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Data Infrastructures in Support of Macro-Regional Development

Experiences and Lessons Learned from the Danube Region

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Title Data Infrastructures in Support of Macro-Regional Development. Experiences and Lessons Learned from the Danube Region

Abstract
The European Union Strategy for the Danube Region (EUSDR) aims to address the challenges and priorities of the region in an integrated manner, leading to concrete results and a better future for the region and its citizens. Such integration requires collaboration and the sharing of existing resources, where more accessible and easy-to-use data are key elements to achieving these aims within a knowledge society. As part of the JRC's Scientific support to the EUSDR, the Danube Reference Data and Services Infrastructure (DRDSI) pilot project was established to facilitate the exchange of open, harmonised and well-documented data to support integrated policy-making needs and provide new digital resources across the macro-region.

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Foreword

Territorial management at all levels requires informed decisions based on access to authentic and timely data and information. The creation of macro-regions offers opportunities to understand the status and connect social, economic and environmental phenomena without being restricted by political boundaries. Given shared cultural traditions and development challenges, macro-regions also provide an opportunity for a broad range of stakeholders to collaborate in sharing and using their knowledge.

Within this context, I am very pleased that in the past four years the European Commission's Joint Research Centre (JRC) has provided scientific support to the European Union Strategy for the Danube Region (EUSDR). Alongside activities exploring the region's environmental and energy concerns, one key initiative has been the creation of the Danube Reference Data and Services Infrastructure (DRDSI). This activity has built on the JRC's extensive experience in Spatial Data Infrastructures (SDI) as technical coordinator of the INSPIRE Directive and the emerging initiatives in Open Data. The DRDSI open platform contains almost 10 000 datasets and is supported by a transparent process to exchange data relevant to macro-regional development.

The rapid setup of the data infrastructure has been aided by investments already made by EU Member States in implementing the INSPIRE Directive. Lessons learned in this process have been successfully transferred to the Western Balkans, Moldova and Ukraine. This has provided a rare opportunity to bring together heterogeneous actors, technologies and objectives, thus offering capacity building and lessons for macro-regions and others in data management, knowledge generation and policy making.

Another achievement of the initiative is the creation of an extensive **network of stakeholders** keen to evolve methods, technologies and membership of the infrastructure to further support data driven innovation. This creates a new dynamic in data-sharing and technical challenges to ensure such data can be readily captured, maintained and reused. The JRC continues its activities in this area by exploring how citizens may also contribute to data infrastructures by providing their observations.

JRC is committed to continue **promoting the use of relevant data for policy making and knowledge creation**. In this spirit and considering that a large quantity of consistent and harmonized data is needed when working on macro-regions, I am pleased to present this overview of the results of the JRC support to the Danube Strategy and I hope that it will be of interest to a larger audience. I believe that the lessons learned this time will be useful for the successful implementation of the Alpine and Adriatic-Ionian Strategies.

Vladimir Šucha
Director-General

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This report is the result of a collaborative process between numerous individuals and institutions. First of all, we would like to acknowledge the work of the Danube_NET, a network of experts established by the JRC to support the ownership of the Danube Reference Data and Services Infrastructure (DRDSI) in the 14 countries of the Danube Region covered by the EU Strategy for the Danube Region (EUSDR). Without their constant and enthusiastic engagement to the promotion of the project across the Danube Region, it would not have developed to reach the mature level it has achieved. In alphabetical order, our thanks, therefore, go to: *Christine Brendle* (Umwelbundesamt Austria); *Lyubomir Filipov* (GAP Consult Ltd., Bulgaria); *Slobodanka Kljucanin* (University of Sarajevo, Bosnia and Herzegovina); *Antal Ferenc Kovács* (Century Technology Innovations L.P., Hungary); *Alla Kovalova* (State Service of Ukraine for Geodesy, Cartography & Cadastre, Ukraine); *Josip Lisjak* (City of Požega, Croatia); *Tomáš Mildorf* (University of West Bohemia, Czech Republic); *Maria Ovdii* (Agency for Land Relations and Cadastre, Moldova); *Dragica Pajic* (Republic Geodetic Authority, Serbia); *Božidar Pavićević* (Real Estate Administration, Montenegro); *Tomaž Petek,* (Surveying and Mapping Authority, Slovenia); *Florian Petrescu* (Technical University of Civil Engineering Bucharest, Romania); *Markus Seifert* (Bavarian Agency for Surveying and Geoinformation, Germany); *Martin Tuchyňa* (Slovak Environment Agency, Slovakia).

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The project was established as part of the JRC's Scientific Support to the EUSDR and our thanks go to colleagues from the JRC's headquarters, especially the keen interest and support of Professor *Miroslav Veskovic*. Our special thanks also goes to the other JRC *Nexi* for their collaboration in conferences and workshops during the course of the project and the data and User Stories they have shared through the DRDSI to the Danube region.

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Executive summary

Policy context

This JRC Science for Policy report investigates data policy and data-sharing technologies through the creation of an Open Data infrastructure for macro-regional developments of the **European Union Strategy for the Danube Region (EUSDR)**. In terms of policy, this work has advanced the objectives of the Public Sector Information Directive, the INSPIRE Directive and related policies and initiatives encouraging the better access and use of data. In particular, this has included the Open Data initiative and the related Juncker priorities of the Digital Single Market's interests for the free flow of data and interoperability.

The report illustrates the results of a three-year long project, **the Danube Reference Data and Services Infrastructure** (**DRDSI**), which has been a key aspect of the JRC's Scientific Support to the EUSDR. Its development has been, importantly, a collaborative effort with a range of stakeholders, including national experts representing all 14 Danube countries and a range of pilot partners from across the region. Their efforts and the operational and research activities of the JRC are presented in this report, offering advice to those interested in better managing data for policy, with a focus on the EUSDR. The region's maturity in data-sharing has been explored and many gaps filled but good quality, transparent, comparable and commonly understood data need to be made available in time for the next Multiannual Financial Framework so that the added-value of investments can be readily demonstrated and a sustained resource supported to further foster the region's digital economy.

This work has extended the JRC's ongoing efforts to help define and implement the INSPIRE Directive to help create a European Spatial Data Infrastructure. This has included new technologies in sharing and visualising Open Data, exploring themes beyond the environment such as cultural heritage and the role of new data sources, especially those created by citizens to support decision-making. Importantly, the DRDSI has demonstrated the benefits INSPIRE brings to public administrations when new data-sharing activities need to be implemented and how capacity can be built with countries of the neighbourhood to also actively contribute to macro-regional decision-making and research.

Its findings are timely, where the EUSDR and other macro-regional strategies can benefit from a reusable approach and technology at different levels of government. These findings should also be of interest to other cross-border and multi-sector policies in Europe, as they can help more relevant information to be shared and new networks to be formed. This can both benefit the development of a true European digital economy and act as a transformative force to help modernise the public sector to be more open, transparent, collaborative and, therefore, valued by Europe's citizens.

Key conclusions

Data are crucial for macro-regional strategies as a means to support policy-making, as a shared asset to support economic growth and as a cultural artefact for the region's citizens. Data are needed to understand the status of the region at different stages of the policy cycle and to ensure that investments are targeted where needed. Countries in the region face similar challenges, for data-sharing but also the topics data can help address.

The findings of the DRDSI project also offer advice for the region, especially in terms of a need for increased coordination in key data flows and a need to rapidly mature common data policies. There is also a need to sustain the capacity building and networking activity that the DRDSI has successfully initiated, with good political backing and scope for training activities with actors across the region so that, for example, its data platform can be widely adopted and extended.

Main findings

The DRDSI has shown how the principles of the INSPIRE Directive can be put in practice, re-purposing them from their core environmental focus to broader concerns of data-sharing for regional policy and collaboration. In particular, it has focused on supporting the collection and management of data resources at a local level, where they are best understood and maintained. Similarly, data standards have been explored and examples given for how data can be combined. This has included offering open tools to overlay datasets from different sources through the DRDSI platform and promoting Open Data as a means to make data a source for innovation without impediment. The launching of pilots has brought data together across borders into a common and comparable frame, in turn powering a range of applications associated with the EUSDR's Priority Areas (PA).

Related and future JRC work

The research and operational activities of the DRDSI have drawn on and contributed further to other work of the JRC. In particular, the JRC's own Open Data initiative has been a key partner alongside the content provided by other Danube *Nexi* projects. New methods and technologies have been used. Several activities have also addressed technical and organisational issues aligned with the reuse of interoperability solutions between public administrations. All these activities are helping to shape ongoing work in the JRC in data-sharing for citizens, businesses and government and it is hoped that DRDSI's evidence can further support EUSDR and other regional policies.

Quick guide

Data is not a neutral entity, it is an asset that needs to be valued and well-managed at all levels to make better decisions and stimulate innovation and economic growth. Sharing data is not a trivial activity. It requires a broad understanding of social, organisational and technical issues and the application of the appropriate standards, technologies and supporting approaches in varied cultural and socio-organisational contexts. This means work often focuses less on technology and more on fostering collaboration, raising awareness and building capacity with key partners.

Over the last twenty years, the steady implementation of multi-organisational, cross-sector and cross-border Spatial Data Infrastructures has been offering collective action and collaboration for tangible and reusable outcomes. European activities add an important means to increase the comparability of data and to share best practices. The emergence of Open Data initiatives has helped to further raise the profile of geospatial data and the efforts of the DRDSI have involved creating operational pilots to show its opportunities, in general, at the potential it offers to the EUSDR and Danube region.

1. Introduction

The Danube Reference Data and Services Infrastructure (DRDSI)[1] is helping to create a data-sharing infrastructure in support of the EU Strategy for the Danube Region (EUSDR)[2]. Launched in June 2011 (Figure 1), the EUSDR aims to boost the development of the Danube Region. The macro-regional strategy relies on an integrated approach to encourage better policy development and the alignment of funding and resources through concrete actions and projects, resulting in a more efficient and better-balanced implementation of the EU's overall objectives under Europe 2020.

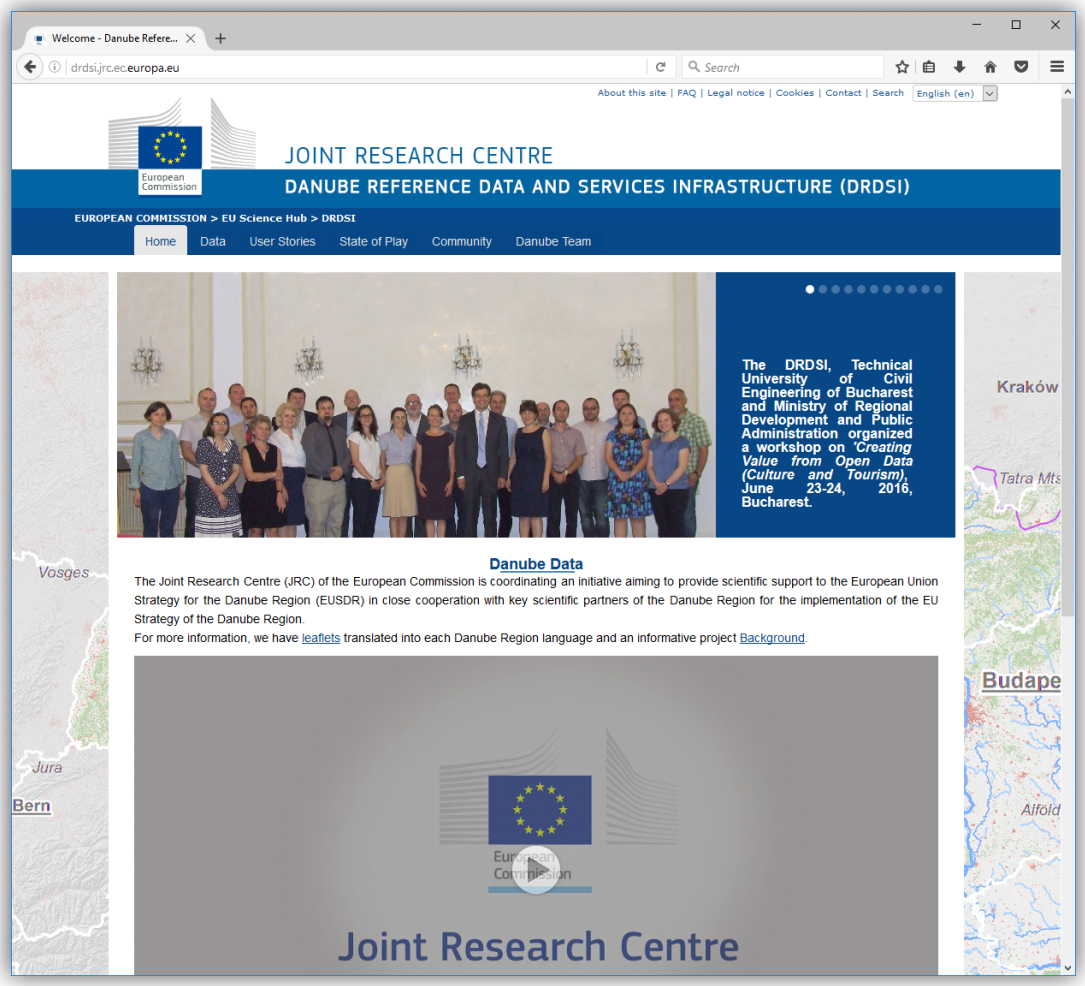

Figure 1 Home page of the DRDSI

For the DRDSI, this involves both supporting the creation and evolution of an **Open Data platform** and the organisational context of stakeholders in the region to populate and use the platform. Since 2014, a series of activities were initiated to help develop the open source platform and fill it with initial content from the Danube region. A key feature has been the creation of an Open Data catalogue that is, in itself, already a useful

[1] http://drdsi.jrc.ec.europa.eu

[2] http://www.danube-region.eu

product of the DRDSI project, covering over 9,000 datasets originating from research projects, the work of other JRC *Nexi* supporting the EUSDR, accessing the official records created under Open Data and INSPIRE initiatives and data sources from the EC and other international initiatives.

A great deal of this work has been supported by the **Danube_NET**, a group of experts working in the Danube Region with the DRDSI to identifying stakeholders organisations and provided the initial metadata records that point to the datasets the platform is now accessing. As the data flows from Danube_NET, the Nexi and other partners are becoming more mature, the work of the DRDSI has started to explore what other content could potentially be shared through the platform.

From the work with the Danube_NET, in particular, it became clear that a series of pilots was needed to build capacity and demonstrate how data harmonisation activities could be built on and contribute to the DRDSI. Already, the **INSPIRE Directive** (2007/2/EC)[3] provides an approach to spatial data harmonisation and a policy context to help harmonise data and underlying data-sharing services for a large range of topics.

The approach of the DRDSI project, therefore, has been to demonstrate how INSPIRE be applied to further strengthen the data infrastructure the project is creating. Supported by evidence from the Danube_NET it also became clear in setting up the pilots that full data harmonisation across the region would not be possible in the lifetime of the project, in part due to limitations caused by only emerging data policies and by the implications of legacy systems in many cases. The pilots, therefore, aim to develop products, services and content for access through the DRDSI Platform that promote INSPIRE and Open Data concepts while building capacity in particular countries in these topics.

