilitating interdisciplinary research in the freshwater and marine sciences. The research must span traditional disciplinary and geographic boundaries and be implemented in a consistent and quality assured framework. Recognizing these needs, the concept of DANUBIUS-RI was developed, and was subsequently evaluated positively for inclusion on the 2016 Roadmap of the European Strategy Forum on Research Infrastructures (ESFRI, 2016).

1.2. DANUBIUS-RI Preparatory Phase (DANUBIUS-PP)

The DANUBIUS-RI Preparatory Phase (DANUBIUS-PP) project will develop the structures and processes to ensure that DANUBIUS-RI can deliver an integrated understanding of the functioning of RS systems and address the key societal challenges associated with, and opportunities of, RS systems. DANUBIUS-PP will bring together the world leading sciences and research programs, already existing within Europe, to deliver the necessary knowledge, understanding and innovation to address these challenges, including:

(i) Earth observation and the development of in-situ technologies through EC Programs (including FPs and H2020) and ESA funding, building on EU Copernicus Program;
(ii) Near real-time processing and management of Big Data;

(iii) Advanced geo- and biochemical analytical platforms, the latter describing genotypic and phenotypic diversity in increasing detail;
(iv) Modeling and simulation capabilities to perform hind-casts, forecasts and 'what-if' predictions critical for informing management; and
(v) Social and economic tools necessary to transform the data and knowledge into the evidence required to inform governance and decision making and hence solve the problems and challenges of complex river-sea systems.

Whilst also generating business, research and innovation opportunities, DANUBIUS-PP will provide the framework to deliver the necessary step change in the knowledge triangle (Research-Education-Innovation). Ultimately DANUBIUS-RI seeks to provide solutions to the greatest research and policy challenges confronting society in ensuring environmental sustainability in the context of growing human-induced stresses. In doing so, it will also links with other major European and global RIs and lead in setting national and European research priorities and standards.

1.3. Objective DANUBIUS-PP

The overall objective of DANUBIUS-PP is to support the further development of DANUBIUS-RI, i.e. to bring it to sufficient maturity that it is ready for implementation as a pan-European distributed RI.

1.4. This deliverable

This deliverable – D9.2 DANUBIUS-PP Ontology reference document – forms part of the output from DANUBIUS-PP WP9 "Capacity Building". It aims to achieve the WP9 objective to "*Develop a common language to facilitate communication between all partners involved in the RI*".

D9.2 DANUBIUS-PP Ontology reference document relates to WP9 task 9.1 "Build the ontology reference document".

This document represents the initial attempt at a DANUBIUS-RI ontology and should be seen as a living document that will be updated over the life-span of DANUBIUS-RI as it matures by interaction with stakeholders during the operational phase.

2. Ontology theory

2.1. Ontology

A specification of a representational vocabulary for a shared domain of discourse — definitions of classes, relations, functions, and other objects — is called ontology (Gruber 1993).

The term is borrowed from philosophy, where ontology is defined as a systematic account of existence. For knowledge-based systems, what "exists", is exactly that which can be represented (Gruber 1993).

Ontology is an explicit specification of a conceptualization, which can be defined as an abstract, simplified view of the world that we wish to represent for some purpose. Or in other words: a conceptualization is the objects, concepts, and other entities that are presumed to exist in some area of interest and the relationships that hold them (Genesereth & Nilsson, 1987). When the knowledge of a particular domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse. This set of objects, and the describable relationships among them, are reflected in the representational vocabulary with which a knowledge-based program represents knowledge. Thus, the ontology of a program can be described by defining a set of representational terms. In such an ontology, definitions associate the names of entities in the universe of discourse (e.g., classes, relations, functions, or other objects) with human-readable text describing what the names are meant to denote, and formal axioms that constrain the interpretation and well-formed use of these terms (Gruber 1993).

Ontologies are commonly used in Information Technology (IT) and according to Gruber (1993) they support the sharing and reuse of formally represented knowledge among Artificial Intelligence (AI) systems. Ontologies have become common on the World-Wide-Web. In an IT setting this also includes machine-interpretable definitions of basic concepts in the domain and relations among them (Noy & MgGuinness 2017).

The reasons for developing an ontology include (Noy & MgGuinness 2017):

- To share common understanding of (the structure of) information among people;
- To enable reuse of domain knowledge;
- To make domain assumptions explicit;
- To analyse domain knowledge.

Ontology defines a common vocabulary for those who need to share information in a domain (Gruber 1993).

Different types of ontology can be distinguished, each of which might be used for different purposes. An overview on ontology types is presented by Kaewboonma *et al*. (2012). Within the context of DANUBIUS-RI the most appropriate ontology type is probably the 'domain ontology'.

A domain ontology provides vocabularies about concepts within a domain and their relationships, about the activities taking place in that domain, and about the theories and elementary principles governing the domain (Kaewboonma *et al.* 2012).

This type is probably most appropriate for DANUBIUS-RI as domain ontologies can explain generic concepts and relations within the water resource management domain (Kaewboonma *et al*. 2012).

The ontology should be designed and developed in relation to the application and context. For example, a domain ontology is used to collect all knowledge about water resource management, as well as represent all terms in noun form (such as basic knowledge of the river basin, sub-river basin, and land use) in order to facilitate future reuse of the ontology (Kaewboonma *et al*. 2012).

2.2. How to create an own ontology for DANUBIUS-RI?

From the previous section four key-activities were extracted to achieve the domain ontology appropriate for DANUBIUS-RI:

1. Define the shared domain of discourse;

And then at different levels of hierarchy:

2. Select the objects of relevance for this domain of discourse;
3. Conceptualize how these objects interrelate (conceptual model);
4. Define these objects in a representational vocabulary (common language).

Activities 3 (conceptual model) and 4 (common language) are further described below.

The most straightforward definition of a model is that it constitutes a simplification of reality, created in order to assist in clarifying and understanding of some aspect of the real world (Rocher and Schnell *sine anno*). The key to successful application of such a model is achieving an appropriate balance between simplifying a complex reality, making it both easier to understand and applicable to a wider range of circumstances, whilst preserving the most important relationships to yield results that are a realisable, representative indication of the functioning of the original system (Merrit *et al*. 2003, Chapman *et al*. 2008).

A conceptual model is a theoretical construct of the interrelationships between a range of known and quantifiable variables acting within a specified area of influence (Merrit *et al*. 2003). Almost all models of any description begin life as a conceptual model: some are developed and subsequently expanded into a quantitative model, while others remain as a concept to aid understanding and develop or test ideas. A conceptual model – and potentially a subsequent quantitative or semi-quantitative model – is an ideal format to assist in improving understanding of the inter-relationships between the biophysisical and societal system (Manley *et al*. 2000).

With interdisciplinary and multi-stakeholder processes, language and use of language is very important. The capability to understand each other is critical in bridging the gap between science disciplines as well as the gap between scientists and policy makers, water managers and entrepreneurs (Slob *et al*. 2007; Slob *et al*. 2014). Communication difficulties originate to a large extent from the 'jargon' used in the different communities (Quevauviller *et al.* 2005). A common language facilitates 'learning together' (Fig. 1). Learning together helps to build trust, develop a common view on the issues at stake, resolve conflicts and arrive at joint solutions that are technically sound and actually implemented in practice (Ridder *et al*. 2005).

Fig. 1 *– 'Jargon' used by different communities (figure left) complicates communication, while a common language (right) facilitates 'learning together' (Source figures: Brils et al. 2014).*

2.3. The need for a dedicated ontology for DANUBIUS-RI?

DANUBIUS-RI is dedicated to facilitating and delivering interdisciplinary research and sharing of information and knowledge exchange (and learning together) with a range of stakeholders (see section 1.1). Hence, for DANUBIUS-RI to succeed it is crucial that the various scientific disciplines represented work together and in collaboration with these stakeholders in order to develop their own ontology. The engagement with stakeholders will mainly take place during the operational phase of DANUBIUS-RI, that is estimated to start 2022. Thus, after a few years of engagement it can be expected that the need arises to update the ontology for DANUBIUS-RI, an ontology which is then based on the common understanding achieved between scientists and stakeholders.

3. The DANUBIUS-RI ontology

3.1. Shared domain of discourse

The domain of discourse shared in DANUBIUS-RI is (http://www.danubius-ri.eu/):

- Advanced studies of river-sea systems;
- Through a distributed research infrastructure (RI).

DANUBIUS-RI will enable and support research addressing the conflicts between societal demands, environmental change and environmental protection in river-sea systems worldwide. Examples of the specific topics under the scope of DANUBIUS-RI are presented in Fig. 2.

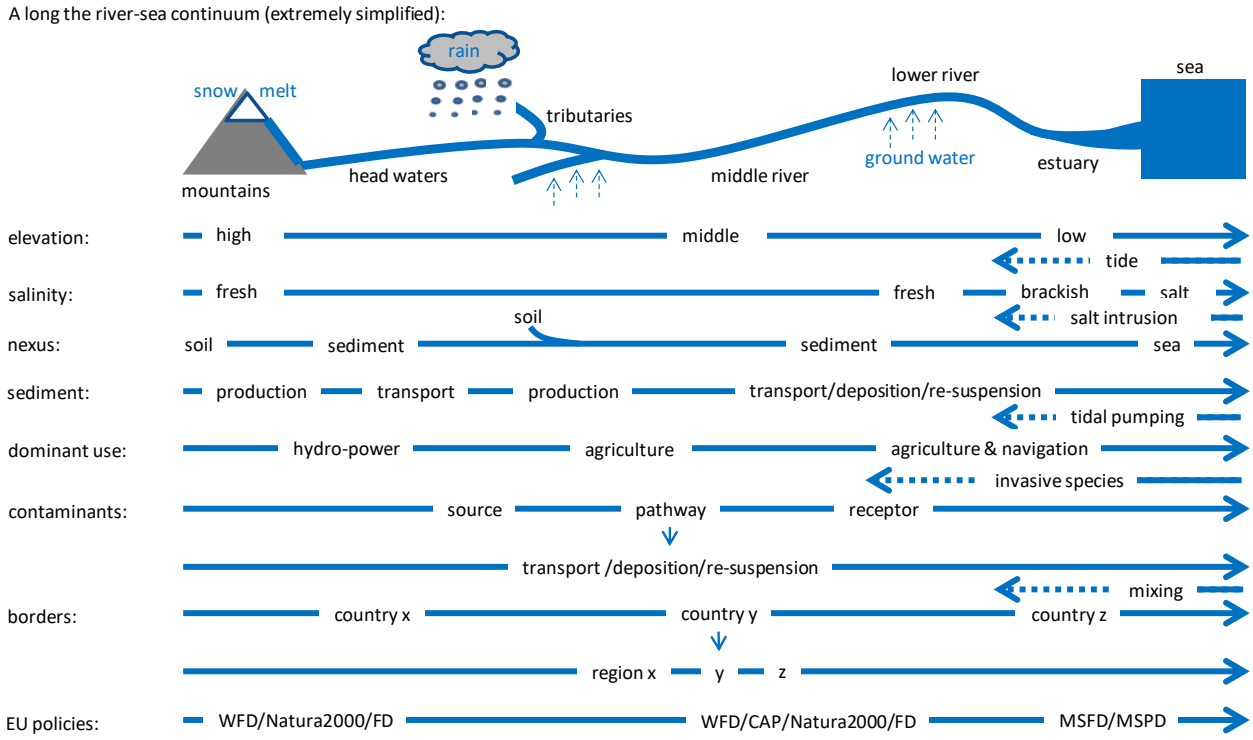

***Fig. 2** – Examples of topics of concern under the DANUBIUS-RI domain of discourse.*

Research Infrastructures (RI's) are facilities that provide resources and services for research communities to conduct research and foster innovation. They can be used beyond research e.g. for education or public services and they may be single-sited, distributed, or virtual[1].

RI's include[1]:

- major scientific equipment or sets of instruments;
- collections, archives or scientific data;
- computing systems and communication networks;

[1] Source: https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures_en

- any other research and innovation infrastructure of a unique nature which is open to external users.

The ontologies that somewhat relate to, or that are complementary to the DANUBIUS-RI domain of discourse are listed in the appendix.

3.2 The 1st level of hierarchy: river-sea systems

3.2.1 Objects

The following objects are selected for river-sea systems at the 1st level of hierarchy as being of relevance for the DANUBIUS-RI domain of discourse:

- River-sea (RS) systems
- RS systems components:
  - River basins
  - Coastal seas

3.2.2 Conceptual model

A graphically conceptualization of a river-sea system 'from source to sea' in an easily understandable way by DANUBIUS-RI scientists and stakeholders, is presented in Fig. 3.

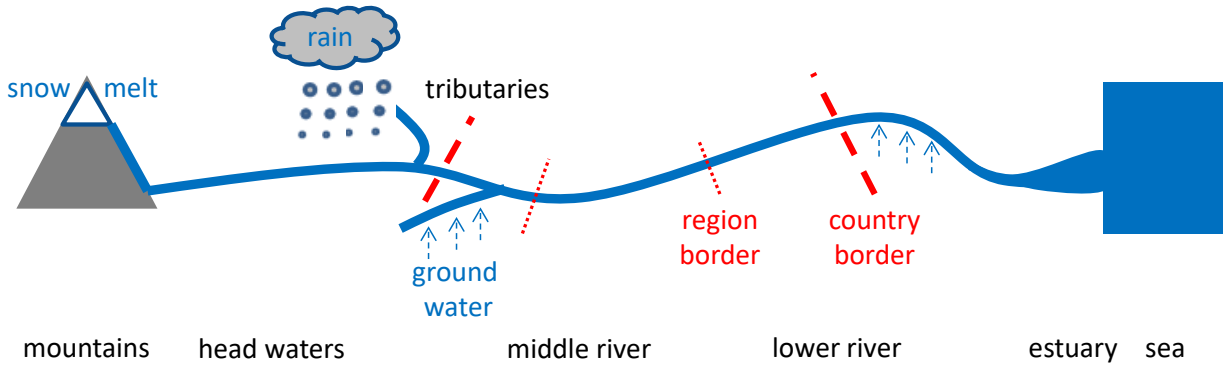

Fig. 3 *– River-Sea system: 'from source to sea'.*

3.2.3 Common language

Object	Described in common language	Source
Coastal seas	The boundary in the sea is determined by the extent of riverine influence of individual parameters, or processes of interest.	DANUBIUS-RI
River basins	The area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta.	Water Framework Directive (EC 2000)

River-Sea systems	Encompass (1) freshwater, transitional waters, e.g. estuaries and deltas, and coastal seas (longitudinal connectivity); (2) semi-aquatic and semi-terrestrial ecosystems, e.g. floodplains and wetlands (lateral connectivity); as well as (3) benthic and pelagic ecosystems (vertical connectivity). These ecosystems are connected by abiotic and biotic factors e.g. through the flow of water and transport of sediments (quantity), the associated transport of organic matter, nutrients and pollutants (quality), as well as the migration and dispersal of organisms (native and non-native species). The wider boundaries of River-Sea Systems are the catchment on land and the region of freshwater influence in the sea.	DANUBIUS-RI

3.3 The 2nd level of hierarchy: RI-components

3.3.1 Objects

The following objects are selected as distributed RI components at the 2nd level of hierarchy as being of relevance for the DANUBIUS-RI domain of discourse:

- Data centre
- E-Learning Office
- Hub
- Nodes
- Science & Innovation Agenda (SIA)
- Supersites
- Technology Transfer Office (TTO)

3.3.2 Conceptual model

A graphical conceptualization of how the RI components interrelate is presented in Fig. 4.

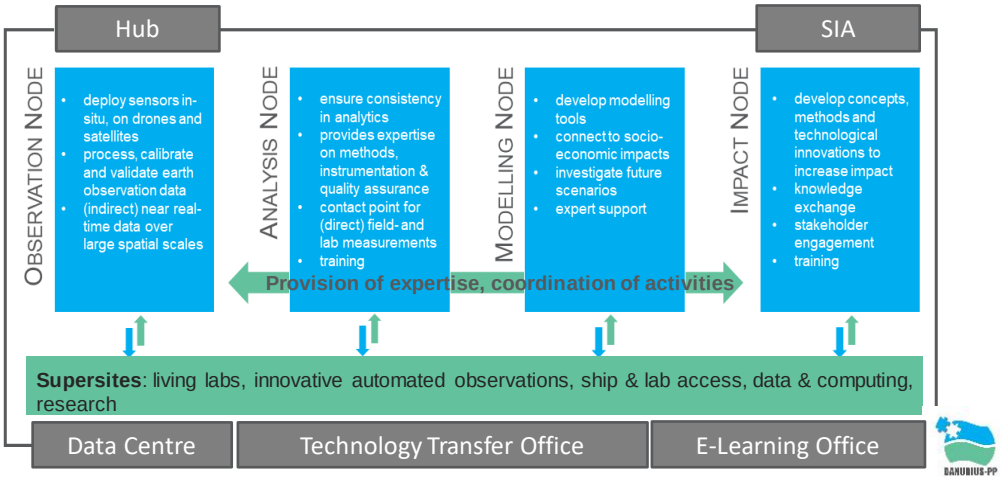

***Fig. 4** – The interrelation of the DANUBIUS-RI components.*

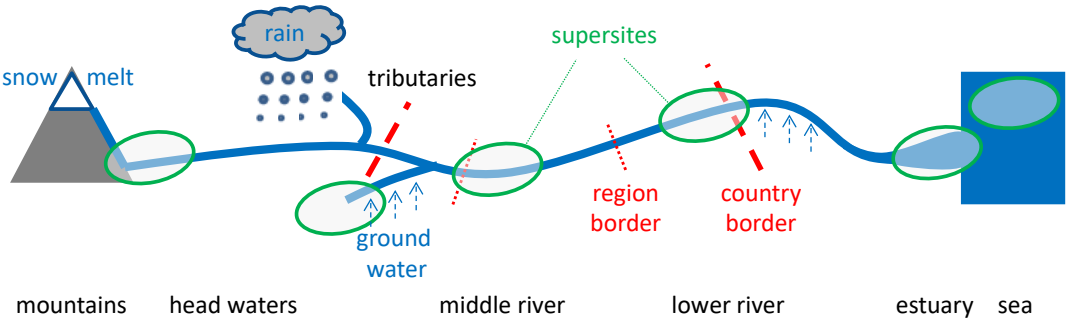

Fig. 5 *– Possible locations of the DANUBIUS-RI Supersites along the river-sea system continuum.*

Using Fig. 3 as starting point, the (possible) locations of DANUBIUS-RI Supersites can be graphically indicated as presented in Fig. 5.

3.3.3 Common language

Object	Described in common language	Source
Data centre	Is responsible for data availability and processing. The data portal provides access to a DANUBIUS-RI meta database covering digital data from: remote sensing; automatic stations in real time and periodic downloading; cruises; computer models; and the results of other physical, sedimentological, chemical, and biological and ecotoxicological analyses.	DANUBIUS-RI
E-Learning Office	Is the umbrella of training and education initiatives for next generation researchers and present practitioners, interested in the river-delta-estuary-sea continuum, supporting the combined efforts by all partners. It serves also as an internet meeting point for academia, administration and the private sector initiatives related to, or interested in DANUBIUS-RI topics.	DANUBIUS-RI
Hub	As headquarters of DANUBIUS-RI, it provides leadership, management, administration and governance, coordination, communication and standardisation activities. It is in charge of strategic planning, scientific evaluation, scientific endorsement, connectivity to the Data Centre, coordination with the Technological Transfer Office, E-Learning Office, Nodes and Supersites and dissemination of research outputs.	DANUBIUS-RI
Nodes	Are centres of expertise providing facilities and services, data storage and provision, experimental and *in situ* measurements facilities, state-of-the-art analytical capabilities and implementation of standardised procedures and quality control. There	DANUBIUS-RI

	is a node on observation, analysis, modelling and impact.	
Science & Innovation Agenda (SIA)	Summarises the scientific and technical framework for the development of DANUBIUS-RI: a distributed research infrastructure dedicated to river-sea systems. The agenda highlights the research priorities for the first five years of the infrastructure's operation.	DANUBIUS-RI
Supersites	Provide natural laboratories for observation, research, modelling and innovation at locations of high scientific importance and opportunity, covering river-sea systems from river source to transitional waters and coastal seas. Ranging from the near pristine to the heavily impacted, the Supersites are selected to provide contrasting systems across environmental, social and economic gradients that have been impacted, to varying degrees either directly or indirectly, by industrialisation, urbanisation, population expansion, land use change and farming. They provide interdisciplinary research platforms and identify, model and define system states and conditions for naturally and anthropogenic triggered transitions in the physical, biogeochemical and biological states. They provide excellent opportunities to undertake social and economic investigations in contrasting settings.	DANUBIUS-RI
Technology Transfer Office (TTO)	Realises the potential of intellectual property generated by DANUBIUS-RI by delivering general use as rapidly as possible, whilst protecting academic and research integrity and generating a financial return to the research infrastructure and inventors; and generating economic growth and employment.	DANUBIUS-RI

3.4 The 3rd level of hierarchy: the 'data-information-knowledge-impact' workflow

3.4.1 Objects

The objects of relevance at the 3rd level of hierarchy relate to the 'data-information-knowledge-impact' (DIKI) workflow in DANUBIUS-RI. This 3rd level provides the highest level of detail regarding the DANUBIUS-RI ontology. At this level all relevant terms used and defined in the DANUBIUS-PP deliverables related to this workflow are selected as objects.