This work has also been supported by a series of workshops with Danube_NET members and other stakeholders in the region, including a concept-based meeting in mid-2015 that explored how sharing spatial data can contribute to sustainable growth in the region.

This report aims to **report on the experience of developing a data infrastructure for macro-regional development**. From the outset, this work can be seen as interdisciplinary as it brings together domains such as Information and Communication Technologies (ICT), the specific approaches in sharing geospatial data related to the INSPIRE Directive, territorial management and planning at a relatively small scale, alongside the thematic areas of the EUSDR such as environmental protection, water management, energy resources and economic development.

Given this broad view, the report mainly focusses on lessons for the continued development of such work in the EUSDR with a view to offering incites for those implementing and managing other macro-regions or looking to share data across several countries for specific policy and organisational objectives. The report is, therefore, mainly aimed at a non-technical audience but, given the nature of the work, sometimes technical approaches need to be explained and, wherever possible, key references have been included to guide the reader to further details.

[3] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32007L0002

2 Policy and research context

2.1 Policy context

Adopted by the EC in December 2010[4] and the European Council in 2011, the EUSDR was jointly developed by the EC, in particular under the leadership of Directorate-General for Regional and Urban Policy (DG REGIO), and the Danube Region countries and other stakeholders to address common challenges. The macro-regional development concept was developed as it was recognised that the variation across EU Member States and their 271 regions meant that policy interventions could not rely on a 'one-size-fits-all' approach and that focussing on parts of Europe could lead to improved policy implementation and development.

An important aspect of this work is that it should increase synergies and coordination that build on existing policies, initiatives and funding, including the activities supporting the EU's cohesion policy, with an aim to increase synergies, coordination and cooperation within the Danube Region. From the outset, this driver of cooperation and the idea to build on existing initiatives implied a need to start from what INSPIRE would have to offer the DRDSI, rather than start a new initiative in data-sharing for the region.

The EUSDR covers both EU Member States and neighbouring countries (Table 1), namely:

Table 1. Countries of the EUSDR

European Union	Non-EU
• Austria • Bulgaria • Croatia • Czech Republic • Germany[5] • Hungary • Romania • Slovakia • Slovenia	• Bosnia and Herzegovina • Moldova • Montenegro • Serbia • Ukraine[6]

The EUSDR is the second macro-regional strategy created in Europe, following the creation of the EU Strategy for the Baltic Sea Region, and now precedes the creation of the European Union Strategy for the Adriatic and Ionian Region (EUSAIR[7]) and the European Union Strategy for the Alpine Region (EUSALP[8]). Countries can belong to more than one strategy, where Slovenia is in the exceptional case of belonging to the EUSDR, EUSAIR and EUSALP. In creating and implementing the DRDSI it is possible to see an approach and technical solutions that can be replicated across strategies.

[4] COM(2010) 715: http://eur-lex.europa.eu/procedure/EN/199962

[5] Baden-Württemberg and Bavaria.

[6] Oblasts of Chernivtsi, Ivano-Frankivsk, Odessa and Zakarpattia.

[7] http://www.adriatic-ionian.eu

[8] http://www.alpine-region.eu

Moreover, it can be argued that when countries belong to more than one macro-regional strategy their data-sharing approach should be similar if not identical for all, ensuring resources are used well and data readily shared and reused across borders. This may call for increased coordination between strategies and more work would be needed to ensure that the Strategies, Action Plans and related documents highlighting key concerns would, indeed, require access to comparable (geospatial) data.

The territory of the EUSDR is the largest of these macro-regional strategies (Figure 2), including a population of some 120 million citizens. It also faces economic issues, where the average Gross Domestic Product (GDP) per capita is around two-thirds of the level of the EU 28 Member States and less than 60% of the level of the Organisation for Economic Co-operation and Development (OECD) countries[9].

Figure 2 Danube River Basin and countries of the EUSDR[10]

To tackle key challenges in mobility, energy, environment, risks, socio-economic disparities and security/crime issues, the EUSDR is organised into **four pillars with 11 main Priority Areas** (Figure 3).

Nearly all these topics can be seen to have a geographical representation, in other words data related to them can be presented on a map. Within the context of territorial management, across borders or at the national or macro-regional scale, geospatial data can form a fundamental building block to understanding the current and past status of phenomena and a means to observe/analyse where interventions/resources may best be targeted.

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[9] Ulm statement http://www.danube-region.eu/attachments/article/616534/Joint%20Statement%2029.10.2015_adopted.pdf

[10] (© EuroGeographics for the administrative boundaries and topographic features; © OpenStreetMap contributors; European Environment Agency; © Copernicus Land Service; EMODnet Bathymetry Consortium (2016). EMODnet Digital Bathymetry (DTM). EMODnet Bathymetry http://doi.org/10.12770/c7b53704-999d-4721-b1a3-04ec60c87238)

Much of this data already exists through research activities and, more importantly, in the public sector thanks to environmental and other policies requiring data to be shared, as well as a key driver from the reuse of Public Sector Information (PSI) Directive (2013/37/EU, revised[11]), and recent emphasis of the role of Open Data, where geospatial data is recognised as having particular value.

INSPIRE, as a support to environmental policies in Europe, covers many of the environmental aspects that the EUSDR is interested in and as its scope also includes other factors such as population distribution, transport and environmental risks, it also offers potential for application to other areas handling geospatial data within the scope of the EUSDR as well as forming the foundation to create geospatial data by combining it with other sources in the common foundation and principles that INSPIRE offers.

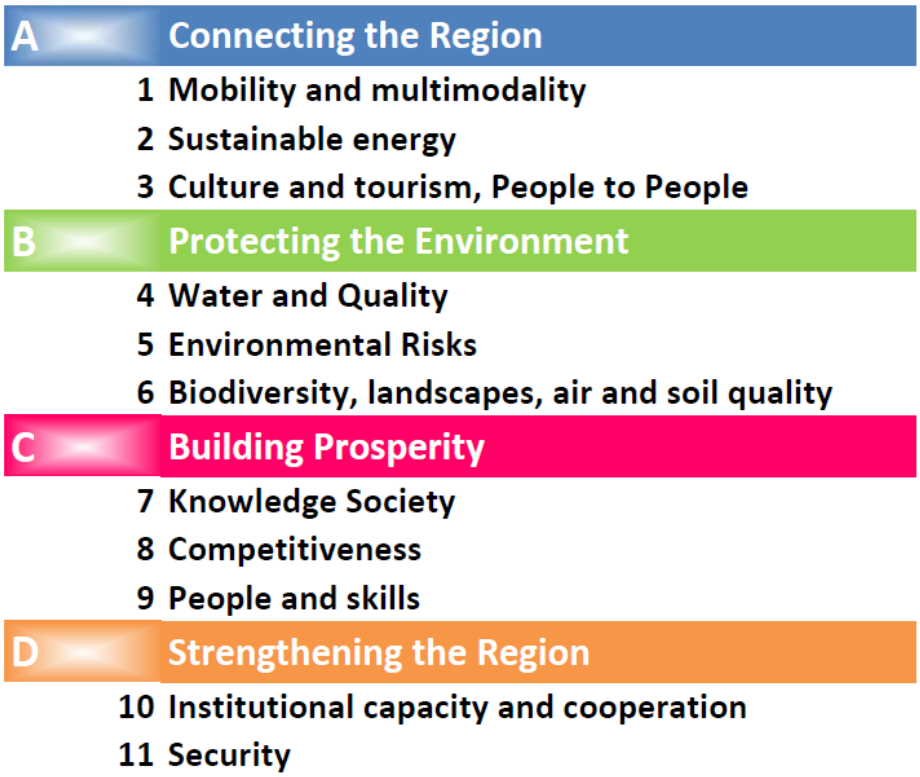

Figure 3 EUSDR Priority Areas

In addition, given its mainly technical focus, the work of the DRDSI was linked to Priority Area 7: Knowledge Society[12].

2.2 Research context

Following earlier commitments, the **JRC's Scientific Support to the Danube Strategy initiative**[13] started in 2013, with an aim to provide an integrated approach between the JRC and its scientific partners to gather essential scientific expertise and data to help

[11] https://ec.europa.eu/digital-single-market/en/european-legislation-reuse-public-sector-information
[12] http://groupspaces.com/KnowledgeSociety/
[13] https://ec.europa.eu/jrc/en/research/crosscutting-activities/danube-strategy

decision-makers and other stakeholders in the Danube region to identify policy measures and actions to support EUSDR implementation. The activities of the JRC also aimed to reinforce ties and cooperation amongst the scientific community of the region.

The JRC was well-placed to do this work because, as well as being the in-house science service of the EC, its activities involve a broad and cross-cutting view on the scientific challenges related to the Priority Areas. In addition, the support would foster cooperation, including the building of scientific research networks that would help transfer knowledge from the highest to the lowest performing countries and stimulate scientific excellence that would lead to increased innovation capacity and economic competitiveness. Although DRDSI is in some senses an operational pilot, the work has focussed on this capacity building and knowledge transfer objectives.

The support involved the creation of seven flagship clusters/projects and activities in key areas, known as ***nexi***. Four of these projects had a thematic focus involving one or more of the Priority Areas, namely the Danube Water Nexus, the Danube Land and Soil Nexus, Danube Air Nexus and the Danube Bioenergy Nexus. With support from the JRC's Open Data project (and metadata catalogue), the DRDSI helped these projects to share their research data with others in the region through the DRDSI platform. This resulted in data from the Danube Water Nexus being used by the International Commission for the Protection of the Danube River (ICPDR) [14] for their Danube River Basin District Management Plan 2015 update, which is presented in the platform[15].

The remaining three projects were cross-cutting and involved the DRDSI, Danube Innovation Partnership and Smart Specialisation. The aim of each nexus was to help join forces within the Danube region to develop common end products. The DRDSI aimed to do this both by creating an open and shared data catalogue and through the creation of exemplary services and products that could be extended and reused to further develop the data infrastructure. More specifically in terms of research objectives, the DRDSI has involved a combination of both research and practical development of a data infrastructure, with a view to gathering lessons on implementation for their potential application in other contexts, especially other macro-regions.

The key aims of the DRDSI project, therefore, were to:

- create an **Open Data platform** based, to a large extent, on Open Data INSPIRE principles that would meet the data needs of the EUSDR, in particular by gathering and visualising (including geographically) metadata from the region with the opportunity to download data wherever possible;
- **ensure that the platform could be redeployed** and sustained after the project (hence its construction using open source technologies);
- **foster collaboration between key stakeholders** in the Danube region that could provide content for the platform's catalogue, while exploring approaches that could be replicated in other macro-regions;
- **foster collaboration with JRC *nexi*** projects to ensure that their data could be made available to researchers and public sector practitioners in the Danube region;
- **help implement INSPIRE** by (i) sharing experience between Member States and build capacity in neighbouring countries (including accession countries) and

[14] https://www.icpdr.org/main

[15] http://drdsi.jrc.ec.europa.eu/user-story/danube-river-basin-district-management-plan

(ii) reuse key aspects of it in the data infrastructure such as technologies to help create data services and provide examples of harmonised data across borders;

- collect, build-on and reuse in **practice data from existing projects** and initiatives related to the region, including cross-border and European-funded projects;
- help build **relationships at the public sector:research:business interface** to explore data-sharing and data reuse topics;
- **summarise this collective experience** for the EUSDR and potentially other macro-regions.

3 Data policy initiatives

The ability to access and reuse data is not only a technical activity but also a concern of policy. This includes a range of legal acts dealing with data protection and how personal information are handled, the right to request information from government (especially for environmental issues) and the push to create a digital economy from the reuse of Public Sector Information.

In this section, we mainly focus on the latter, as it is the PSI Directive, work on Open Data and the INSPIRE Directive which provide the most important policies across Europe today regarding data reuse. The challenge for macro-regional strategies is that data policy is highly varied across Europe in terms of its maturity both between Member States and between those countries outside the EU. It is likely that great efforts will be needed to help clarify policy for both practitioners aiming to share data and for data consumers able to handle and reuse data within the requirements of legal frameworks.

Moreover, the Danube region is providing examples where no data policy for data access and reuse seems to be in place, both hampering the sharing of data between organisations with a stake in the EUSDR and for any potential to use data assets as part of a digital economy. The remainder of this section explores these issues in more detail with a view to the further development of regional and national data infrastructures and economies based on data-sharing.

Image 1 Wind turbines around Vienna © Jean Dusart

There are several European policies that affect how public data and information should be shared, with many stemming from an environmental policy context. Firstly, Directive 2003/4/EC on public access to environmental information (repealing Directive 90/313/EEC), which set out some of the principles for non-governmental actors to request access to data about the environment at reasonable cost. For almost 25 years,

this policy has been enabling people to make requests for information from public bodies in the context of understanding who polluters can be and where developments impacting on the environment are taking place. More over the 1998 United Nations Economic Commission for Europe (UNECE) Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters establishes rights for citizens to not only gain access to environmental information but also to participate in decision-making about the environment that affects them. This convention can be seen to follow the principles of sustainable development, including policy areas such as (Local) Agenda 21 where citizen participation is seen as essential to achieving sustainability goals.

Information society policies are another major stream of activity relating to data-sharing. Over the past several years under Europe 2020, the Digital Agenda for Europe (DAE) set out seven pillars, all of which are relevant to data-sharing:

- Pillar I: Digital Single Market (DSM)
- Pillar II: Interoperability & Standards
- Pillar III: Trust & Security
- Pillar IV: Fast and ultra-fast Internet access
- Pillar V: Research and innovation
- Pillar VI: Enhancing digital literacy, skills and inclusion
- Pillar VII: ICT-enabled benefits for EU society

The first two of these pillars are particularly notable as they set in place key data-sharing policies in Europe and some of the technical developments this requires. Key DAE actions include Action 27, where Member States agree to implement Malmö and Granada declarations supporting cross-border e-government (relating to Pillar II); and Action 3, aiming to open up public data resources for re-use and Action 107, which involves proposals to strengthen the data industry in Europe, and thus create a data market (relating to Pillar I).

Specifically, in terms of interoperability, the EU Programme on Interoperability Solutions for European Public Administrations (ISA) has been putting in place the tools, frameworks and support mechanisms to enable cross-border e-government in a number of service delivery and public administration tasks. This includes work in the JRC to support geospatial data-sharing through *A Reusable INSPIRE Reference Platform* (ARE3NA, Action 1.17) and *the European Union Location Framework* (EULF, Action 2.13). The launch in 2016 of the follow-on ISA[2] Programme will see key policy areas such as Better Regulation and the DSM addressed in more detail. From these broader policies and programmes there are also specific policies and initiatives for data sharing and reuse.