3.4.2 Conceptual model

There are simply too many objects at the 3rd hierarchy level to interrelate all of them in a single conceptual model. For a meaningful conceptualization the individual objects are grouped under five R&I related activities that go logically with the DIKI workflow. These five R&I related activities are:

1. Observing & analyzing
2. Storing & gateway providing
3. Modelling
4. Learning together
5. Transferring & applying

A graphical conceptualization of how these five R&I activities relate to the DIKI workflow as well as to the DANUBIUS-RI SIA, is presented in Fig. 6, which can be interpreted in the following way:

- The impact aimed for defines the scope of the DANUBIUS-RI SIA (see D2.6 for details);
- The SIA gives guidance on:
    - What and how to observe and analyze at the Supersites (or other sites), thus guiding data production;
    - The modelling of these data, thus via modelling processing data into information;
    - The 'learning together' R&I activities, thus via those activities processing information into knowledge;
    - The transferring of that knowledge to those who could benefit from applying that knowledge in their practice;
- The storing of data, and providing of a gateway to these data is a crucial activity to facilitate R&I, but not as such an R&I activity in it selves;
- The knowledge obtained basically informs:
    - **water managers** about operational perspective, i.e. about measures they could integrate in their management plans and thus apply in practice;
    - **water policy makers** on trends in the functioning of river-sea systems and thus policy makers can respond to these trends – if deemed necessary – by adapting current policies, or adopting new or complementary policies;
    - the **business sector** on market opportunities.
- Measures, trends or market opportunities can – if deemed desirable – be further demonstrated and tested (and thus improved) at the Supersites, thus starting the flow of R&I activities again;
- Practical application of the knowledge by managers, policy makers and the business sector results in actual impact, such as:
    - A restored or improved functioning of river-sea systems as a result of measures that have been implemented;
    - Adapted current or adopted new or complementary policies;
    - Profits;
- Finally, that actual impact may lead to further, additional or completely new needs of managers, policy makers or business sector regarding river-sea systems R&I. This may result in re-defining of the SIA.

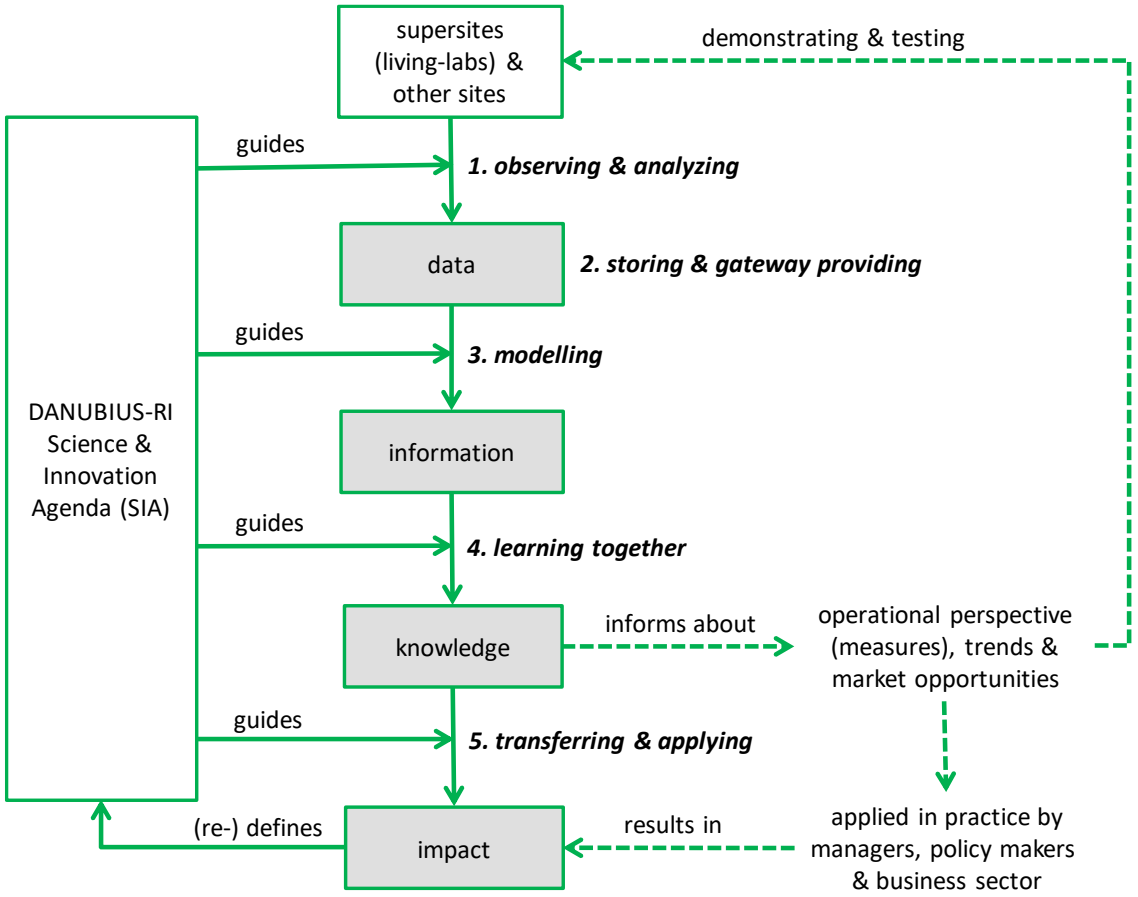

***Fig. 6** – The DANUBIUS-RI 'data-information-knowledge-impact' workflow and related R&I activities (1-5).*

3.4.3 Common language

1. Observing & analyzing

Object	Described in common language	Source
In situ	Measurements made at the actual point of sampling, in contrast to remote sensing, laboratory work or model simulation.	D7.2_final
Parameters	Fluxes, rates, abundances, concentrations etc. that are analysed or measured comparably at Supersites: Core parameters: parameters to be measurable at least in all Supersites. As the Supersites develop, new parameters will be added to this category. Secondary parameters: comprise measurements and analysis that will be done in the Supersites to fulfil the scientific goals of the Supersite and of DANUBIUS-RI. Some of these will become core parameters as the Supersites develop.	D5.10_final

	Site specific parameters: parameters that cannot be measured or analysed at every Supersite for example, “shoreline position” in Supersites located in the coastal zone.	
Procedure	A specified way to carry out an activity or a process	D6.1_final & ISO webpage
Quality assurance (QA)	A set of procedures established to ensure that the scientific, administrative as well as monitoring and observation program performs according to the DANUBIUS-RI rules, principles and goals	D7.2_final
Quality control (QC)	A set of activities that confirm the quality assurance methods are efficient and the data conform to defined data quality standards	D7.2_final

2. Storing & gateway providing

Object	Described in common language	Source
Access	The legitimate and authorised physical, remote and virtual admission to, interactions with and use of Research Infrastructures and to services offered by Research Infrastructures to Users. Such Access can be granted, amongst others, to machine time, computing resources, software, data, data-communication services, trust and authentication services, sample preparation, archives, collections, the set-up, execution and dismantling of experiments, education and training, expert support and analytical services.	D8.1_final & EU, 2016
Access manager	The person(s) who manages all the access accounts, responsible of creating the digital data administrator accounts, creates user accounts, generates digital certificates for administrators, users and servers, associating a digital certificate account, assigning access rights, logging access, change access rights, account revocation, and more.	D7.7_final
Access policy	Policy defining how RIs regulate, grant and support Access to (potential) Users from academia, business, industry and public services	D8.1_final & European Charter for Access to RIs
Access Unit	A measure specifying the Access offered to the Users. Research Infrastructures are responsible for the definition of Access Units, which may vary from e.g. precise values like hours or sessions of beam time processing time, to gigabytes transmitted for the	D8.1_final & EU, 2016

	conduction of complex experiments and projects up to quotations based on an inventory of Users' needs.	
Authentication Server	Grants and guarantees the access of digital data administrator to digital data.	D7.7_final
Availability (related to information)	Ensuring authorised users have access to information when required	D6.1_final & ISO 27001
Byte	The base storage capacity unit of measure, consisting of an eight-bit sequence. One kilobyte or KB is 2^{10} (e.g. 1024, sometimes rounded to 10^3) bytes. As a result of steadily increasing storage capacities, for its characterization bigger multiples of byte, such as TB (terabyte - 1TB = 10^{12} bytes) and PB (petabyte – 1PB = 10^{15} bytes), are used.	D7.7_final
Cloud	Distributed computing and storage infrastructure able to provide services on different levels of abstractions.	D8.1_final & e-IRG, 2017
Cloud computer	A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.	D7.7_final & NIST
Collection protocols (related to non-digital data)	Detail how the samples are collected from different parts of the RSS, what kind of equipment is used, and guidelines on ensuring sample consistency across the DANUBIUS-RI monitoring platforms and avoiding sample contamination	D7.1_final
Confidentiality (related to information)	Ensuring that access to information is appropriately authorised	D6.1_final & ISO 27001
Data	Digital data: Any representation of data that can be stored in digital form: text, numbers, images, video, audio, software, algorithms, equations, models, animations, simulations. When we look into the collected data from the point of view of its form as numbers, video, images, etc., we are investigating the nature of the data. Digital data can be accessed electronically, via Internet or Intranet or other computer-based communications Non-digital data: Include biological (plants, invertebrates, fishes, microbes) aqueous and particulate (bed sediments, suspended solids) matrices, which can be preserved and stored long-term to provide a research resource for DANUBIUS-RI partners and collaborators internationally.	D7.2_final D7.1_final

	Research data: Information, in particular facts or numbers, collected to be examined and considered as a basis for reasoning, discussion, or calculation. In a research context, examples of data include statistics, results of experiments, measurements, observations resulting from fieldwork, survey results, interview recordings and images available in digital form. This type of data may be generated through observation, computation/simulation or experiment. Qualitative data deals with descriptions that can fit into categories, data that are names, characteristics or labels. The qualitative data do not result from measuring or counting and although can have numerical form, no mathematical manipulations can be applied (e.g. average). This type of data can be collected from monitoring and recording the visual observation. An example of this type of data would be recording the species, taxonomy. Social perception on the impact of sustainable management on biodiversity, Impact of land use classification on water quality or change of the regulatory framework with impact on design flows are examples of qualitative analysis output. In DANUBIUS-RI, qualitative data may refer to strategies, designs, feedback, guides, policies, notes and transcripts Quantitative data is defined as physical and measurable data. An example of this type of data would be collecting an empirical measurement such as turbidity values from a body of water. In DANUBIUS-RI, quantitative data may also mean: measurements, counts, estimates, predictions. Experimental data: may be either qualitative or quantitative data, each type being appropriate for different investigations, as is the case for the computational data.	D7.2_final & H2020 D7.2_final D7.2_final D7.2_final
Data administrators (related to digital data)	The person(s) responsible of digital data management, and also the software applications requiring data transfer. The following operations are allowed: upload data to the storage system, verify data, modify data, generate metadata and logs, erase data, synchronize data, verify storage volumes and their integrity, data security and other specific actions. All permitted/forbidden operations are assigned by Access manager.	D7.7_final
Data authors	The individuals involved in research, education, or other activities that generate digital data that are afterwards deposited in a data collection	D7.2 & National Science Board

Data Centre	A component of DANUBIUS-RI. It will be responsible for data availability and processing. The data portal will provide access to a DANUBIUS-RI meta database covering digital data from: remote sensing; automatic stations in real time and periodic downloading; cruises; computer models; and the results of other physical, sedimentological, chemical, and biological and ecotoxicological analyses. It is the DANUBIUS-RI portal to the community of users and the connection with other major e-Infrastructure initiatives in Europe and elsewhere. In this respect it will be the 'front door' of the RI.	D3.2_final D5.2_final
Data collections	Data stored by infrastructure, organization or individual and the resources to preserve access to the data. Data collection can be outcomes of one or more research projects, research vessels, observing systems Argo floats, gliders etc., or model simulations, that may or may not conform to file formats standards, metadata structure, that may vary in digital size and that may not be preserved beyond the lifetime of the project, or can be observing a given community standards in place or by the consensus of the community, new standards can be developed. Digital data collections can be stored in a physical location or may be virtual, located in several physical locations connected electronically to create a single entity. These collections differ in size, scope and usage	D7.2_final & National Science Board
Data formats	Biological data formats - chemical data formats - marine science data formats - geophysical data formats - satellite imagery data formats	D1.2_final_amended
Data origin	Can be observational, computational or experimental. Such differentiation is crucial to choices made for archiving and preservation. Observational data, such as direct observations of water temperature on a specific date are historical records that cannot be recollected. Thus, these observational data are usually archived indefinitely. Observational data are captured in real time (*in situ*) and are impossible to re-create if lost. Examples of observational data: sensor readings like temperature or salinity, samples, images or human observations, through citizen science data. Experimental data (measurements of gene expressions, chemical reaction rates) that can be accurately reproduced will not necessarily be long term stored. However, this is a rare occurrence,	D7.2_final

	since the experimental conditions cannot be reproduced exactly, the experimental variables may not be known, the costs of reproducing the experiment may be too high, hence long-term preservation of the data is recommended. Therefore, a key characteristic of this type of data is that data comes from lab equipment produced under controlled conditions. Examples of experimental data: gene sequence, chromatographs, spectroscopy. Experimental data is collected through dynamic involvement of the researcher to produce/measure/identify differences when a variable (by variable understanding the characteristic that can be measured or counted) is altered. Computational data are produced by numerical model applications. They are replicable, generally stored with continuity if produced by operational models, just stored on purpose for singular applications. The possibility to reproduce this kind of data is connected with the availability of all contour information and the availability of computing time. Additional information on models used and model's setups are needed to reproduce these data. Generally, there could be a high need of digital storage due to the large size of data Example of computational outputs: maps of computed variables (i.e. currents, sediment concentration, significant wave height, etc.). Derivate data: Data are most frequently gathered in raw form (lowest form) and undergo either at the various sites or at the Data Centre various stages of calibration, quality control and correction to reach higher data levels. With additional refinement and curation, it is possible to generate derivative data that may be more easily used by others; hence data may be stored in multiple forms, depending on the circumstances. Compiled data are produced by applying a transformation process on existing data (mathematical manipulation, aggregation), therefore obtaining new data. Such data can be easily replaced if lost, although the process to create it may be time consuming. Therefore, compiled data results from data analysis or combination of various sources and although possibly expensive is reproducible. Example of compiled data: maps of monthly mean observed attributes, re-analysis of models using data assimilation, compiled databases	

Data portal	Will be the main entrance for the users, redirecting the user to the services and data assigned to his role/rights of access after he is authenticated and if authorized.	D5.11_draft & D7.7_final
Data quality management	The process of reviewing, plausifying and updating the data in order to minimize inaccuracies and eliminate redundancies, such as duplicate records	D7.2_final
Data types (by structure)	Raster data in its simplest form, consists of a matrix of regular cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as temperature. The raster is easy to visualize and can be obtained in a number of ways. Raster models are useful for storing data that varies continuously, as in an aerial photograph, a satellite image, a surface of chemical concentrations, or an elevation surface. Vector data provide a way to represent real world features within a geographical information system (GIS) environment. A feature is anything you can see on the landscape. Within GIS vector data can be created and edited, as well as scaled without using the information from the original image. Vector models are useful for storing data that has discrete boundaries, such as country borders, land parcels. Gridded or Array-oriented data is a data structure consisting of a collection of elements (values or variables), each identified by at least one array index or key. NetCDF is a set of software libraries, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. The data format is "self-describing". This means that there is a header which describes the layout of the rest of the file, in particular the data arrays, as well as arbitrary file metadata in the form of name/value attributes. NetCDF data has variables, attributed and dimensions. NetCDF allows efficient storage of the data, and is portable, offers direct access (a small subset of a larger dataset may be accessed without first reading through all the preceding data) and it is appendable (data may append to a structured netCDF file without copying the dataset). Hierarchical Data is a type of file format for storing scientific data. HDF has a set of file formats (HDF4, HDF5) designed to store and organize large amounts of data. It supports n-dimensional data sets.	D7.2_final

	Times series data consist of a sequence (vector) of data points, measured typically at successive times either in one location (in the Eulerian sense when measuring in water) or at varying location (in the Lagrangian sense), and have a natural temporal ordering. Examples of time series data are: population size measured annually, temperature data measured at fixed intervals, river discharge measured over time, heights of ocean tides. Time series data includes patterns of variation and can also include data that can be correlated in space as well as time such as variables measured at intervals along transects, water depth, soil chemistry.	
Data users	Include researcher, educators, administrators, students and other individuals who use the information in the data collections in develop research, education activities or policies	D7.2 & National Science Board
Digital certificate	An electronic credential that is used to certify the online identities of individuals, organizations, and servers	D7.7_final
e-Infrastructures	Addresses the needs of European researchers for digital services in terms of networking, computing and data management. e-Infrastructure refers to a combination and interworking of digitally-based technology (hardware and software), resources (data, services, digital libraries), communications (protocols, access rights and networks), and the people and organisational structures needed to support modern, internationally leading collaborative research be it in the arts and humanities or the sciences.	D8.1_final & Research Councils UK, 2010
e-IRG	e-Infrastructure Reflection Group: a strategic body to facilitate integration in the area of European e-Infrastructures and connected services, within and between member states, at the European level and globally. The mission of e-IRG is to support both coherent, innovative and strategic European e-Infrastructure policymaking and the development of convergent and sustainable e-Infrastructure services.	F7.7_final & D8.12_final & e-IRG website
e-Science	The use of immense data sets that require high computing capabilities. The term is typically used to refer data analysis in highly distributed network environments.	D8.1_final & National e-Science Centre, 2017
e-service	Electronic resource designed and provided to users for a specific purpose. Within a RI context, the term typically refers to an application in the areas of research or education.	D8.1_final

EUDAT	European e-infrastructure of integrated data services and resources	D5.11_draft
European Open Science Cloud (EOSC)	Will be developed as a data infrastructure commons serving the needs of scientists. It should provide both common functions and localised services delegated to community level. Indeed, the EOSC will federate existing resources across national data centres, European e-infrastructures and research infrastructures; service provision will be based on local-to central subsidiarity (e.g. national and disciplinary Nodes connected to Nodes of pan-European level)	D7.7_final & ec.europa.eu
FAIR principles (related to data)	Data have to be Findable, Accessible, Interoperable and Re-usable	D7.7_final & force11.org & D8.12_final
Index Access (in relation to non-digital data)	An inventory system that tracks the location and status of every sample, with labelling and an associated database. The resulting metadata should be available to the wider scientific community, to foster collaborations between Supersites, DANUBIUS partners and international researchers.	D7.1_final
Integrity (related to information)	Safeguarding the accuracy and completeness of information and processing methods	D6.1_final & ISO 27001
IT infrastructure	Communication network, computing servers and storage facilities.	D5.11_draft
Metadata	Data describing data sets and data services and making it possible to discover, inventory and use them	D7.2_final
User interface	A web portal, presenting the data access point to the DANUBIUS-RI user community, offering an appropriate search engine and other services like, authentication, authorization and accounting. The data access for registered users (regular users of stored data) through the portal interface provides simple data gathering functions, but for the data providers a different interface should be developed, including protocols and procedures to exchange large amounts of data and to synchronize the information across all the storages taking part in DANUBIUS-RI data repository at the Data Centre.	D7,7_final