The PSI Directive 2013/27/EU outlines how data and information in public administrations should be seen as an essential contribution to the DSM and the modernisation of public services. Key to this policy effort is the limited charging that should be made on making such information available to a brought set of stakeholders for reuse. New guidelines on licensing released in July 2014 should help to make more information available[16], where special attention may need to be paid to the needs of

[16] https://ec.europa.eu/digital-single-market/en/news/commission-notice-guidelines-recommended-standard-licences-datasets-and-charging-re-use

geospatial data in this context, given potential restrictions on information reuse in different sectors and the licencing issues present when someone combines data from sources with different licencing constraints. The issue of data licensing should be addressed in the national data policies.

Moreover, the emergence of Open Data in this context helps to reinforce the importance of making data available with only a small set of necessary controls. The last couple of years have seen the emergence of national/regional and thematic Open Data portals. This has included efforts to make EU institutions data available as Open Data through the EU Open Data Portal and further steps to help share content from national portals to a European platform through the Pan-EU Open Data Portal. Within the Open Data setting, geospatial data can be seen to play a leading role. The PSI *Guidelines on recommended standard licences, datasets and charging for the reuse of documents* has outlined that there are particular datasets "in highest demand from re-users across the EU" (ref*), where the top five items are:

1. Geospatial data
2. Earth observation and environment
3. Transport data
4. Statistics
5. Companies

Within this context, the importance of how to share geospatial data has also been acknowledged, where the EU implementation of the G8 Open Data Charter (published in October 2013) also outlines similar examples. It can be seen that the top four of the above list are of particular interest to macro-regional strategies in their planning, execution and monitoring. It is also worth noting that the United Nations Initiative on Global Geospatial Information Management (UNGGIM), especially in Europe, is also exploring how such data can be better shared, especially geospatial and statistical data, and that data coming from European-funded research activities should be more open, for both data and research publications, including the results from Horizon 2020 projects.

As well as policies which mainly apply to Member States, there are also policies relevant to the European institutions. These include the Charter of Fundamental Rights of the EU, Treaty on the functioning of the EU & Regulation (EC) No 1049/2001 for European Parliament (EP), Council and EC right of access to documents of the institutions, bodies, offices and agencies of the Union (whatever their medium) which mean that information held by, for example, the EC should be made available to interested parties. In addition, the revision to Decision 2011/833/EU governing re-use of Commission's documents takes a broad view of what content should be in scope, including data produced by EC-led research. This policy has implications for how JRC outputs must be made widely available for reuse and the importance of addressing any limitations created by the requirements of input data to JRC's analyses.

Moreover, the strategic use of data, information and knowledge is becoming a significant part of modernising the EC by improving collaboration/synergies (and reducing silos), alongside considering how they are gathered, managed, shared and preserved. A new Communication (C(2016) 6626 final) has been approved which will provide a governance framework and four main areas for action:

1. Improving information retrieval and delivery

2. Maximising use of data for better policy-making
3. Working together and sharing information and knowledge
4. Creating a culture of knowledge sharing and learning

While the first two actions could be seen to have a more technical dimension, the last two focus on work practices related to data, information and knowledge. Information retrieval foresees searching across systems and can be, therefore, linked to issues of interoperability and, in particular, the need to adopt standards for corporate data and metadata management. Better policy-making will come through the improved use of data, for example for impact assessments or policy monitoring. Challenges may occur in a number of areas, including Intellectual Property Rights (IPR) issues of data from third parties, data quality and trend detection through Big Data analytics (with further development of the 'Data4Policy' initiative).

The use of INSPIRE in data-sharing and e-reporting is also highlighted, as well as the need to share data in open formats and make outputs available through the EC Open Data portal. Working together will require knowledge-sharing and collaboration across activities, including reviews of business processes or collaborative tools and the development of knowledge and competence centres, extending work already underway in the JRC.

Changing the way people work and the organisational culture is recognised as a major challenge but with the ambition to support knowledge sharing and creative policy work across organisational boundaries at unit, directorate and DG levels. This will be addressed through skills development, promotion of the appropriate values and behaviours for data, information and knowledge sharing, the exchange of best practices in thematic areas and professional networks, establishing relevant job profiles in this context and support to offline activities that help to achieve better policy design across the organisation.

Lastly, the foreseen governance framework will aim to allow tailoring to Directorate-General's (DG) specific needs while helping to reach common objectives. In particular, the Communication foresees the creation of a Data, Information and Knowledge Management Steering Board and Information Management Team to help avoid data/information/knowledge duplication, overlaps and inconsistencies across the Commission.

4 Data infrastructures in the Danube Region

4.1 Open Data developments

At the end of 2015, Open Knowledge published the Global Open Data Index (GODI) 2015, which includes details on Open Data developments for most countries in the world. The creation of this dataset allows the DRDSI to take stock of progress in Open Data and contrast the region's level of development and capacity to respond to the needs of the EUSDR. Although some useful results are available, missing data in several countries means that an assessment can only be partial.

This section of the report aims to benchmark progress in Open Data in the Danube region and provide comparisons between the countries and how such liberal data policies could both support data coming from the EUSDR and how, in turn, this could involve spatial data identified in the INSPIRE Directive.

Image 2 The Danube River in Bratislava © Dragica Pajic

The remainder of this section, therefore, provides some further details about Open Knowledge and their views on Open Data, before briefly outlining EU policy approaches to Open Data and geospatial data-sharing relevant to the EUSDR (Section 4.1.1). Specifically, this includes mappings (See Annexes I and II) between GODI data themes, the EUSDR Priority Areas and the INSPIRE Directive Annex themes to show the range of data that may be sought to support these three initiatives. It covers a brief benchmarking analysis of the EUSDR countries, reflecting on results from 2013-2015

(Section 4.1.2), before making recommendations on how this information could be useful to the DRDSI project and EUSDR stakeholders (Section 4.1.3).

4.1.1 Open Knowledge, EU Open Data and the GODI

Open Knowledge is a worldwide non-profit network aiming to increase the availability of Open Data and its use to create and share knowledge. According to their website[17] is also now the term being used to define what Open Data becomes when it is "useful, usable and used" and covers the following three main aspects:

- Availability and access: the data must be available as a whole and at no more than a reasonable reproduction cost, preferably by downloading over the internet. The data must also be available in a convenient and modifiable form.
- Reuse and redistribution: the data must be provided under terms that permit reuse and redistribution including the intermixing with other datasets. The data must be machine-readable.
- Universal participation: everyone must be able to use, reuse and redistribute — there should be no discrimination against fields of endeavour or against persons or groups. For example, 'non-commercial' restrictions that would prevent 'commercial' use, or restrictions of use for certain purposes (e.g. only in education), are not allowed.

It should also be noted that the priorities of Open Data were promoted by the EU through the DAE's Action 3 on opening up public data resources for reuse, in line with the update of the PSI Directive (2003/98/EC) and in June 2013 when the EU endorsed the G8 Open Data Charter[18], with the following six EU commitments:

1. Identifying and making available core datasets held at EU level;
2. Identifying and making available high value datasets held at EU level;
3. Publishing data on the EU Open Data portal;
4. Promoting the application of the principles of the G8 Open Data Charter in all 28 EU Member States through the revised PSI Directive and guidelines to Member States;
5. Supporting activities, outreach, consultation and engagement;
6. Sharing experiences of work in the area of Open Data.

This report provides a small contribution to the last point from the point of view of the DRDSI project. In July 2014, the EC produced "Guidelines on recommended standard licences, datasets and charging for the reuse of documents" (2014/C 240/01)[19]. Within the Notice it prioritised the following datasets that are "*in highest demand from re-users across the EU*": Geospatial data, Earth observation and environment, Transport data, Statistics, Companies. All except the last example are of interest to the DRDSI.

With this context in mind, we can explore the GODI and the 12 data themes that it relates to government activities. We have separated this into two tables to show the possible relationships of the GODI themes to the EUSDR Priority Areas and the themes of

[17] http://okfn.org/opendata/

[18] http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=3489

[19] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.240.01.0001.01.ENG

the INSPIRE Directive (2007/2/EC[20]). Table 1 focuses on the broader 1. Location Datasets and 2. National Map GODI themes, which can include both specific geospatial data and broad geospatial 'reference data', that allows other information to be mapped and analysed in tools such as a Geographical Information System (GIS, see Annex I). Five of the priority areas do not have a direct relationship to INSPIRE but the reference data it contains may relate to the National Map mentioned and these are also included. Table 2 addresses the other GODI themes, including some that already appear in Table 1 (See Annex II).

The GODI also measures Open Data coming from the following areas which are felt to be less relevant to the EUSDR and INSPIRE, and hence the DRDSI: Government Budget, Procurement Tenders, Election Results, Company Register, Government Spending.

Importantly, the GODI scores for each country are likely to be impacted on the weighting of these other measures and the information below may not reflect the ability of a country to readily provide EUSDR-relevant data, as analysed above. The following section discusses the current status of the Danube countries in terms of the GODI data.

4.1.2 GODI Results in Danube Countries

The 2015 GODI dataset covers nearly all countries in Europe, where only Estonia is missing from the EU Member States and only Montenegro is missing from the EUSDR countries. Of the 149 countries measured by the Index, Taiwan is ranked first globally, with a score of 78. In terms of Europe as a continent covering 44 reporting countries, the United Kingdom is ranked second globally and, therefore, also leads the Member States with a score of 76. For the nine EUSDR Member States, Romania has the highest score of 58, ranking 13 globally, followed by Bulgaria which ranks 16th globally. Moldova leads the 5 non-EU countries in the EUSDR, with a score of 51 and a global rank of 22. Overall, most of the Danube countries are performing relatively well in the GODI but the 2015 figures have not been reported for Bosnia and Herzegovina, Croatia, Hungary, Serbia and Slovenia. This can be contrasted with data from previous years that are of interest, given the EU's policies, mentioned above.

The variations in development can be seen from the following graph (Figure 4).

[20] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32007L0002&from=EN

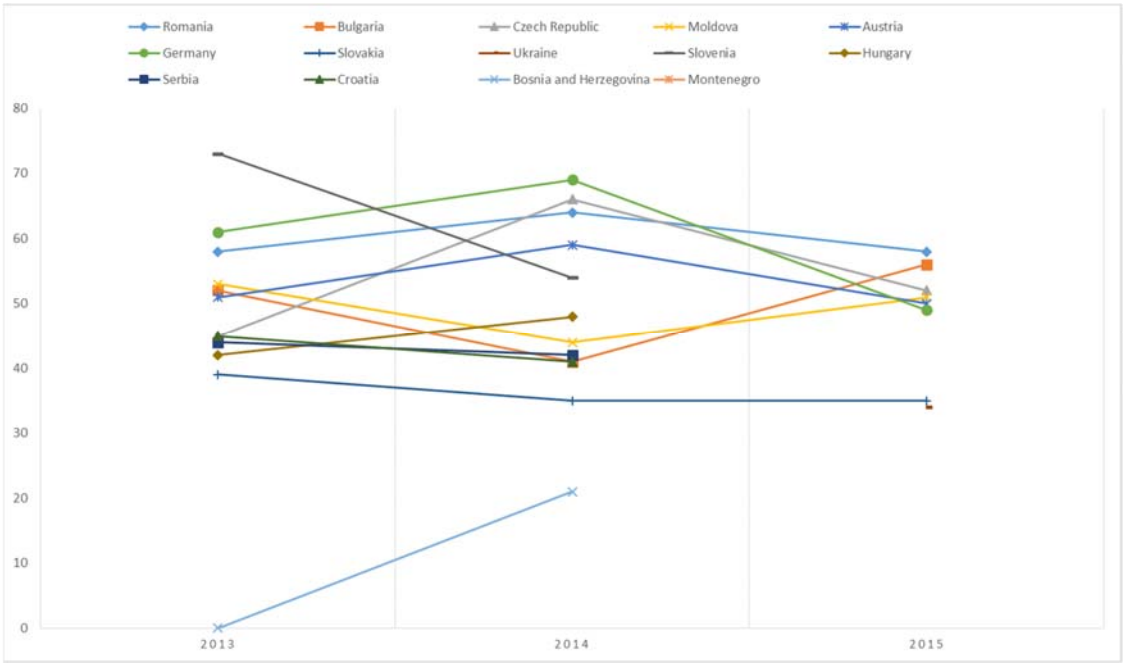

Figure 4 GODI Scores in EUSDR Countries 2013-2015

Assuming that the measurements have not changed over the three years (2013 - 2015), there may be some variations shown in the graph worth exploring.

Ukraine (34) reported for the first time in 2015, with a global ranking of 54.

For the countries with missing data in 2015, Bosnia and Herzegovina (from 0 to 21) and Hungary (42 to 48) were seeing some progress between 2013 and 2014. There was also a notable decline in Slovenia (73 to 54) and small decrease for Serbia (44 to 42) and Croatia (45 to 41).

For the countries reporting across the three years four had made progress in 2014 but then seen some decline. This included Romania (58, 64, 58), which leads the region as a whole in 2015 and Germany (61, 69, 49), although this data reflects the whole country and not only the two EUSDR German states (Bavaria and Baden Württemberg). One of the greatest variations was in the Czech Republic (45, 66, 52), which started from a relatively low base, whereas Austria (51, 59, 50) saw less change although some decline in the last year and Slovakia (39, 35, 35) has remained fairly constant. In contrast other countries saw some decline and have improved in the last year. Moldova (53, 44, 51) leads the non-EU countries and saw some change, whereas Bulgaria (52, 41, 56) saw a relatively large drop in 2014.

Image 3 Confluence of the Morava and the Danube © Jean Dusart

Moreover, the 2015 scores also show that Romania, Bulgaria and the Czech Republic are above the global average (27.3) and Moldova, Austria and Germany join them with scores above the EU28 average (38.78). An anomaly in these scores is Slovakia, which is slightly below the EU28 average but which has organised events to use Open Data, including a hackathon [21] using data from the DRDSI platform, resulting in the development of an app and a value-added pilot for the DRDSI project (See Section 7.3.3).

4.1.3 Relationships between Open Data, the EUSDR and INSPIRE

The DRDSI provides an opportunity to explore the relationships between Open Data, the EUSDR and INSPIRE. The mapping between the GODI target themes and the EUSDR's Priority Areas helps to show how Open Data can support policy. The subsequent mapping to INSPIRE then both shows how a Spatial Data Infrastructure (SDI) can both support the policy interests of the EUSDR as well as the sorts of data that could be in scope for the GODI. This is clearly a lot of information held by public administrations and the scope of the G8 Open Data Charter and the EC's reuse of documents guidelines both highlight spatial data as a target for Open Data.

In addition, the reference data that public administrations produce can be combined to form new information products that could support policies and projects, as found in the EUSDR. These include the important and broad topics of statistical data, where examples are emerging in Open Data catalogues, as well as being of interest to INSPIRE's statistical units theme and the efforts of international activities such as UNGGIM and

[21] http://2015.danubehack.eu/

technical and standards developments associated with, for example, the Open Geospatial Consortium (OGC) Table Joining Service (TJS).

Another important element that should be noted in this context, therefore, is not only the ability to share such data for the purposes of geostatistical analyses through GIS but also the opportunity to create Open Data that can be reused in a number of technologies, including the developments being made in semantic interoperability and the creation of Linked (Open) Data, allowing information to be associated and reused for multiple purposes. Opening up access to data online in standardised ways and creating liberal data policies to allow data to be fully exploited for policy, research and business needs is a desired outcome of Open Data and INSPIRE can help ensure that the content of datasets is semantically rich and well packaged for end users.

Within the specific context of the DRDSI project, Open Data and INSPIRE are two key topics that the project aims to raise awareness about in the Danube region and with EUSDR stakeholders. The topic has already been presented to workshop participants and the project's experts in Serbia in November 2014 but the emergence and potential of longitudinal data has motivated the creation of this report to explore benchmarking progress. Based on this initial information some recommendations can be made.

1 EUSDR structures need to be made aware of the potential of Open Data and assess if it is relevant to the objectives of the Strategy and validate the mappings provided in this reports annexes.
2 EUSDR structures should explore the extent to which (open) geospatial data can specifically aid their objectives, including the data being made available through INSPIRE (and in turn identifiable as metadata through the DRDSI platform)
3 Given the broad scope, EUSDR structures should set some priorities of the INSPIRE data they would need to support their tasks and initiate discussions with INSPIRE data holders to understand what data policies are in place, which data may be readily accessed and if any of this data is or can be used and reused as Open Data.
4 Ideally knowing where data priorities lie, the DRDSI projects national experts, Danube_NET (Annex III), can be further involved in raising awareness about INSPIRE and Open Data in the EUSDR countries and support discussions in how core/reference datasets can be shared through the DRDSI platform and other portals. This identification of scope will ensure that the current resources being made available by the JRC can be targeted to fit users' needs and for more sustainable data-sharing arrangements to be established once the project finishes.
5 Lastly, in terms of benchmarking, if the data could be gathered it would be useful to repeat the methodology adopted by Open Knowledge to fill the gaps in the 2015 data to aid a full benchmark of Open Data scores in the EUSDR counties. It may, however be more important to encourage those who have provided data in the past to continue to contribute to this initiative.

4.2 Spatial Data Infrastructures

A **Spatial Data Infrastructure** (SDI) is defined as a framework of policies, institutional arrangements, technologies, data, and human resources that enables the sharing and effective usage of spatial information by standardizing formats and protocols for access and interoperability. An SDI allows information to be integrated from a variety of disciplines for a variety of uses. Building an SDI means establishing a common framework or language for sharing spatial information (Masser and Crompvoets 2015).

Image 4 The Iron Gates gorge on the Danube River © Brooke Tapsall

The Global Spatial Data Infrastructure Association (GSDI) defines an SDI as spatial data and attributes, sufficient documentation (metadata), a means to discover, visualize and evaluate the data (catalogue and Web mapping), and methods to provide access to spatial data (Nebert, 2004). Beyond this are additional services or software to support applications on data. Typical components of an SDI are data, metadata, services, and organisational agreements and measures needed to coordinate and administer it on different levels (individual, corporate, local, national, regional and global). In an ideal case, these levels are interconnected, accommodating each other's relevant components (Tóth *et al*. 2012).

There are many SDI initiatives around the world developing on different levels and with different background. Their aim is to create an environment in which all stakeholders (producers and users) can cooperate with each other and interact with technology, to better achieve their spatial data objectives at different levels. Some of them are legally binding (e.g. INSPIRE and National SDIs) while others are not and are usually driven by private sectors and/or particular projects. The best examples are maybe Google and Microsoft in developing global SDIs (i.e. Google maps and Bing maps). Very strong movements in last decade is coming from citizens or better to say volunteers trying to develop open SDIs (e.g. OpenStreetMap[22]).

4.3 INSPIRE Implementations

INSPIRE is a prominent example of a legally enforced infrastructure. Through the Directive for the establishment of an Infrastructure for Spatial Information in the

[22] http://www.openstreetmap.org

European Community (INSPIRE), the European Union has created a common standard to make environmental information quickly and easily accessible for integrated policy decision-making at all levels of government while supporting the flow of information and data between the local, regional, national and European or international levels. By implementing INSPIRE and the Shared Environmental Information System (SEIS), Member States, the Commission, and the European Environment Agency are adopting innovative data management practices that greatly improve the consistency, availability and re-use of spatial information for environmental policy making.

The **INSPIRE Directive** and the Implementing Rules Legal Acts have become law in all EU Member States and in several countries of The European Free Trade Association (EFTA). INSPIRE rules are binding for all public environmental data management activities. Within the Danube Region status of INSPIRE implementation is variable and heterogeneous. It is due to the reason that some countries are EU Member States and are legally obliged while others are not. Nevertheless, non-member states e.g. Ukraine, Moldova but also Western Balkan countries are implementing their NSDIs largely in line with the INSPIRE (Cetl *et al*. 2013).

On October 21st 2013 the EC amended Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC as regards interoperability of spatial data sets and services, thus completing what is probably the world's single largest data harmonization effort for environmental information. It is the result of an effort of hundreds of experts from across Europe that have been working together for several years to agree common definitions in important policy areas such as energy, climate change, biodiversity, the marine environment, and human health (Figure 5).

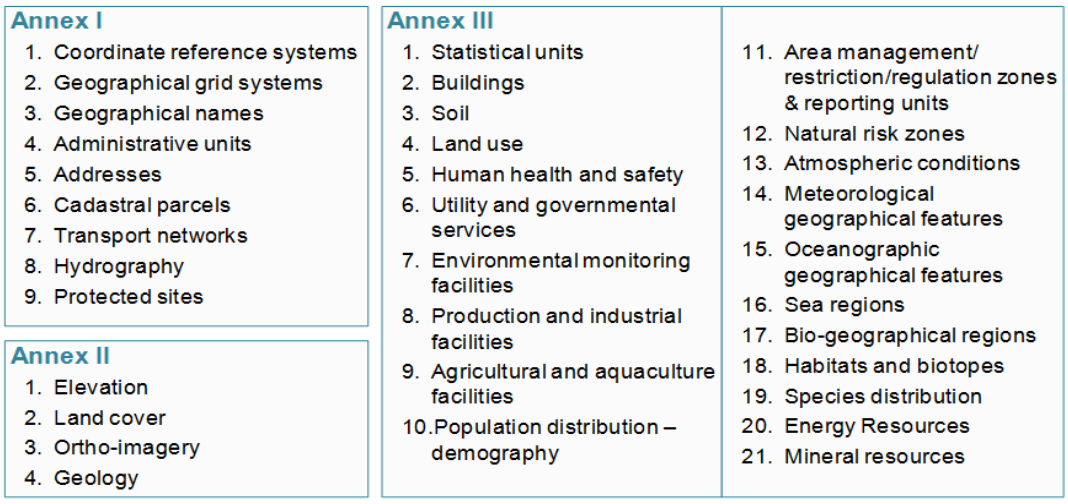

Figure 5 INSPIRE data themes

This legal act complements other INSPIRE legal acts and standards, that together form the basis of the Infrastructure for Spatial Information in the European Community (INSPIRE) that Directive 2007/2/EC envisions. Now that most documents needed for the establishment of the infrastructure are agreed, the implementation of INSPIRE continues with Member State implementation and maintenance. Considering the deadlines, INSPIRE will be fully implemented by 2020.

INSPIRE uses international standards as building blocks of the European spatial data infrastructure. By implementing the legislation, authorities add value to existing systems

by making them interoperable. All legal acts, technical guidance documents, and the INSPIRE geoportal are accessible through the INSPIRE Knowledge base on: http://inspire.ec.europa.eu.

5. Danube Reference Data and Services Infrastructure

The JRC has been developing the Danube Reference Data and Service Infrastructure in support to the EUSDR (Scientific Support to the Danube Strategy Concept Paper, 2014). Within this context, the overall idea of the DRDSI project is to 'unlock' and harmonise data, which are relevant for the so-called 'macro-regional' development of the Danube region. Priority is given to geospatial data within the scope of the EUSDR, including research projects of the JRC.

Moreover, the establishment of the DRDSI benefits from the lessons being learned, and the capacity and resources being developed, in the creation of a pan-European Spatial Data Infrastructure as a result of the implementation of the European INSPIRE Directive (2007/2/EC, 2007). The project is not a stand-alone act but, from the very beginning, attempts to align the scope of the activities with other similar initiatives. For example, a technical report (Smith *et al.*, 2015) has investigated existing project databases and similar resources, as well as how this information may be presented and reused by DRDSI.

The first phase of the DRDSI involved setting-up an Open Data platform, providing access to existing resources (including data, metadata and web services) related to the Danube region (Figure 2). The platform currently provides access to more than 9,000 datasets (as of November 2016) which can act as a solid foundation for the integration of scientific knowledge into policy-making process on different levels (local, regional and international). From the perspective of macro-regional strategies, this would only be possible if data can be used across borders and domains, and put in the right context.

Within the platform the available datasets can be discovered together with their descriptions (metadata). Furthermore, the information can be visualized interactively online or, whenever available, be loaded into an external GIS.

5.1 Technical and organisational context

The development goal of the platform has been to create an informative, user-friendly, stakeholder-engaging site[23]. The platform started at the beginning of the project 3 years ago with a basic interface, scattered with small amounts of information before evolving over this period into an advanced and mature platform well appreciated by the Danube Community.

To achieve this, the platform has advanced its technical functionalities, streamlined data processes and improved data interaction and viewing capabilities, aesthetically, the 'look and feel' has been re-aligned with Commission standards and more avenues for user and stakeholder engagement and information added.

The phases of platform evolution follow closely the development of the Danube Strategy and DRDSI project.

Year 1:

- Set-up of a beta platform in open source code.
- Populate platform with currently available information.
- Commence task of data population.

[23] http://drdsi.jrc.ec.europa.eu

Year 2:

- Progress development and maturity of platform with advanced functionalities.
- Up-date and improve information available on the platform.
- Create greater methods of knowledge and information sharing via leaflets, videos and posters.
- Greater population of data on the platform.
- Sharing success via 'User Stories'.
- Providing professional social media avenues for stakeholder and user engagement and information sharing.
- New information leaflets of the DRDSI (translated into every language of the Danube Region).
- Posters and project logos for the DRDSI and the Experts (Danube_Net).
- Information video of the DRDSI.

Year 3:

- Up-date and improve information available on the platform.
- Smooth integration of the DRDSI platform into the newly released Knowledge Centre for Territorial Policies in the geographic macro-regions dimension[24].
- Documentation and packaging of the platform for handover.

Now, the platform provides access to metadata about resources of relevant interest to the EUSDR. The selection of resources is based on keyword matching between the resources identified for harvesting and the semantic content of the EUSDR Action Plan[25]. In addition, the geographic inclusion of the resource into the area of interest of the EUSDR is considered, including its limitations to the areas of competence in Germany and Ukraine: Bavaria, Baden Württemberg and the four oblasts neighbouring Romania and Moldova. When possible, the resource is matched to the corresponding priority area.

The following "Wordle" (Figure 6) is derived from the EUSDR Action Plan showing greater prominence to words that appear more frequently in the source text. It has been used to filter out content from Open Data portals that are relevant to the EUSDR. The process is further detailed in Section 5.2 (below).

[24] https://ec.europa.eu/jrc/en/territorial-policies/geographic-dimension/macro-regions

[25] Commission Staff Working Document (SEC(2010) 1489)): Action Plan accompanying document from the Commission to the European Parliament, The Council, The Economic and Social Committee and the Committee of the Regions. European Strategy for the Danube Region

Figure 6 "Wordle" of the EUSDR Action plan

5.2 Data platform

The DRDSI platform is built around CKAN (Comprehensive Knowledge Archive Network), an easily usable interface for browsing and searching both spatial and non-spatial resources. CKAN[26] is an open source Open Data management system and data portal developed by the Open Knowledge Foundation[27]. Several government and public administration Open Data portals use CKAN[28], including PublicData.eu, the European Data Portal or at national level, data.gov.uk, the United Kingdom Government's official Open Data portal, which was a pioneering example of Open Data portals in Europe.

The schema represented in Figure 7 depicts the software modules that are integrated parts of the DRDSI infrastructure.

Figure 7 Technical components of DRDSI

[26] CKAN http://ckan.org

[27] OKF http://okfn.org

[28] CKAN case studies http://ckan.org/case-studies

Throughout the development cycles of the DRDSI, a recurrent requirement has been to provide stakeholders within the Danube Region a platform, which can be used for information dissemination. The DRDSI platform provides access to open source data and the exchange and sharing of information and knowledge 'non-data' related. By establishing an avenue for communication within the region, stakeholders have benefited by increasing exposure to relevant Open Data, increasing their network, data awareness and even project collaborations.

The **Danube RDSI Community Platform** goal is to engage end-users such as EU Institutional Decision Makers, Danube Region Stakeholders, Data users and Data providers in sharing information about the Danube Strategy, projects in the Danube Region, provoke useful and relevant discussions on data and to provide a high-level engagement via third party professional 'social' platforms. Currently, the platform host over 9,900 datasets and more than 100 users on the DRDSI professional social media sites.

From the DRDSI activities, we can estimate a total of more than **700 stakeholders** have been successfully engaged during the DRDSI pilot project. These engagements have occurred from workshops (organized by JRC or by the local Danube_NET experts), the pilot stakeholders and the DRDSI collaborative platform. This positive result confirmed the effectiveness, impact and need within the region to engage and support local communities via events organized in their countries, addressing both scientific issues and training. This impact has been most prevalent in candidate, potential candidate countries and countries of the neighbourhood.

Via the platform and social media, a wide selection of information and promotional material is available to stakeholders in the form of a video, information leaflets, which have been translated into every Danube Region country language and "State of Play" documents detailing the Open Data arrangements in each country from the Danube_NET (Annex III)[29]. A dedicated newsfeed from the European Media Monitor Unit has been integrated into the platform allowing stakeholders to access news from all over Europe and the Danube Region in one location. In general, metadata catalogues are used as a tool for discovery of desired spatial data resources in quick and simple way by applying different search criteria on metadata records. Prerequisite for enabling public users to achieve this goal is to have a set of clear, well-functioning and comparable metadata records in the metadata catalogue.

There are various resources of spatial and non-spatial data relevant for the scope of the project that should be presented in the DRDSI platform. Separate procedures have been defined for various use cases: harvesting from an existing and accessible metadata catalogue; harvesting of metadata available in Open Geospatial Consortium web services (OGC); metadata collected by the members of the network of experts in the Region, the so-called Danube_NET and provision of on-demand metadata.

Wider acceptance of Open Data initiative resulted with more Open Data portals being implemented and available in the Danube region.

With the implementation of an Open Data portal harvester, some of the records already registered in JRC's Open Data portal (http://data.jrc.ec.europa.eu) were re-used for DRDSI (Figure 8). As such, data resources that were already available on JRC servers

[29] Full versions of all 14 "State of play" reports are available at http://drdsi.jrc.ec.europa.eu/state-of-play

and described by metadata records in JRC's metadata catalogue become accessible from DRDSI platform as well.