3. Modelling

Object	Described in common language	Source

High Performance Computing (HPC)	Computer environments that deliver a huge amount of compute power over a short period of time. HPC environments are often measured in terms of Floating point Operations Per Second (FLOPS).	D8.1_final
High-throughput computing (HTC)	The use of many computing resources over long periods of time to accomplish a computational task. It can also be defined as computing environment that delivers large amounts of computational power over a long period of time.	D8.1_final & Wikipedia
Modelling Stakeholders	All the institutions that use model products but that do not run models.	D1.2_final_amended
Modelling users	All the laboratories and institutions that use models, apply models but do not develop models	D1.2_final_amended

4. Learning together

Object	Described in common language	Source
Anthropocene	This term is often assigned to the current geological epoch, where human activities are exerting increasing impacts on the environment on all scales and are outcompeting in many ways natural processes	D2.2_final & Crutzen, 2006.
Area of expertise	A set of scientific competences and skills to which one DANUBIUS-RI Node is associated. The first four areas of expertise at DANUBIUS-RI are “Observation”, “Analysis”, “Modelling”, and “Impact”.	D5.4_final
Benthic zone	The lowest levels of the water column, including the upper sediments. This region provides the principal habitat for benthic invertebrates, and algal and bacterial communities within epilithic biofilms. It is also often a zone of major biogeochemical cycling, with chemical / nutrient fluxes occurring between the upper sediment and the overlying water column.	D7.1_final
Biodiversity	The foundation for ecosystem structure and functioning, and thus ecosystem services.	D2.2_final
Blue Growth	Initiative to protect the potential of the oceans, lagoons and inland waters by introducing responsible and sustainable approaches to reconcile economic growth and food security with the conservation of aquatic resources	D2.3_final & Eikeset *et al*., 2018
Climate Change (CC)	A mixture between natural climate variability and man-made changes	D2.1_final

Coastal seas	The WFD defines 'coastal water' as 'surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters'. While 'territorial waters' are defined as 'bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters, but which are substantially influence by freshwater flows'. However, the WFD usage of 'coastal waters' is difficult to relate to the MSFD, which focuses on 'marine waters': i.e 'waters, the seabed, and subsoil on the seaward side of the baseline from which the extent of territorial waters is measured extending to the outmost reach of the area where a Member State has and/or exercises jurisdictional rights, in accordance with the UNCLOS'.	D2.3_final
Contaminant (or pollutant)	Organic and inorganic dissolved, colloidal and particulate substances of anthropogenic origin other than nutrients that have undesirable effects on ecosystem and human health.	D2.2_final
DPSIR	Driver-Pressure-State Change-Impact-Response: Drivers refer either to exogenic forces (, e.g. natural hazards) or human activities (e.g. fisheries, urbanisation) originating from economic and social fundamental needs. These drivers create pressures. Both natural forces and human activities exert cumulative effects on the system, either reinforcing or alleviative. Pressures refer to mechanisms by which an activity has an actual or potential effect on any part of the ecosystem, and hence, contributes to change in ecosystem state, which can be either positive or negative. Unlike drivers, the intensity and direction or even the occurrence of pressures can be directly influenced through appropriate management. The effects on the components of the ecosystem are State Changes. State Changes encompass e.g., alterations to sediments, water column or their constituent biota due to the occurrence of a pressure. Hence, the state is the actual condition of the ecosystem and its components established in a certain area at a specific time frame. Ecosystem states are attributes reflecting ecosystem integrity (or not). The state can be described based on physical, biological, and chemical characteristics as	D2.1_final & Oesterwind *et al.*, 2016

	highlighted also in the Marine Strategy Framework Directive Changes in ecosystem states are having Impacts on the ecosystem services and on human welfare. Impacts can be defined as consequences of environmental state change in terms of substantial environmental and/or socio-economic effects which can be both, positive or negative Response refers to the human/societal intervention intended to reduce the impacts through e.g., policy measures, information, behaviour change or management to reduce or prevent an unwanted change or to develop a positive (desirable) change in the ecosystem.	
Early Career Investigator (ECI)	A researcher whose career span is less than 8 years between the date of the PhD/doctorate (or similar experience) and the date of evaluation.	D6.2_final & COST
Ecosystem approach	A philosophy for summarising the means by which the natural functioning and structure of an ecosystem can be protected and maintained while still allowing and delivering sustainable use and development by society.	D2.1_final & Gregory *et al*., 2013
Ecosystem services	The direct and indirect contributions of ecosystems to human well-being. Ecosystem services can be categorized in four main types. (1) Provisioning ecosystem services represent goods such as water, fish and sediments; (2) regulating services are benefits such as water purification and climate regulation; (3) supporting services are benefits for other ecosystems services and include e.g., nutrient cycling and primary production; and (4) cultural services include e.g. recreation and tourism.[2]	D2.2_final & de Groot *et al*., 2010
Exogenous drivers (see also DPSIR)	Geographic/geologic conditions, natural hazards and climate change	D2.1_final
Extreme events	Natural phenomena such as floods, storm surges, strong short-term fluctuations in river discharges and severe droughts	D2.2_final
GÉANT	The pan-European network for research and education. GÉANT is leading in the field of network services for research and academic community, harmonizing the methods and the solutions across the European countries by its partners – national research and education networks (NRENs). GÉANT is a fundamental element of Europe e-infrastructure, delivering services in a pan-European network for	D8.6_final

[2] https://biodiversity.europa.eu/topics/ecosystem-services

	about 10000 institutions and 50 million users. GÉANT provides users with high speed and reliable access to computing facilities, storage, applications and other resources. This permits efficient sharing, accessing and processing of the high data volumes generated by research and education communities, but also testing innovative technologies and applications.	
Global change	Encompasses planetary scale changes, which may alter the Earth's capacity to sustain life e.g. by impacting the climate system, carbon and nitrogen cycles, food webs, biodiversity. While global change is not solely caused by a byproduct of human activities, humans have vastly accelerated the pace of change. Humans are driving global change due to e.g., increasing population, economic growths, unsustainable resource use, transport, land use and urbanisation.[3]	D2.2_final
Grant portability	Occurs when an individual researcher or a group of researchers continues the research at another institution in another country than originally foreseen in the grant agreement and the remainder the grant is transferred for that purpose" or more succinctly, "money follows researcher",	D9.3_final & Euraxess, 2012
Healthy ecosystems	Those that are resilient, stable and sustainable, and maintaining their organisation over time	D2.2_final
Information	See Scientific information	
Interdisciplinary research	A mode of research by teams of individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.	D2.2_final & National Academy of Sciences et al., 2005
Intersectoral mobility (related to researchers)	Being mobile to a sector outside academia, in a researchers own country or abroad. The outside sectors include: private industry, private not for profit, as public and government sectors.	D9.3_final
Megatrends	The Earth's resilience will be significantly affected in coming decades by 'large-scale, high impact and often interdependent social, economic, political, environmental or technological changes', commonly referred to as global megatrends. Megatrends that are important for Europe's environment are for example demographic changes, urbanisation, disease burdens and health risks, accelerating	D2.2_final & EEA, 2015

[3] http://www.igbp.net/globalchange/earthsystemdefinitions.4.d8b4c3c12bf3be638a80001040.html

	technological change, continued population and economic growth, intensified resource use, climate change, increasing pollution, and diversifying approaches to governance	
Nexus	Link or connection	D2.3_final
Lateral (RSS related)	River to floodplain and coast to sea interfaces and interactions with interrelated processes between physical, chemical, biological components plus human activities	D2.1_final
Longitudinal (RSS related)	Freshwater to marine interfaces and interactions with interrelated processes between physical, chemical, biological components plus human activities	D2.1_final
Macrophytes	Higher plants, cryptograms, bryophytes and single-species colonies of algae	D7.1_final
Methodology	The design process for carrying out research or the development of a procedure; it is not in itself an instrument for doing those things.	D6.1_final
Open Access (OA)	The practice of providing online access to scientific information that is free of charge to the end-user and reusable. For Horizon 2020, providing open access to publications in funded projects is an obligation for all grants. “Each beneficiary must ensure open access to all peer-reviewed scientific publications relating to its results” (GA Article 29). Beneficiaries can choose one of two main ways to meet this requirement: A. Self-archiving (also referred to as 'green' open access) means that the published article or the final peer-reviewed manuscript is archived (deposited) by the author - or a representative - in an online repository before, alongside or after its publication. Repository software usually allows authors to delay access to the article (‘embargo period’) B. Open access publishing (also referred to as 'gold' open access) means that an article is immediately provided in open access mode as published. In this model, the payment of publication costs is shifted away from readers paying via subscriptions.	D7.2_final & D10.1_final D10.1_final
Pelagic zone	The open waters in seas, lakes and rivers that are not in contact with the bed and marginal shore areas. Also the environment in which many key components of the aquatic ecosystem exist, such as algae, cyanobacteria, zooplankton, fish and aquatic mammals.	D7.1_final