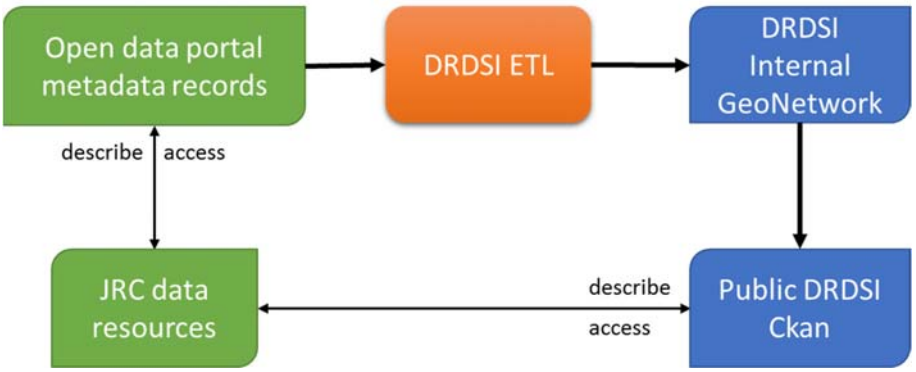

Figure 8 Reuse of available data and metadata resources

6. Data sources

One of the biggest challenges for the DRDSI project and its partners was to identify, document and make available existing datasets that can be used in support of informed decision maker. The data-related landscape in the 14 EUSDR countries turned out to be heterogeneous and data in the beginning of the project was not readily available. There were some exceptions such as pan-European datasets, which are harmonized and cover significant portions of the Danube region by definition (e.g. Copernicus Land Service datasets). Still, those international datasets in most cases did not cover the Western Balkan part of the region, and most noteworthy – Moldova and Ukraine.

Within this section of the JRC report we are providing an overview of the resources which the DRDSI project has made accessible. It is subdivided based on the geographical extent of the data source into (i) international (covering more than one of the 14 EUSDR countries) and (ii) national covering parts, or the whole territory of a country.

It should be noted that the content of the DRDSI platform is dynamic, with a regularly increasing number of datasets, so the content of the section is only illustrative, and provides a snapshot of the data content as of November 2016. Furthermore, we should highlight that the statistics provided below is based on metadata being made available within the platform. The datasets presented are, in accordance with principles of the Shared Environmental Information System[30] accessed in a distributed, service-oriented architecture, and are thus made available where best managed, i.e. close to the provider.

6.1 International data sources

A number of international data sources are made available in the DRDSI platform (Table 2). From the stakeholder engagement point of view, making those data accessible required an intensive dialogue with different organizations with an international mandate. In some cases, e.g. with the International Commission for the Protection of the Danube region (ICPDR) the partnership has led to a mutual benefit, where ICPDR used data from DRDSI as input, and contributed back resource they are maintaining.

The biggest portion of those data is research-based and is harvested from the JRC Data Catalogue[31]. Organized around the concept of thematic data collections, and build with open source tools, the JRC data catalogue provides access to heterogeneous data being created by different JRC research groups. It is worth noting that not all data, available through the JRC Data catalogue is made available within DRDSI, but only a subset, based on the geographical coverage of the region, and themes, relevant to at least one of the Priority Areas of the EUSDR (as described in Annex I). Data, made available by JRC explicitly by the JRC Scientific support to the Danube strategy, i.e. by one of the thematic *nexi* are provided separately.

[30] See Commission staff working document SWD(2013) 18 final. "EU Shared Environmental Information System Implementation Outlook".
http://ec.europa.eu/environment/archives/seis/pdf/seis_implementation_en.pdf

[31] JRC Data Catalogue: https://data.jrc.ec.europa.eu/

Table 2. Data made available in DRDSI from international data sources

Data provider	Number of datasets
Total	
JRC Data Catalogue, incl.:	739
JRC Air Nexus	53
JRC Bioenergy	13
JRC Water Nexus	9
JRC Soil Nexus	1
International Commission for the Protection of the Danube River (ICPDR)	75
European Environment Agency (EEA) data catalogue	67
Copernicus Land Monitoring Service	13
EuroGeographics	1

Another major source of data for the DRDSI are projects, implemented in the Danube region. Table 3 provides an overview of projects in the region that have been used as source of data. This table does not cover data-related projects being implemented on a national or sub-national level. Those are included in the national data sources, described in section 0. The projects, provided in Table 3 are already accomplished, and by providing access to their datasets the DRDSI platform not only provides additional visibility of the results, but also ensures sustainability of the resources.

Table 3. Project data made available within the DRDSI platform

Project	Number of datasets
CarpatCLIM	170
EuroGeoSurveys	116
EnviroGRIDS (FP7 project)	84
FFEM-EECCA project (Moldova, Ukraine)[32]	65
SPATIAL Cross-Border project (Bulgaria-Romania)	3

6.2 National data sources

The national datasets that DRDSI makes available are considerably more diverse and difficult to combine than the international ones. Moreover, while the pan-Danube or European datasets are in most, if not all cases, available in English, data on the national level is in the large majority of cases encoded using the national language. This creates serious problems for simultaneous use of data in a transboundary setting. With the implementation of the INSPIRE Directive this problem should to a large extent be resolved for data which falls within the thematic scope of the Directive. Still, there would be need for translation, and or other form of transformation to ensure mutual use of

[32] Capacity Building in Data Administration for Assessing Transboundary Water Resources in the countries of Eastern Europe, Caucasus and Central Asia (EECCA)

datasets from more than one country. Issues with language would be more severe for data outside the scope of INSPIRE, and/or where no particular harmonisation agreements are put in place.

6.2.1 Open Data

Open Data platforms are contributing significantly to DRDSI. A total of 2,959 datasets were made available from Open Data portals, thus forming 34,7% of all data made available by the platform.

We observed a rapidly growing number of Open Data initiatives in the Danube region. For some of the countries, the number of datasets in the Open Data portals has tripled during the past two years. That is partly why some of the countries in the Danube region, such as Romania, Bulgaria and Moldova, rank very high in the Global Open Data Index (GODI). We did not observe a direct link between the economic development of the countries (expressed by GDP) and the state of the Open Data infrastructure in the country. At the same time countries from the West Balkans (Bosnia and Herzegovina, Serbia and Montenegro) still do not have a fully functional Open Data portal, going beyond the prototyping/project phase. That is why targeted activities, aiming at filling that gap would contribute to filling that gap. Furthermore, as described in this section of the report, there are many good practices in the Danube region to be followed.

The free and open source CKAN is, fully in the spirit of the Open Data movement, the *de facto* standard platform for discovery and download of Open Data. CKAN is used as an Open Data platform solution in 8 of the 14 Danube countries. The use of this technology allowed DRDSI to consume data directly from the different Open Data platforms without the need of an extensive data transformation. The process is described in further details in section 0 above. The data however had to be filtered for relevance to at least one of the Priority Areas of the EUSDR.

6.2.2 Data from SDI

Spatial data infrastructures contributed the largest portion of data for DRDSI, forming 46.5 % of all data in the platform. The total of 3,961 datasets are made available by harvesting national metadata catalogues (discovery services), and the biggest percentage of that resources (94,9%) came from EU Member States. The implementation of the INSPIRE Directive in EU Member States is from that perspective very important. Even if not mandatory for non-EU countries in the Danube region, we discovered that literally all non-MS countries are following the developments of INSPIRE on legal, organisational and technological levels. In doing this, they are extensively using different EU financial mechanisms such as the Technical Assistance and Information Exchange instrument of the European Commission (TAIEX), Instrument for Pre-Accession Assistance (IPA), Horizon 2020 and other sources: World Bank, National Funding programmes, etc.

At the same time, identifying and using Danube region data from different national sources in a combined manner is still a particularly challenging task for geospatial resources. That is why the establishment of a macro-regional spatial data infrastructure is necessary. The map (Figure 9) shows the distribution of discoverable datasets made available through the DRDSI infrastructure.

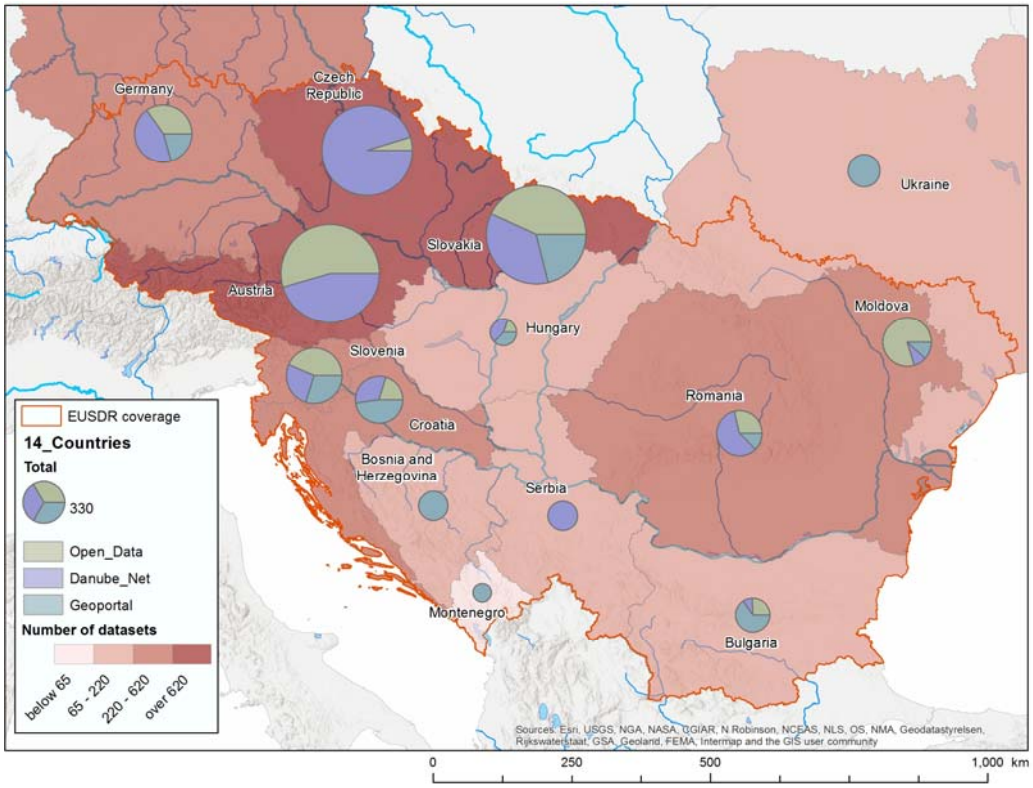

Figure 9 National datasets discoverable through DRDSI

Where the DRDSI can be seen to create a means to bring together data from across the macro-region, from local to global levels, in a common infrastructure and data portal, there have been some persistent issues uncovered by this process. A key aspect is the way in which data are variously managed and valued by organisations, illustrated by some cases presented below. In general, the issues are reflections on the degrees of openness of organisations in the region about the data they hold and can share.

The most closed situations experienced in the project was an inability for DRDSI stakeholders to engage some organisations and find out what data they may want to contribute to the infrastructure. This may not count strictly as a data policy but other examples exist more closely related to restricting access to data through approaches and data licencing. An example of the former is where researchers were not willing to share data unless the correct citation of their work was made, something that can be seen as an area of development in putting online and interconnecting research materials, often referred to as e-science. A similar situation in a research context was the desire for organisations to work in partnership with others before data would be shared, so that research outputs such as publications could be achieved. This is somewhat mixed, as it can improve collaboration between organisations, including between the academic and public sectors, while simultaneously restricting the potential disco very of the data through an infrastructures for others to reuse.

Another example more strictly related to data policy was where some organisations have focussed more on data protection than on data use and reuse. An example of this involved an organisation reasonably requesting that data be managed securely for the purposes of an analysis but that all derived data should be destroyed once the analysis is complete. Such an approach is in line with many policies regarding data about

individuals but, although care is needed in considering some data being shared (as catered for in the INSPIRE Directive), one restrictive policy should not be applied universally, especially to aggregated data that can help to power applications, transparent decision-making or further research across disciplines and organisations.

Although these cases have been found in many other contexts across Europe, there have also been moves to improve data licencing, in part aided by the Open Data movement and proposals for national profiles for geospatial data, as found in Germany (Löhrer *et al*., 2014). The DRDSI has partly tackled this issue thanks to the reuse of metadata profiles and national content stemming from INSPIRE but the quality of data licencing details in metadata is still somewhat limited. Data licencing and data policy, as well as how to share details about data in a standardised way requires wider discussion across Europe to ensure that there is more clarity about what geospatial and other data are restricted or more ready for reuse as part of a digital economy.

7. Data infrastructure and value-added pilots

A key challenge about data infrastructure is that they are inherently a back-office activity. The end user should not be aware of their existence and, like a water supply, should simply turn on a tap of data and start using it. We, therefore aimed to build capacity and create platform content by illustrating what can be done with such data assets through analyses and end-user applications. We also wanted to fill gaps in the data infrastructure in key cases that would build capacity and develop expertise in the region and provide examples for others to follow.

From the work with the Danube_Net, in particular, it became clear that a series of pilots was needed to build capacity and demonstrate how data harmonisation activities could be built on and contribute to the DRDSI. Already, the INSPIRE Directive (2007/2/EC) provides an approach to spatial data harmonisation and a policy context to help harmonise data and underlying data-sharing services for a large range of topics.

The approach of the DRDSI project, therefore, has been to demonstrate how INSPIRE be applied to further strengthen the data infrastructure the project is creating. Supported by evidence from the Danube_NET (Annex III) it also became clear in setting up the pilots that full data harmonisation across the region would not be possible in the lifetime of the project, in part due to limitations caused by only emerging data policies and by the implications of legacy systems in many cases. The pilots, therefore, aim to develop products, services and content for access through the DRDSI Platform that promote INSPIRE and Open Data concepts while building capacity in particular countries in these topics.

This work has also been supported by a series of workshops with Danube_NET members and other stakeholders in the region, including a concept-based meeting in mid-2015 that explored how sharing spatial data can contribute to sustainable growth in the region. All pilots have recently been launched and the findings and lessons learned from this work will contribute to the conclusions of the DRDSI project as a whole.

The pilots can be divided into three main groups, presented in the following sections of this report. The first group involves data infrastructure pilots that help establish services to populate the DRDSI in a sustainable manner, focussing on work in Serbia and Ukraine (Section 0). The second group of pilots focusses on cross-border data harmonisation, involving reference data coming from organisations in Ukraine and Moldova and expertise from Germany, which also acts as a knowledge-transfer case (Section 0).

The last group of pilots aims to create harmonised, comparable and open macro-regional data of interest to the EUSDR, focussing on examples for policy-related indicators, for the protection of the regions cultural heritage, thus extending the scope of INSPIRE, and the creation of value added products with and for citizens through an application for urban agriculture in Slovakia that could be extended to other countries (Section 0).