Periphyton	The microorganisms that colonize the natural or artificial substrate within waterbodies. They are represented by an extremely heterogeneous complex of organisms consisting of algae, diatoms, cyanobacteria, detritus and heterotrophic organisms.	D7.1_final
Pollutant (or contaminant)	Organic and inorganic dissolved, colloidal and particulate substances of anthropogenic origin other than nutrients that have undesirable effects on ecosystem and human health	D2.2_final
RESAVER	Retirement Savings Vehicle for European Research Institutions	D9.3_final
River basins	The area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta.	WFD (EC, 2000)
River-Sea Systems (RSS)	Comprise rivers and their catchments, estuaries, deltas and lagoons, as well as their adjacent coastal seas. As such, RSS cover freshwater, transitional and coastal waters, including semi-aquatic and semi-terrestrial environments, such as floodplains. The extent of a RSS is defined by the surface-water (or groundwater) boundary and the marine boundary, which is more variable. It is defined by the extent of riverine influence on individual parameters of interest.	D2.2_final
Scientific information	Scientific' refers to all academic disciplines. In the context of research and innovation, 'scientific information' can mean: 1. peer-reviewed scientific research articles (published in scholarly journals) or 2. data publication with DOI and/or in a data journal like ESSD or 3. research data (data underlying publications, curated data and/or raw data).	D7.2_final
Sediment	A resource and intrinsic part of RSS like soil and (ground)water. River-born sediment originates from the weathering of rocks and their minerals, organic material and soils in upstream catchment, and from river bank erosion and other instream sources.	D2.2_final
Sediment regime	The maintenance of sediment quantity and quality in RSS.	D2.2_final
Societal challenges	Multi-faceted and interconnected problems that in many respects are difficult to resolve [e.g. lack of data and understanding; the problems span traditional disciplinary boundaries] with a social and economic context that is fundamental to	D2.3_final

	understanding potential trajectories of change in RSS.	
Sustainable Development Goals (SDG)	Reflect a desire for society to live safely within current constraints, whilst retaining the aspiration of continuing to increase human wellbeing. They were intended to be action-orientated, universally applicable, goals to secure sustainable development. They were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. The 17 SDGs are integrated so that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.[4]	UN, 2015 D2.3_final
Vertical (RSS related)	Surface to groundwater interfaces and interactions with interrelated processes between physical, chemical, biological components plus human activities	D2.1_final
Virtual Laboratory (VLab)	An interactive environment that provides virtual access to scientific instruments, numerical experiments, data sets, libraries and/or communication interfaces for conducting simulated experiments. VLab is designed to cater for researchers, students and ultimately support decision making in the RS continuum. VLabs enables a group of researchers located around the world to work together on a common project. VLabs addressed to researchers aim to (i) make available a compressive database that helps in the design and direction of experiments, (ii) permit the use of interactive tools such as numerical models or scientific facilities for the development of their research. VLabs provide a learning environment to students and enthuse them to conduct research trough specific designed numerical experiments, web-resources, video lectures, animated demonstrations and self-evaluations	D8.1_final
Water sufficiency	Ensured continued water availability for both anthropogenic and environmental needs. It includes water of sufficient quantity as well as quality of both surface waters and groundwater along the freshwater-marine continuum to maintain ecosystem functioning and to provide ecosystem services.	D2.2_final

[4] https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

Wicked problems	Problems characterised by uncertainty, limited understanding, differing viewpoints and perspectives.	D2.3_final & Rittel & Webber, 1974

5. Transferring & applying

Object	Described in common language	Source
Actors	National environmental ministries, research institutes and universities, NGOs as well as other research infrastructures dealing with River-Sea Systems	D2.2_final
Business Model Canvas	An approach that includes a strategic management and lean start-up template for developing new or documenting existing business models. It assists organisations in aligning their activities by illustrating potential trade-offs.	D5.6_final & Osterwalder, 2008
Intellectual Property (IP)	Ireland (home of the TTO) defines IP as “a term used to describe the rights which protect your ideas and other forms of intellectual creation. It is made up of a bundle of different rights. Some rights have to be registered to be effective, others arise automatically” and divides IP into six main categories: know-how, designs, patents, copyright, database rights and trade-marks.	D5.15_draft
Intellectual Property Rights (IPR)	Patents, copyrights, trademarks, service marks, domain names, company names, registered designs, database rights, design rights, confidential information and trade secrets, applications for any of the above, and any similar right recognised from time to time in any jurisdiction, including all rights in an action related to the infringement of any of the above.	DANUBIUS SLA
Intellectual Property Rights Committee	Administrates the IP rights within the Data Centre and will have an advisory and approval role for Nodes, Supersites, and Technology Transfer Office.	D5.4_final
Stakeholder	A third-party entity affected in their interests by actions carried out by DANUBIUS-RI. The set "stakeholders" includes the sub-set "users".	D9.1_draft
Technology Transfer Office (TTO)	A component of DANUBIUS-RI. It will bring the intellectual property generated into public use as rapidly as possible whilst protecting academic and research freedom, providing a financial return to the RI, inventors and innovators and generating economic growth and employment. It will aim to ensure that the contracts between DANUBIUS-RI and external partners fully represent	D3.2_final

	the best interests of DANUBIUS-RI. As such its primary, though not only, role will be to leverage the IP and infrastructural resources to engage relevant industries and increase the number of developments and innovations and ensure that are effectively exploited for the advantage of both individual innovators and DANUBIUS-RI as a whole.	D5.13_draft
Three Os	Open innovation, Open science and Open to the world	D3.1_final

3.5. DANUBIUS-RI governance related ontology

3.5.1 Objects

At this level all relevant terms used and defined in the DANUBIUS-PP deliverables related to the governance of DANUBIUS-RI are selected as objects.

3.5.2 Conceptual model

A graphical conceptualization of how the DANUBIUS-RI governance (DANUBIUS-ERIC) as well as the RI components interrelate is presented in Fig. 7.

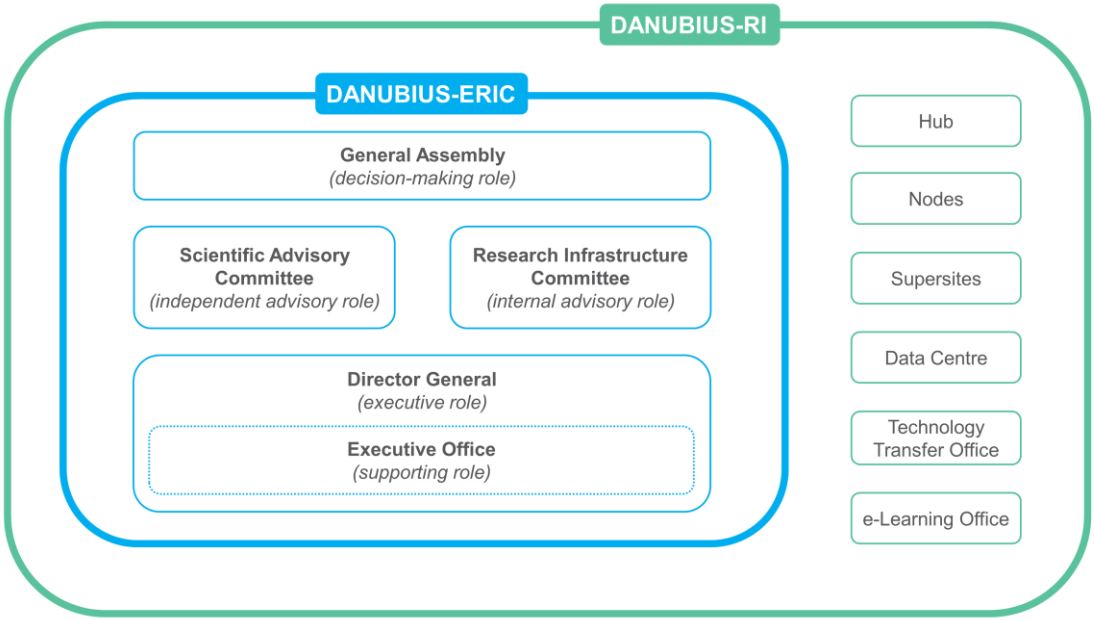

***Fig. 7** – The DANUBIUS-RI governance components.*

3.5.3 Common language

Object	Described in common language	Source
Accredited Service Provider (ASP)	An entity (e.g. university, knowledge institute or company) that is located in an ERIC Member State; that delivers scientific expertise or knowledge or	D5.8_final

	technical capacity and capability to, and demanded by a Node Leading Institution; and that in its delivery is capable and obliged to apply the DANUBIUS Commons. The ASP is being developed under the coordination of the Specific Node Leading Institution.	
Component (of DANUBIUS)	A site or a constituent part of the distributed infrastructure, located in the territory of a member or observer, at which DANUBIUS related activities are carried out and include, but is not limited to, the hub, the supersites, the nodes, the data centre, the technology transfer office and the e-learning office. A DANUBIUS Component is led by one DANUBIUS Partner and is linked to the DANUBIUS-ERIC through a Service Level Agreement.	ERIC statutes
DANUBIUS Commons	Harmonized regulations, methods, procedures and standards for all kinds of scientific and non-scientific activities. They guarantee the comparability and transferability of the RI functioning and recorded data across the different components, and member states of DANUBIUS-RI. Thereby they also guarantee a defined minimum quality that in turn set a quality label ("DANUBIUS approved") as they are based on internationally accepted standards and will be continually reviewed and revised. Thus, DANUBIUS-RI will be able to continuously offer data and expert support of state-of-the-art quality for RS systems.	D2.5 & D6.4 (supplement)
DANUBIUS Commons Committee	Periodically analyses and regulates the activities related to interdisciplinary procedures (standardisation, quality control, etc.) established within DANUBIUS Commons	D5.4_final
DANUBIUS-RI	The International Centre for Advanced Studies on River-Sea Systems	D9.1_draft
Distributed	RIs can be single-sited (a single resource at a single location), distributed (a network of distributed resources), or virtual (the service is provided electronically). These distributed resources are called components in DANUBIUS-RI	D5.1_final & EC DG R&I D9.1_draft
Economic Net Present Value (ENPV)	Difference between the discounted total social benefits and costs.	D4.7
Financial Present Value of the Investment (FNPV/C or FNPV(C))	Sum that results when the expected investment and operating and replacement costs of the project (discounted) are deducted from the discounted value of the expected revenues.	D4.7