7.1 Infrastructure components

The focus of the work on the DRDSI is the access to, and sharing of, geospatial data that is typified by the requirements of the INSPIRE Directive that aims to build a European SDI. These developments already well underway in the EU Member States, that is building on the SDIs at regional and national levels to provide access to data for use in environmental policy-making and assessment. The data infrastructure pilots have been

designed as exemplars for other countries to follow that are interested building capacity in SDI and the federated approach the infrastructure promotes.

The focus of this work is to mobilise existing content to provide information for the DRDSI and to fill gaps in existing information that will help data to be better managed for wider access and potentially offer experience in modernised metadata management as part of a larger data infrastructure.

The activity focusses on two cases, one from Serbia, which has recently made major investments in its national SDI geoportal, and the other from Ukraine, where the DRDSI project as a whole has been aiding the rapid development of their approaches to spatial data-sharing, in some cases starting from paper maps that have need to be digitised.

The two cases are described in more detail, below.

7.1.1 Serbian research data portal

The purpose of the work within the Serbian research data portal is to establish a 'local node' for the DRDSI in Serbia and to explore how this approach could be adopted by key actors in the country. This work created a ready and sustained means to harvest metadata using an Open Data approach, based on the technologies used by the DRDSI platform. In addition, it acts as a demonstrator for other organisations to share data by documenting the approach and experience gained, creating further content for the DRDSI Platform.

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The main objective of the work was to create a standardised approach to obtain existing metadata. This includes creating an OGC based Catalogue Service for the Web (CSW) endpoint[33] that contains metadata relevant to the EUSDR for consumption in the DRDSI platform that comes from the country's National Mapping Agency (NMA), the Republic Geodetic Authority of Serbia (RGA) and other sources (Figure 10). The creation of such a system means that metadata are not only available for the DRDSI but also potentially for other Open Data platforms, thus creating a more sustainable approach to managing metadata and some help towards INSPIRE implementation in Serbia, which is looking towards EU membership.

To make best use of the developments in this case, the work also involved promotion of the approach with other organisations in Serbia, so that others could be encouraged to make data more readily flow to the DRDSI. This is felt to also help establish more sustained partnerships for data-sharing within the country and hopefully for the Danube region as whole.

A particular emphasis has been put on providing resource locators for relevant data (registered through the dataset metadata), pointing to both view and, wherever possible, download services. The service node instance for the DRDSI serves relevant metadata records and services in an unrestricted way, as defined in INSPIRE (Figure 10). It is however possible that not all relevant data can be licensed as Open Data. The

[33] http://osgl.grf.bg.ac.rs/geonetwork/srv/eng/catalog.search?node=srv#/home

approach, however, should aim to support the reuse of data which, in turn, should lead to increased efficiency in decision-making, more targeted research and potentially value-added products contributing to growth and job creation in the country and region.

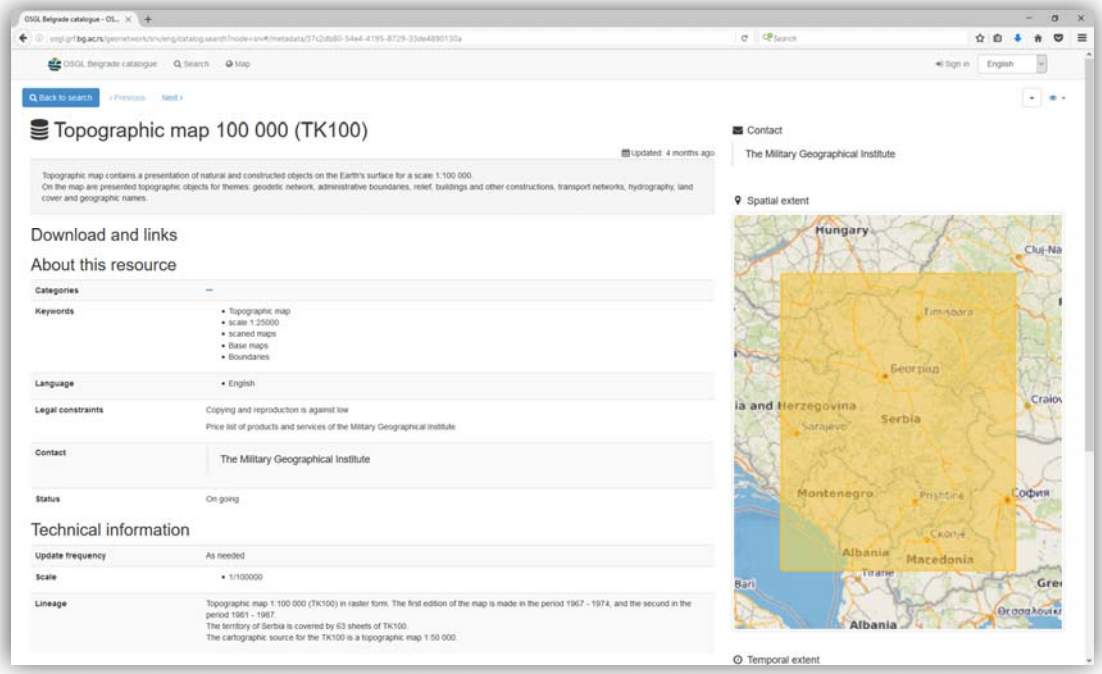

Figure 10 Serbian Metadata catalogue local node

The content of this work includes creating a defined set of data records in both Serbian and English, following a metadata application schema that is in accordance with the requirements of the INSPIRE Directive. This work also includes reusing existing metadata records or individual metadata items (i.e. the pieces of information metadata requires, such as data publisher, date of creation or resource locator), as well as creating additional records or metadata items within the scope of the DRDSI. Importantly, the metadata also contain details of any access control or licencing restrictions related to the dataset.

To further explain the approach and share experiences with others in the region, the work has provided details about RGA's work involving the presentation of User Stories (Annex IV) in the DRDSI Platform that help explain how metadata and data can be used to support the DRDSI (Figure 11). This work involves documenting the improved accessibility and availability of good quality metadata from the above work and how this is improving both the core business of RGA and the benefits arising from collaboration with other stakeholders. Another example is the data used in the context of RGA's Public Private Partnership, which also includes the sharing of data with citizens to better manage agricultural holdings.

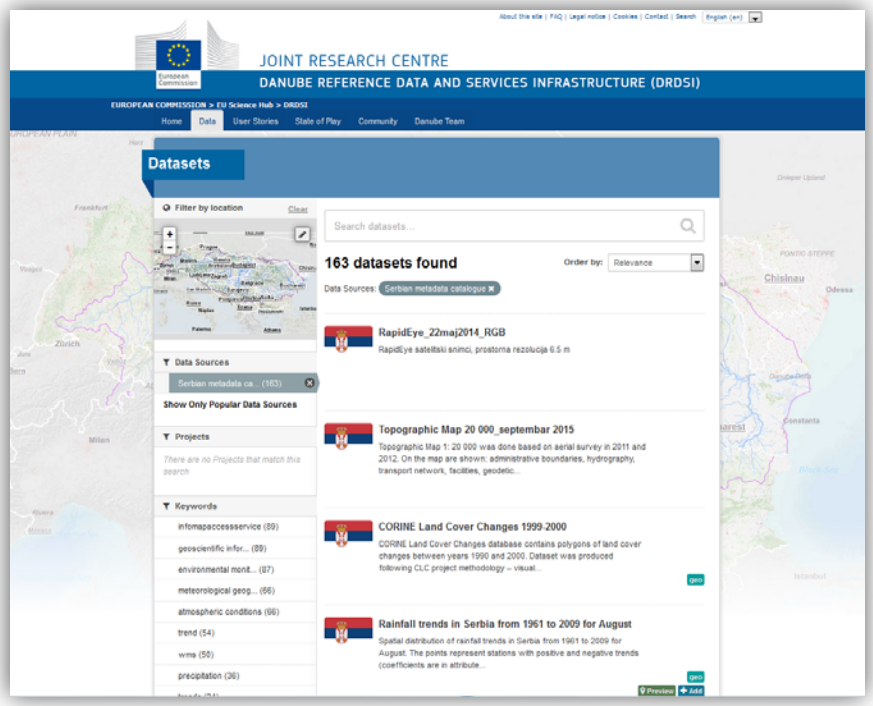

Figure 11. Data from the Serbian geoportal

Overall, the approach and technologies used should be transferable to other organisations interested in, but not yet familiar with, SDIs and INSPIRE.

7.1.2 Ukrainian geoportal

The Ukraine pilot involves a similar approach to the Serbian case but takes into account the organisational setting of their National Mapping Agency, the Ukrainian State Cadastral Centre, and the resources available in their country, where the development and sharing of metadata has been somewhat limited until now.

Geospatial Data Center of Ukraine

GSD Center.UA

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The purpose of this work has been to establish a Ukrainian metadata endpoint[34] and add content and value to the existing DRDSI platform by again creating a 'local node' (Figure 12) and to establish the CSW endpoint containing metadata relevant to the EUSDR that the DRDSI platform can then harvest. This approach is, again, seen to be a potential investment not only for the DRDSI but also an aid to the reuse of such metadata in other Open Data platforms.

The metadata within scope to the EUSDR follows the scoping of the Danube_NET and work explores collaboration with other organisations who could potentially offer their metadata to the DRDSI Platform. Again, a simple list of target datasets has been created early on in the process of setting up the CSW and records are

[34] http://geoportal.dzk.gov.ua/geonetwork/srv/eng/catalog.search#/home

available in Ukrainian and English. Should any dataset and/or service within scope require password protection or other form of access restriction, the metadata being serviced explain these restrictions. This also has implications for how data can be defined as Open Data, as both policy and technical barriers need to be made clear to potential users of a dataset. This work has also been an opportunity to understand why data access restrictions are being put in place and the possible approaches that could be adopted to make data more freely available in Ukraine, bearing in mind the data-harmonisation pilot discussed below (see Section 7.2).

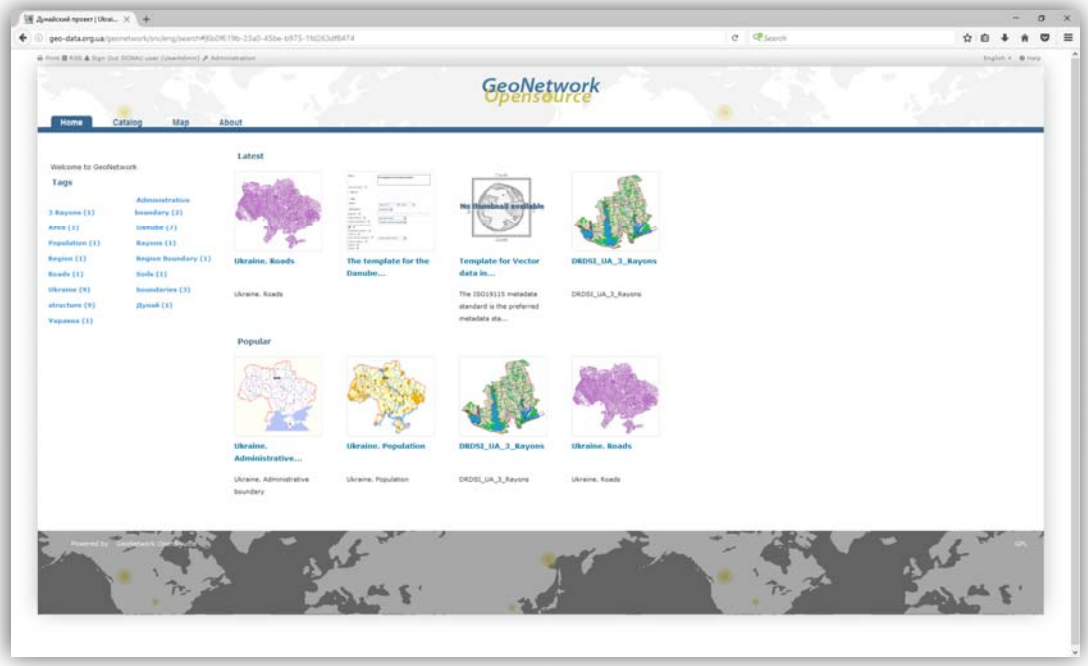

Figure 12 Ukrainian Metadata catalogue

Using the same standards-based approach as Serbia offers some comparison between countries in the issues encountered in implementing the standards and technologies and lessons-learned for other organisations. More formally, this work has produced user stories, including presentation of the value being added to their data management activities stemming from the establishment of the metadata catalogue solution and examples of data usage relevant to the EUSDR that will build on the metadata held in the catalogue. This latter example is the main approach of User Stories as a whole, helping to go beyond metadata catalogues to show what data sharing provides to real-world research and policy-making applications. Investing in infrastructure technologies and making improvements in information management are important steps to supporting data-sharing for a macro-region. The next important step is the harmonisation of data between partner organisations.

7.2 Cross-border Data Harmonisation

Data harmonisation is both a challenge and an important opportunity for organisations sharing and using reference data in the EUSDR. The need for harmonised data is driven by a need for comparability, so that, for example, measurements can be made and reported consistently, problems understood and communicated by parties in the same

way and methodologies and tools developed to fit a range of needs, thus breaking down silos between domains to create reusable data for a range of applications. In the case of the EUSDR, data harmonisation can provide an important means to agree on the extent of territorial issues on the ground and the way those issues can be both analysed and results shared for other uses, thus creating a common framework for decision-making.

Within this context, pilots have been set up as a cross-border use case between Ukraine and Moldova to create comparable data on agreed themes. To bolster this effort, expertise has been added by WeTransform GmbH[35], a company specialising in spatial data transformation and open source tools, especially their own Humboldt Alignment Editor (HALE)[36]. This work provides an additional example of how knowledge on the topic can be transferred from more developed settings to partners outside the EU.

The three complementary cases are described below in more detail in terms of the data providers and expert perspectives.

7.2.1 Data harmonization (Moldova-Ukraine)

This work has focussed on harmonising some of the data holdings belonging to the NMCAs (National Mapping and Cadastral Agencies) of Moldova and Ukraine as a cross-border use case in the Danube Region. It has also helped to up-skill these organisations in the data harmonisation task, following the approaches being developed and implemented in other countries following INSPIRE requirements. On the basis of these pilots and their outputs the organisations themselves and partners have explored how other data could be harmonised as part of the EUSDR or other data infrastructures.

Agency for Land Relations and Cadastre of Moldova

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The purpose of this work was to add content and value to the existing DRDSI platform by creating harmonised data for the EUSDR, and demonstrate a cross-border use case between Moldova and Ukraine, based on INSPIRE. This work involved filling in gaps in regional datasets by creating harmonised data for the two countries at the largest possible scale and documenting results for use in the DRDSI platform, as well as presenting outputs to stakeholders of the EUSDR. The objective was to create a worked example of data harmonisation for around five datasets relevant to the EUSDR, thus creating new macro-regional reference data for the Platform. To aid the potential reuse of this new harmonised content, all the data and metadata created had to be ideally made publicly available for view and download[37].

Already some work has taken place in this context, including for international datasets such as the EuroGeographics EuroRegionalMap pan-European dataset and the efforts in this pilot were complementing such resources to make accessible new data and associated metadata. This work involved four main stages.

[35] https://www.wetransform.to
[36] https://www.wetransform.to/products/halestudio
[37] http://drdsi-pilot.wetransform.to/services.html

Firstly, data were selected covering at least 500 sq. km of the territory of the Danube basin within the two countries. An approximate reference scale of 1:100 000 (or more detailed) has been selected. As reference data are being sought, preference has been given to reference geographies such as the Administrative Units data theme specified in INSPIRE, as such data ca be used in, for example, planning process as well as some regional statistics. At this first stage data were shared either as a package or through services for the following work.

Secondly, the organisations drafted mappings between their source data and the target schemas required by INSPIRE's data models. These mappings were reviewed by the JRC and other experts so that definitions in INSPIRE were well understood and all available spatial objects (the building blocks of the data models INSPIRE has specified) could be taken into account in terms of both structure and content. Resources such as the INSPIRE Data Specification toolkit[38] were used to help scope the necessary building blocks and related information (such as codelists) that the harmonised data needed. Once the mappings were agreed, INSPIRE compliant data were then produced in Geography Markup Language (GML) that could then be documented and shared online (Figure 13).

Thirdly, therefore, the pilots involved serving the output data as both INSPIRE View Services, as OGC Web Map Services (WMS), that provide an online preview of the data being produced for end-users, and INSPIRE Download Services as either OGC Web Feature Services (WFS) or Web Coverage Services (WCS), that allow end users to process the data being shared on their local machines, normally in analytical packages such as Geographical Information Systems (GIS). A preference was being given to well-established open source technology to serve the data and the services coming from this work were made accessible without any restrictions, allowing further testing and experimentation.

[38] http://inspire-regadmin.jrc.ec.europa.eu/dataspecification

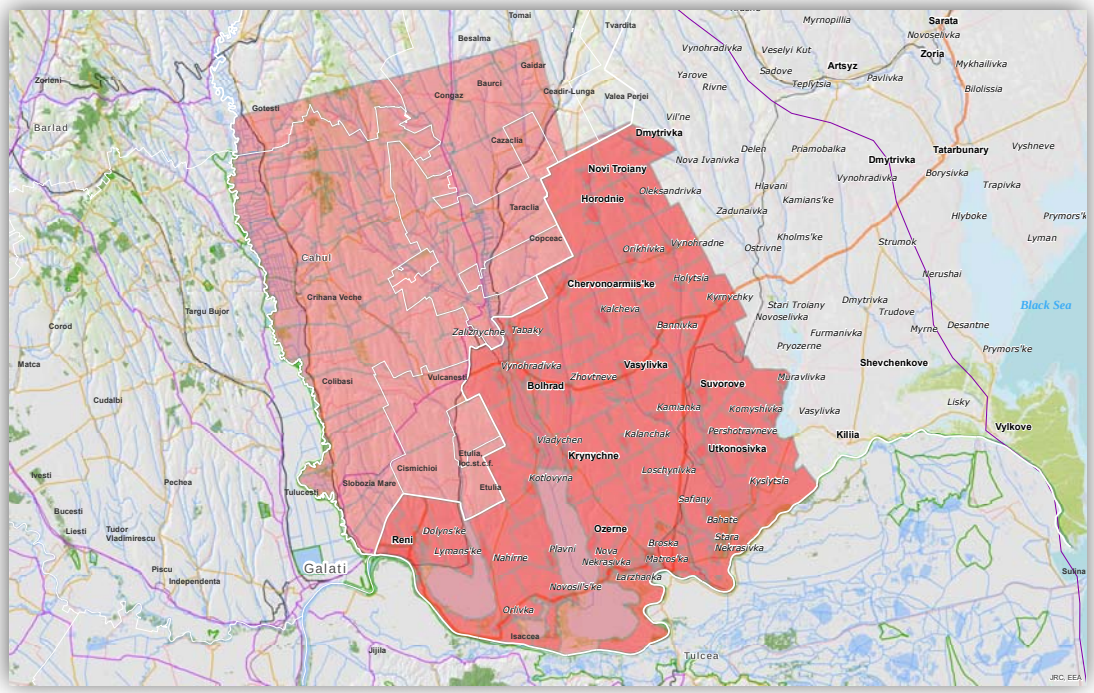

Figure 13 Moldova and Ukraine data harmonized to INSPIRE

Lastly, in order to ensure that the View and Download services of the new data could be easily found, metadata were created for the DRDSI platform, including their resource locators. In addition, more user stories were created for the DRDSI platform to describe the results of the harmonisation activity, the lessons learned and examples of possible applications of this data in support of EUSDR as well as policy support on other levels.

Overall, the experience of harmonising these datasets according to INSPIRE and contrasting the approaches between the two countries for the test area provided important evidence about the benefits and challenges being met through this work and where additional support could be needed to make more data available through this approach both in the participating organisations and with their partners at a national level.

7.2.2 Data harmonisation technical expertise

The main approach of this work was to provide the technical guidance, support and skills needed to take the data providers material and transform it into INSPIRE data, while documenting some of the issues encountered from the technical perspective. This work involved supporting three joint datasets selected in the Moldovan and Ukraine cases, including support to create any missing metadata that would be made accessible to the platform and, in turn, the User Stories.

Wetransform Gmbh

Expert: Thorsten Reitz

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For the data harmonisation tasks two main phases were foreseen. The first phase begins with conceptual mapping through consensus building among domain experts who discussed how a particular source data model (the representation of the dataset to be transformed) can be mapped to a target data model, in this case a model required by

INSPIRE. The more detailed steps for the mapping involves target mapping (i.e. scoping parts of target models); source scope (establishing which source data meet the target's requirements); mapping source and target data 'types', classes or tables; and mapping properties from source to targets.

This work was supported by the use of mapping tables that contain source and target structures. Such work can also help to analyse in detail the supply and demand of data, as INSPIRE may require objects that are not present These mappings and source data are then loaded into HALE for execution, to support the actual transformation of the data to the target schema. Once the project file for the transformation alignment is created in HALE it can be saved and reused for other transformations in whole or for any parts (Figure 14).

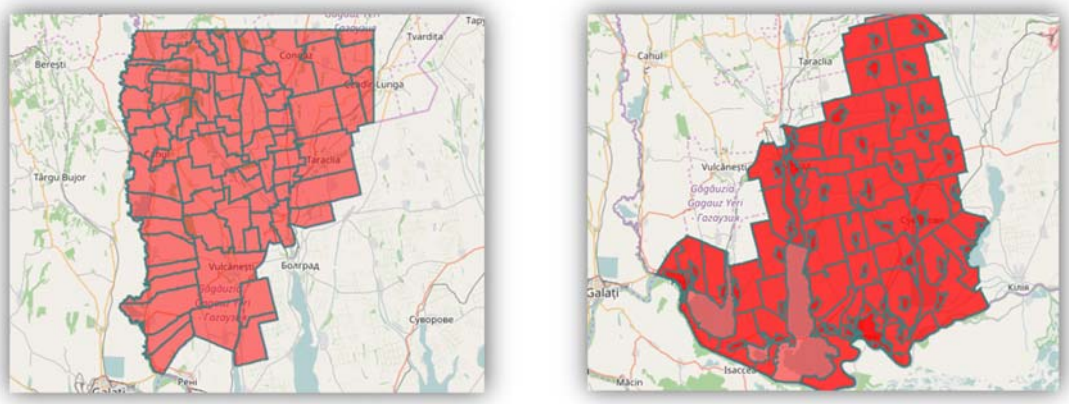

Figure 14 Moldova and Ukraine example services for INSPIRE Administrative Units

The advantage of using HALE is that it also automatically validates the transformations using different validation engines. It also contains WFS functionality through other open source tools, Geoserver and deegree. This combination of open source packages is one of the reasons this expertise was brought into the case studies, as the approaches can be readily adopted by others.

One of the additional outputs of this work is a report summarising the results and key findings of this work, alongside lessons being learned in data-sharing that could aid the unlocking of data in the scope of the EUSDR[39]. This will not only be valuable for the participating organisations and DRDSI project as a whole but also others interested in creating macro-regional datasets.

Overall, this pilot has provided expert support to the participating organisations in transformation tasks and technology but it has also acted as an example of how knowledge transfer can take place within the region, enabled by small pilots and projects that bring together partners to explore how data-sharing can be enabled and what other capacities may be needed to create a more sustainable activity. This has also provided important lessons for other countries and organisations aiming to contribute data to infrastructures, including those in neighbouring regions to the EU, such as those in the Western Balkans.

[39] http://drdsi-pilot.wetransform.to/conclusion.html

7.3 Value-added applications

The previous pilots have outlined cases on modernising organisations to help them contribute effectively to a data infrastructure and demonstrate how to create comparable data. In order to explore the benefits of data harmonisation three other pilots have been established with different approaches to creating macro-regional data that build on INSPIRE. More importantly, they aim to demonstrate the value of using Open Data approaches and principles to power the development of their applications.

The first pilot aims to fill gaps in the underlying data of the DRDSI by creating a common view of indicators that can be used for policy-making, complementing existing resources and following some traditional GIS-based approaches to dataset analysis and new data creation.

The second pilot aims to demonstrate how Open Data coming from expert citizens can be used to drive analyses about different topics in a common spatial frame, including those outside the main focus of INSPIRE but reusing some of its data models. The third pilot looks towards the potential reuse of DRDSI platform content, again involving citizens and considering topics outside the main focus of INSPIRE, by creating feely available applications, potentially as mobile apps. Together, these pilots provide an important contribution to show how SDIs and the DRDSI in particular can be used for range of purposes.

7.3.1 Macro-regional indicators

GIS are built for spatial data-handling. Building a 'bridge' between GIS usage and SDIs is one of the key points of this pilot. Such a step is evident to the SDI community but the concrete approach to connecting existing data resources such as the DRDSI to analytical approaches and new outputs can be documented and followed through this case.

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The purpose of this work was to create new comparable quantitative data that covers the Danube region (for the NUTS2 and/or NUTS3 levels and equivalents in non-EU countries) based on harmonised content and geospatial analysis. This work involved identifying and filling gaps in existing indicators from international actors relevant to the EUSDR, including the data created by the European Observation Network, Territorial Development and Cohesion (ESPON), Eurostat, and the work of the JRC already in the DRDSI Platform, such as the work on territorial indicators for regional development through the use of the LUISA database by colleagues in the JRC Air Nexus[40]. The case study aimed to apply and transfer the JRC S3 Regional Benchmarking Tool[41] to the Danube Region and evaluated on:

- How the S3 Regional Benchmarking Tool can be transferred conceptually to the Danube region;

[40] http://drdsi.jrc.ec.europa.eu/user-story/luisa

[41] http://s3platform.jrc.ec.europa.eu/regional-benchmarking

- How the S3 benchmarking method can be applied with data either existing in the Danube Reference Data and Services Infrastructure, or integrating ancillary data available from other publicly available sources;
- How the S3 index can be applied on administrative units (NUTS2 level) as well as homogenous regions for competitiveness.

The S3 approach aims to identify homogenous (thematic) regions. So to say, regions in Europe which share similar characteristics – reflected in this case through the indicators and respective dimensions. What provided potential is to expand this notion of homogeneity, not only to the 'internal characteristic' of the 'units' but also to a spatial and disaggregated context? An approach which allows the identification of spatial-explicit homogenous regions as well as the identification of regions, the so-called geons (Lang *et al.* 2014) which share similar characteristic was applied (Figure 15).

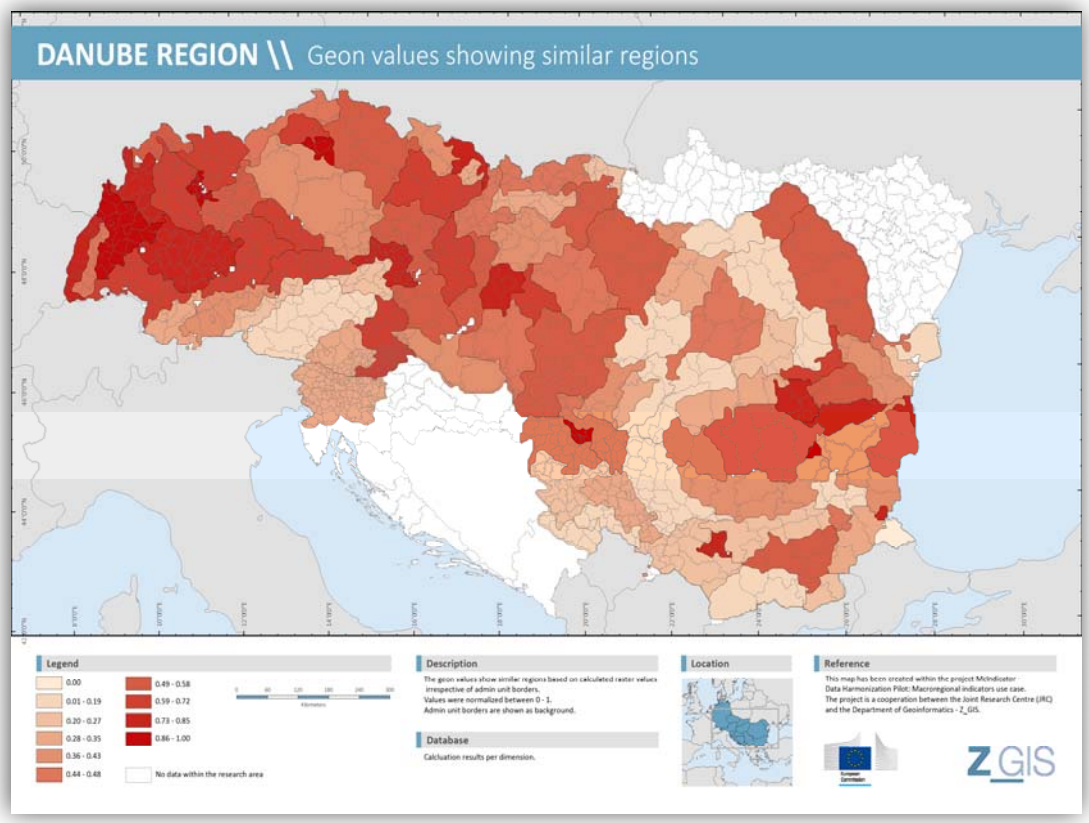

Figure 15 Geon values showing similar regions

The results from this pilot study on macro-regional indicators enable a comparison of units over large areas. One main requirement is the homogeneity of units all calculations are based on. In this approach, those units have been chosen as NUTS 2 level and equivalent regions. A fundamental issue for these approaches in general is the data availability.

Such a benchmarking exercise has not only provided useful indicators for the EUSDR but also helped to take stock of how readily measurements can be made of use to, for example, ex ante assessments or other details that can support decision-making in the EUSDR or potentially other macro-regions.