Financial Present Value on Capital (FNPV/K or FNPV(K))	Measure of the extent to which the project's net revenues are able to repay the financial resources provided by the national funds (both private and public sources).	
General Assembly	General Assembly of DANUBIUS-ERIC	D5.4_final
Headquarters (HQ)(of DANUBIUS-ERIC)	The central office of DANUBIUS-ERIC, located in the Statutory Seat. Its primary responsibility is to deliver effective management and coordination of the entire DANUBIUS-RI, whilst also promoting its activities and growing its outreach and development throughout Europe and internationally. Administratively, the HQ will perform the necessary central services to ensure the smooth running of the RI and its component parts (Hub, Nodes, Supersites, Technology Transfer Office, E-Learning Office and Data Centre), including: finance, personnel, business and communications. The HQ will coordinate and manage the overall activities of the research infrastructure, including the primary communications with the external RIs and the stakeholders. It will facilitate the communications among Nodes, Supersites, Data Centre, E-Learning Office and the Technological Transfer Office.	ERIC statutes D5.4_final
Hosting Institution	Institution hosting a Supersite with a single named manager	D3.2_final
Hub	A component of DANUBIUS-RI. There is no standardisation of terms between RIs. In particular, Hub and Node are used by several RIs but in different ways. The primary office of the RI, usually the legal seat, is variously referred to as the Headquarters, Head Office, Hub, Project Office, Secretariat, Integrated Core Services, Interim Office, Office, Statutory Seat and Knowledge Centre. DANUBIUS-RI uses the term Hub. The Hub will supervise, manage and administer the operations of the RI and of the ERIC. The legal seat of DANUBIUS-ERIC will be at the Hub. It will be the base for the Director General together with some or all of the other members of the Executive Team (Operations Director, Administration Director, Science Director, Data Director and Business Development Director), together with support and administrative staff. The primary responsibility of the Hub is to deliver effective management and coordination of the entire	D3.2_final D5.1_final D5.2_final

	DANUBIUS-RI, whilst also promoting its activities and growing its outreach and development throughout Europe and internationally.	
Independent Advisory Board	Advises the General Assembly and gives periodic reports regarding current needs to the General Assembly	D5.4_final
Leading Institution	Institution coordinating the development and functioning of the DANUBIUS-RI Nodes over the entire RI lifespan	D5.6_final
Managing Authority (MA)	In the context of ESIF, an authority in charge of managing an Operational Programme	D4.7
Member	A country that is a party to the DANUBIUS-RI ERIC agreement	D5.4_final
Node	A component of DANUBIUS-RI. A set of legal entities, led by a leading institution, in agreement between them to carry out services within a defined area of expertise, for the benefit of DANUBIUS-RI and their users Nodes are composed of Leading Institutions and specific ASPs. It is a centre of expertise providing facilities and services, data storage and provision, experimental and *in situ* measurements facilities, state-of-the-art analytical capabilities and implementation of standardised procedures and quality control. The Nodes will be entrusted with the task of developing, implementing and maintaining the quality of the DANUBIUS Commons in their areas of expertise The Nodes will be key facilitators spanning observation and analysis across biological, physical, chemical and social sciences, and modelling and (societal) impact. Observation Node, comprising operational data processing with calibration, validation and training facilities, which will capitalise on the launch of the latest generation EO satellite sensors and will deploy a network of in situ sensors to provide near real-time observation capability. Analysis Node, will ensure consistency in applied methods that require analytical rigour and quality control to enable effective comparison between research groups operating within and between Supersites.	D3.2_final D5.4_final D5.8_final D3.2_final D5.2_final D5.6_final

	Modelling Node, will deliver a range of services from modelling tools to expert support in modelling activities to simulate specific processes for each of the Supersites and deliver high performance modelling solutions for the investigation of RS systems. Impact Node, will enable DANUBIUS-RI to create impact and value for society by facilitating the connection of science, research and development with (the rest of) society to providing solutions for societal challenges. The Impact Node will facilitate the development and testing of concepts, methods and instruments to realise this goal.	
Participant institutions	Institutions participating in the DANUBIUS-PP (Preparatory Phase) project consortium	D3.1_final
Participating country	Country who is member of an ERIC	D3.1_final
Partner (of DANUBIUS)	A research facility, an institution, a university, a laboratory, or a related juridical person, established in the territory of a member or observer and appointed as such by that member or observer. A DANUBIUS Partner provides resources and related services to one or more DANUBIUS Components and, through them, to Users.	ERIC statutes
Policy (related to quality assurance)	A brief statement or document that defines the quality goals and objectives, a commitment to achieve these goals and objectives as well as continuous improvement. It should provide an outline for creating, stating, and measuring the performance against the quality objectives	D6.1_final & ISO 9000 (2015) and ISP 9001 (2015)
Principles (of DANUBIUS-RI)	The framework and overarching rules for the common values or common standards of DANUBIUS-RI which all partners adhere to.	D6.2_final
Quality Assurance Panel (QAP)	A panel with one representatives of each Node, the Hub, TTO, Data centre and three delegates representing the supersites. The panel is responsible for the reviewing and administration of the DANUBIUS Commons.	D6.4 supplement
Research Infrastructures (RI)	Facilities, resources or services of a unique nature identified by European research communities to conduct top-level research activities in all fields. They include: major scientific equipment, resources such as collections, archives or scientific data, e-infrastructures such as data and computing systems, and communication networks.	ESFRI, 2016 EC DG R&I[5]

[5] Source: https://ec.europa.eu/research/infrastructures/index_en.cfm?pg=about

Scientific and Economic Access Committee	Provides the access framework of DANUBIUS-RI's components and different organizational forms of business interest representation (companies, associations, consultants, etc.) to the general assembly in terms of supply and demand of access goods.	D5.4_final
Scientific and Technical Committee	Monitors the scientific quality of DANUBIUS-RI activities; gives feedback and make recommendations to develop DANUBIUS-RI activities; and presents recommendations annually to the General Assembly	D5.4_final
Service Level Agreement (SLA)	An agreement that defines the relationship between a DANUBIUS Component and the DANUBIUS-ERIC and which sets out the terms and conditions on which the DANUBIUS Component shall provide resources and services to the DANUBIUS-ERIC, to other DANUBIUS Components and to Users. A Service Level Agreement may be signed by a lead DANUBIUS Partner on behalf of a DANUBIUS Component in cases where the DANUBIUS Component lacks legal personality.	
Staff (of DANUBIUS-RI)	Headquarters, administrative personnel, lawyers, coordinators, educators, etc. to manage and coordinate Hub, Nodes and Supersites activities.	D4.2_draft
Standard	A document that provides rules, guidelines or characteristics for activities or for their results, aimed at achieving the optimum degree of order in a given context. It can take many forms. Apart from product standards, other examples include: test methods, codes of practice, guideline standards and management systems standards.	ISO Wep page
State representative (in ERIC)	One or more public entities or private entities with a public-service mission that are selected by an ERIC member State to represent that State in the ERIC	D3.1_final
Supersite	A component of DANUBIUS-RI. It is: • A defined area of water/land and a site for research and observation activities. However, it is not a local network of institutions nor a research site only for DANUBIUS-RI components; • Is a site for access by researchers, students and professionals across Europe and elsewhere; • May be the national focus for DANUBIUS research community in the host country. Supersites will provide natural laboratories for observation, research, modelling and innovation at	D3.2_final & D5.10_final

	locations of high scientific importance and opportunity, covering RS systems from river source to transitional waters and coastal seas. Ranging from the near pristine to the heavily impacted, the Supersites will be selected to provide contrasting systems across environmental, social and economic gradients that have been impacted, to varying degrees either directly or indirectly, by industrialisation, urbanisation, population expansion, land use change and farming. They will provide interdisciplinary research platforms and identify, model and define system states and conditions for naturally and anthropogenically triggered transitions in the physical, biogeochemical and biological states. They will provide excellent opportunities to undertake social and economic investigations in contrasting settings.	
Supersite Association or Partnership	Association or partnership of the Supersite Hosting Institution and other local institutions that will play a major role in the Supersite	D3.2_final
Supersite Local Consortium	Is led by the Supersite Manager and Hosting Institution, will organize, according to national rules and law, in order to support the correct and sustained implementation of the DANUBIUS-RI principles in the field, representing the “ambassadors” of the infrastructure in the field. The local governance bodies must comprise groups and committees dealing with the Technical aspects, the Scientific part, under the umbrella of a coordination group, which is responsible for the local governance.	D5.10_final
Supersite Manager	Representative for the Supersite, interface with the DANUBIUS-RI Operations Director, works closely with the Executive Team and the local governance structure at the local level.	D5.10_final
User	Individuals and institutions from academia, business, industry and public services that are granted access to DANUBIUS Components.	ERIC statutes

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Appendices

Appendix 1 – Existing ontologies related to the DANUBIUS-RI domain of discourse

The following ontologies somewhat relate, or are complementary to the DANUBIUS-RI domain of discourse (the search is not yet exhaustive and builds on the overview of Kaewboonma *et al.* 2014):

Domain	Source
Drought management information system	Kaewboonma et al. 2014
Environmental Analysis	Radojevic & Bashkin 2006
Flood management	De Wrachien *et al*. 2012
Flow and water quality	Chau 2007
Hydrographical	Lopez-Pellicer *et al.* 2007
Marine and coastal geoinformatics interoperability	Lassoued & Leadbetter 2017
Wastewater treatment plants	Cabezut-Boo and Sanchez-Aguilar 1999
Wastewater treatment processes	Ceccaroni *et al*. 2004

Appendix 2 – Abbreviations

1. Observing & analyzing

AVHRR	Advanced Very High Resolution Radiometer	D7.5_final
CMEMS	Copernicus Marine Environment Monitoring Services	D7.2_final
CML	Chemical Markup Language	D7.2_final
CMLspect	CML developed for spectral data	D7.2_final
EMBL	European Molecular Biology Laboratory	D7.2_final
EO	Earth Observation	D5.6_final
GTN-H	Global Terrestrial Network – Hydrology	D7.2_final
GTOS	Global Terrestrial Observing System	D7.2_final
ISO	International Organization for Standardization	D6.1_final
MSI	MultiSpectral Imager	D7.5_final
O&M	Observations and Measurements	D6.1_final
OGC	Open Geospatial Consortium	D6.1_final & D8.2_final
OLCI	Ocean and Land Colour Instrument	D7.5_final
QA	Quality assurance	D7.2_final
QC	Quality control	D7.2_final
RAID	Redundant Array of Independent Disks: data storage technology that combines multiple physical disk drives into a single logical storage system for the purposes of data redundancy and performance improvement.	D5.11_draft
RAS	Remote Access Service	D8.1_final
SLSTR	Sea and Land Surface Temperature Radiometer	D7.5_final
SOP	Standard Operating Procedure	D6.1_final
SOS	Sensor Observation Service	D7.4_final
WCO	Western Channel Observatory	D7.1_final
WMO	World Meteorological Organisation	D6.1_final

2. Storing & gateway providing

AAA	Authentication, Authorization and Accounting	D7.7_final
API	Application Program Interface	D7.7_final
ATC	Automatic Transfer Switch	D5.11_draft
AWS	Amazon Web Services	D7.7_final
BDC	Biodiversity Data Centre	D7.2_final
BODC	British Oceanographic Data Centre	D8.2_final
CA server	Certification Authority server: Issues and revokes digital certificates based on a certificate request and providing proof for verifying the identity of online entities. The Access manager operates and administrates the CA Server	D7.7_final
CERIF	Common European Research Infrastructure Format: An international standard for the exchange of research information, which provides a model for the development of research information systems	D6.1_final & CERIF web page
CSW	Catalogue Service for Web	D8.2_final
DAP	Data Access Protocol: a protocol designed specifically for science data	D7.7_final
DDSS	Data, Data Products, Software and Services	D6.1_final
DFN	Deutsches Forschungsnetz	D7,7_final
DODS	Distributed Oceanographic Data System	D7.7_final
DOI	Digital Object Identifier	D7.2_final
DWC	Darwin Core (TDWG standard) ABCD (Access to Biological Collections Data) and DwC are presently the most popular data exchange formats for biodiversity species data.	D7.2_final
DWDM	Dense Wavelength Division Multiplexing	D7.7_final
EGI	European Grid Infrastructure	D5.11_draft
EML	Ecological Metadata Language	D7.2_final
EOSC	European Open Science Cloud	D7.7_final & D8.12_final
FLOPS	FLoating point Operations Per Second (see also HPC).	D8.1_final

FTP	File Transfer Protocol	D7.7_final
GCOS	Global Climate Observing System	D7.2_final
GEO	Group on Earth Observations	D7.2_final
GEOSS	Global Earth Observation System of Systems	D5.17_draft
GML	Geography Markup Language	D7.2_final
GUID	Globally Unique Identifier	D7.2_final
HTTP	Hyper Text Transfer Protocol	D8.4_final & D8.14_final
HVAC	Heating, Ventilation and Air Conditioning	D5.11_draft
IaaS	Infrastructure as a Service	D7.7_final
ICT	Information and Communications Technology	D8.12_final
ID	Identifier	D7.2_final
IdPs	Identity Providers	D5.11_draft
IP	Internet Protocol	D8.4_final
ISP	Internet Service Provider	D8.4_final
LAN	Local Area Network	D7.7_final
LTP	Long-Time Preservation	D7.7_final
OASIS	Organization for the Advancement of Structured Information Standards	D7.2_final
OC-CCI	Ocean Colour Climate Change Initiative dataset	D7.5_final
OSI	Open Systems Interconnection	D7.7_final
PaaS	Platform as a Service	D7.7_final
POP	Point of Presence	D8.6_final
REDCap	Research Electronic Data Capture	D7.1_final
RPM	Rotations per minute: represent a measure of the frequency of rotation, specifically the number of rotations around a fixed axis in one minute. It is a rotation speed characteristic for hard disks with rotating motion components. The most popular RPM	D7.7_final

	values: 5.4K, 7,2K, 10K and 15K, higher values giving better performance.	
RTT	Round-trip time = The time interval required for a packet to travel from a source to a specific destination and back again. RTT is the most often used parameters in network performance measurements. The value of RTT can be influenced by: data transfer rate of the sender, the nature of the transmission media (e.g. optical fibre or wireless), the distance between two end devices, the value of hop count, the amount of traffic or bandwidth on the network that is being used, the retransmission process and the presence of interference.	D8.4_final
SAN	Storage Area Network	D7.7_final
SBML	Systems Biology Markup Language	D7.2_final
SDN	Software Defined Network	D7.7_final
SRM	Storage Resource Manager	D7.7_final
SWE	Sensor Web Enablement	D8.2_final
TCS	Taxonomic Concept transfer Schema: a standard for the exchange of taxonomic data between different taxonomic data models i.e., different data models used by different providers of taxonomic data.	D7.2_final
Tflop	Teraflop = 10^{12} flops: number of floating-point operations the computer can perform per second.	D5.11_draft
UGRID	Unstructured grid	D7.2_final
UPS	Uninterruptible Power Supplies	D5.11_draft
VPC	Virtual Private Cloud	D7.7_final
W3C	World Wide Web Consortium	D8.2_final
WCS	Web Coverage processing Service	D8.2_final
WDP	Water Data Portal	D8.2_final
WFS	Web Feature Service	D7.5_final & D8.2_final
WMS	Web Map Service	D7.4_final & D8.2_final
WPS	Web Processing Service	D8.2_final
WSDL	Web Services Description Language	D8.14_final
WWW	World Wide Web	D8.12_final

XML	Extensible Markup Language	D7.2_final & D8.14_final

3. Modelling

GIS	Geographical Information System	D7.4_final
HPC	High Performance Computing	D5.11_draft
HPLC	High Performance Liquid Chromatography	D7.1_final
HTC	High-throughput computing	D8.1_final
PRACE	Pan-European High Performance Computing infrastructure and services	D5.11_draft & D8.1_final

4. Learning together

CC	Climate Change: a mixture between natural climate variability and man-made changes	D2.1_final
CF	Climate Forecasting	D6.1_final
ECI	Early Career Investigator	D6.2_final
ECIP	Early Career Investigator Panel	D6.2_final
e-DNA	environmental DNA	D7.1_final
ERA	European Research Area	D3.1_final
ERC	European Research Council	D9.4_final
ESR	Early Stage Researcher	D9.2_final
FD	Floods Directive	EC, 2007
GARR	Gruppo per l'Armonizzazione delle Reti della Ricerca	D7.7_final
HD	Habitats Directive	EC, 1992
HEI	Higher Education Institutions	D9.3_final
ICZM	Integrated Coastal Zone Management	D2.3_final
IWRM	Integrated Water Resource Management	D2.3_final
JPI	Joint Programming Initiative	D4.2_draft
MSFD	Marine Strategy Framework Directive	EC, 2008
MSPD	Maritime Spatial Planning Directive	EC, 2014

ND	Nitrates Directive	EC, 1999
NIST	National Institute of Stands and Technology	D7.7_final
NREN	National Research and Education Network	D7.7_final & D8.12_final
OA	Open Access	D7.2_final
PI	Principle Investigator	D9.4_final
R&I	Research and Innovation	
RoEduNet	Romanian research and Education Network	D5.17_draft
RPO	Research Performing Organisations	D9.4_final
RSS	River-Sea Systems	D2.2_final
SDG	Sustainable Development Goals	UN, 2015, D2.3_final
SES	Socio-Ecological Systems	
SPM	Suspended Particulate Matter	D7.1_final
UWWTD	Urban Waste Water Treatment Directive	EC, 1991
VLab	Virtual Laboratory	D8.1_final
WFD	Water Framework Directive	EC, 2000

5. Transferring & applying

CAPEX	Capital Expenditure	D5.11_draft
CID	Contract of Indefinite Duration	D9.4_final
DCP	Dissemination and Communication Plan	D10.1_final
EIP	European Innovation Partnerships	D4.2_draft
ERCR	European Research Area Partnership for Excellence and Growth	D9.3_final
IP	Intellectual Property	D5.13_draft & D5.15_draft
IPR	Intellectual Property Rights	D5.13_draft & D5.15_draft
KT	Knowledge Transfer	D5.13_draft

TTO	Technology Transfer Office, a component of DANUBIUS-RI	D3.2_final
WIPO	World Intellectual Property Organization	D5.15_draft

DANUBIUS-RI governance related

ASP	Accredited Service Provider	D5.4_final
CBA	Cost-Benefit Analysis	D4.7
DCC	DANUBIUS Commons Committee	D6.2_final
DCD-RI	Data Centre of DANUBIUS-RI e-Infrastructure	D5.11_draft
DCIM	Data Centre Infrastructure Management	D5.11_draft
ENPV	Economic Net Present Value. Is the Difference between the discounted total social benefits and costs	D4.7
ERIC	European Research Infrastructure Consortium: a specific legal form to facilitate the establishment and operation of research infrastructures with European interest between several Member States.	D3.1_final
ESFRI	European Strategy Forum on Research Infrastructures	
ESIF	European Structural and Investment Funds	D4.7
FNPV/C or FNPV(C)	Financial Present Value of the Investment. Is the sum that results when the expected investment and operating and replacement costs of the project (discounted) are deducted from the discounted value of the expected revenues.	D4.7
FNPV/K or FNPV(K)	Financial Present Value on Capital. Is a measure of the extent to which the project's net revenues are able to repay the financial resources provided by the national funds (both private and public sources).	D4.7
HQ	Headquarters	D5.4_final
HR	Human Resources	D9.4_final
IQR	Independent Quality Review	D4.7
KPI	Key Performance Indicator	D5.6_final
MA	Managing Authority. In the context of ESIF, an authority in charge of managing an Operational Programme	D4.7

OP	Operational Programme	D4.7
OPEX	Operating Expense	D5.11_draft
PPP	Purchasing Power Parity (adjusted salaries)	D9.3_final
QMS	Quality Management System	D6.1_final
RI	Research Infrastructures	ESFRI, 2016
SLA	Service Level Agreement	ERIC statutes
SP	Service Providers	D5.11_draft
STAB	Science and Technology Advisory Board	D1.2_final_amended
TO	Thematic Objective	D4.7

DANUBIUS-PP

Preparatory Phase for the pan-European Research Infrastructure DANUBIUS–RI "The International Centre for advanced studies on river-sea systems"

European Commission

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