7.3.2 Cultural heritage analyses

This pilot also aimed to maximise the use of Open Data about the region, combining research outputs with citizen generated content and applying INSPIRE to create harmonised products from heterogeneous data sources. More specifically, it addressed topics within INSPIRE that are outside the core perspective of environmental policy by combining data to examine how the region's cultural heritage could be at risk from natural hazards, in turn creating new indicators about these topics.

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The work followed a similar approach to the Macro-Regional Indicators Use Case, and involved identifying data already within the DRDSI and other sources, selecting data for further analysis and creating new indicators as regional statistics. In this case, however, more focus was placed on harmonising some of the Open Data according to INSPIRE, creating important lessons about the adoption of citizen-generated content for policy-making.

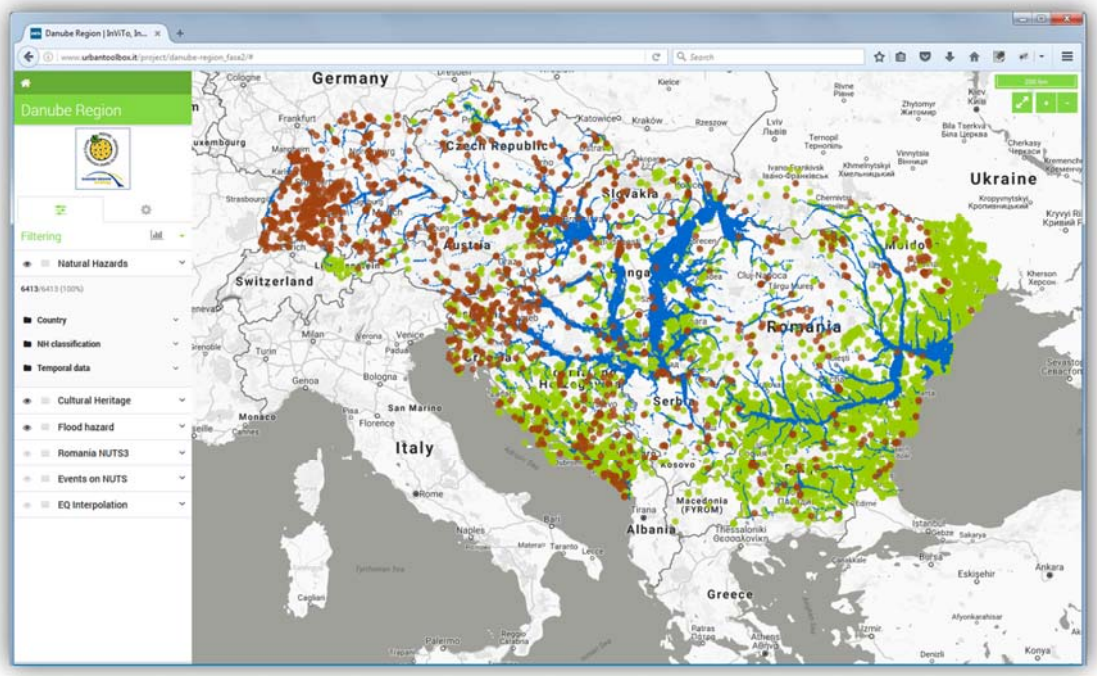

Figure 16. Web interface, combining data on cultural heritage and environmental hazards[42]

More specifically, the work outlined the whole process of data creation, including processing data to common model and creating new indicators. Input data can, again, come from Open Data portals and the DRDSI platform but more emphasis was placed on the use of OpenStreetMap. Thematically, the pilot explored existing data on natural

[42] Data is available at http://www.urbantoolbox.it/project/danube-region_fase2/#

hazards (e.g. floods, forest fires, etc.) with data for cultural heritage, both as cultural heritage sites and as museums or other buildings holding cultural artefacts.

This work explores cultural heritage and natural hazards data sources including international organisations, such as the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), as well as details from website such as Wikipedia. OpenStreetMap is used to identify possible cultural heritage sites or hazard-related data and a data model has been developed reusing data models specified through the INSPIRE Directive's technical guidelines. Using INSPIRE mean that those interested in the topic in other regions can adopt the same model and public administrations can have their data reused in similar application areas.

The creation of this harmonised data can then be used in new analyses for the whole region to show which cultural heritage sites and museums (etc.) are exposed to particular natural hazards, using GIS-based analysis techniques. This work involved discussions with experts and stakeholders at national or regional levels to ensure that the data represents their perception of the modelled risks for their cultural heritage sites. Based on this core dataset the data have been aggregated to create region statistics on the NUTS2 and/or NUTS3 level. This can illustrate, for example via a dedicated web interface mapping, the number of cultural heritage sites exposed to a particular hazard in a given area (Figure 16).

This work has been documented as a User Story and a report on the lessons learnt, for others to potentially follow both within the region and beyond. The advantage of this work is that it also offers an important opportunity to demonstrate the strengths and weaknesses of Open Data in supporting such processes for research and policy-making.

In addition, by grounding some of the data on citizen-generated content, it will be possible to create a resource where citizens can take a sense of ownership of the data produced and subsequent analyses. Such work can also help to draw some contrasts between official data and the use of less formal data sources, and explore how official data could be combined with results to support research-led conclusions. Moreover, the approach in this case could produce data for use in mobile applications, as the output data will be standardised and reusable according to both INSPIRE and Open Data principles.

7.3.3 Urban agriculture webapp

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The last DRDSI pilot also related to data harmonisation but focussed more on the reuse of data for value-added applications that have citizens as some of the intended end-users by creating an open source application. Such work not only provides useful evidence for policy-making but also provides a window on the potential of the region to create such data-driven products and services that could be applied in a range of cases, in turn illustrating data's contribution to the sustainable growth of the region.

More specifically, it focusses on a practical demonstration of such issues by creating a web and/or smartphone application (app) which addresses urban agriculture in Danube region cities. This pilot has been chosen for

further development, having already won an open competition supported by the DRDSI at the DanubeHack event in October 2015[43].

The app consumes data from readily available sources including, but not limited to, data coming from the DRDSI platform and other Open Data platforms (Copernicus Land Services). This application is tailored to the needs of stakeholders in the Danube region, including urban farmers, land owners, local authorities, non-governmental bodies and residents. The work also sees several stages of development.

This begins with refining the scope and conceptual design of the app, including initial inputs from stakeholders (such as public sector organisations, NGOs and citizens), a mock-up of the application and details of the technology to be uses, where open source software was explored in particular to help maximise reproducibility and reusability. The work also involved defining in detail the data to be used based on the outputs of the DanubeHack event. This included, for example, EC-related sources such as Urban Atlas, LUCAS, CORINE Land Cover that feed the urban agriculture application, alongside any additional data collected from handheld devices or citizen engagement.

Based on these designs the end-user application was developed along with relevant documentation for developers and end users (Figure 17). The work also involved publishing the SmartLand application and collect feedback from end-users[44]. Such an approach ensures that the output is not only fit for purpose but that those developing the app can understand how relevant it is alongside other approaches to help target urban land for agriculture. Ideally, events organised in the context of the EUSDR could also be used to gather feedback in order, overall, to improve the end product. Relevant public authorities have also been consulted about their potential demand for, and use of, the app in order to release a final version. Again this experience of creating value-added products on top of the DRDSI resources has been documented in a User Story and final report.

[43] http://2015.danubehack.eu

[44] http://smartland.vps.websupport.sk

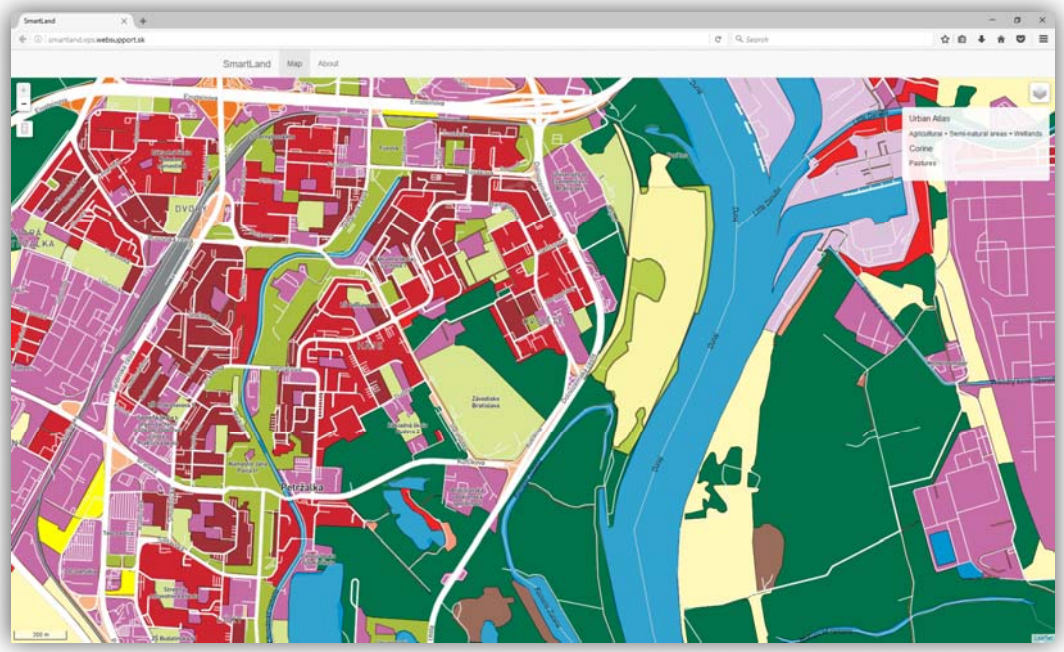

Figure 17 Urban Atlas and Corine data processed for the Urban Agriculture app

This work will, in particular, help others to understand how to make use of Open Data resources and tie the development to the creation of open source applications, creating a highly reusable approach within the Danube region and beyond. In addition, the work will also involve the promotion of this work in networks related to the topic and actors in the Danube region.

7.3.4 Study on Invasive Alien Species with a smartphone app[45]

The majority of resources made available by DRDSI are created by the public sector. At the same time the importance alternative sources of data such as sensors and citizens are quickly growing. Within this context, the purpose of this pilot is to test the practical use of smartphone applications in order to complement official environmental monitoring and early warning of Invasive Alien Species (IAS) occurrences. It particularly investigates the implementation in the field of an app that has been developed by the JRC within the MyGEOSS project[46]. The app is capable of recording sightings of IAS of Europe concern according to the EU Regulation 1143/2014 including an initial list of 37 species, flora and fauna. The app therefore supports the objectives of the Danube Invasive Alien Species Network (DIAS), established by Priority Area 6 of the EUSDR. Whereas the technical development of the app and supporting information infrastructure is already finalized, this pilot carries out

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[45] At the time of writing (November 2016) work within this DRDSI pilot is still ongoing.

[46] http://digitalearthlab.jrc.ec.europa.eu/mygeoss/

practical tests, provides feedback about the feasibility and possible challenges when using the app for early warning and monitoring purposes, and provides input to ongoing data validation mechanisms. The objectives of this pilot are to gain and document practical experience about the use of the app and the collected data by stakeholders in the Danube region and to recommend steps for putting the app into use across the region. The work involves (i) the identification of suitable test sites; (ii) planning and organisation of testing campaigns with stakeholders at the identified sites (at least one campaign at each site); (iii) data gathering, user feedback and summary of lessons learned, and recommendations for possible operational use. It will thus provide valuable input on the possibilities for diversification of data sources for the JRC European Alien Species Information Network (EASIN)[47]. Furthermore, it contributes to JRC's activities on citizen science, and in particular to the Citizen Science Platform (CSP)[48], exploring mechanisms for extending scientific advice to policy making based on citizens contribution (Figure 18).

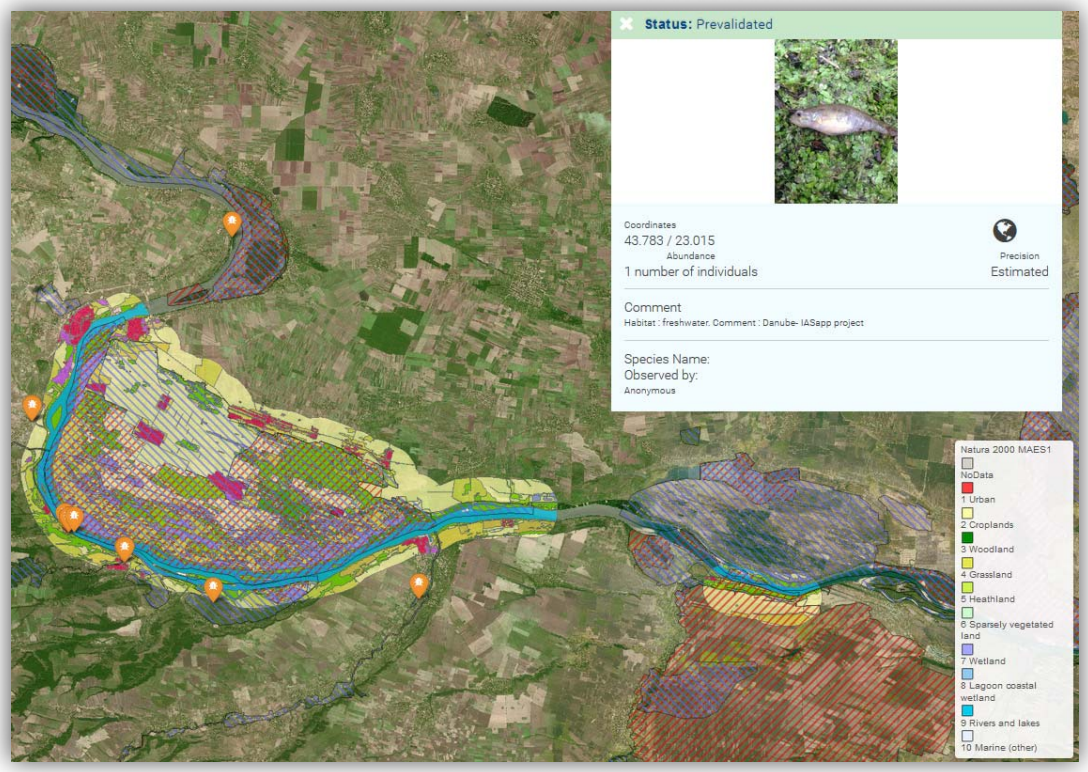

Figure 18 Data for aquatic Invasive Alien Species collected by the IAS pilot (preliminary results)

The pilot is jointly implemented by experts from the Bulgarian Academy of Sciences (Institute of Biodiversity and Ecosystem Research); "Ovidius" University of Constanta, Romania; University of Forestry, Bulgaria and the University of Belgrade (Institute for Biological Research "Siniša Stanković") under the umbrella of DIAS.

[47] http://easin.jrc.ec.europa.eu/

[48] http://digitalearthlab.jrc.ec.europa.eu/hub/ias/

In terms of scope, the study covers test sites in Serbia, Romania and Bulgaria, involving local field-testing for site in each country. The work involves using the JRC app "Invasive Alien Species Europe"[49] as the primary tool for data collection. The pilot experts are gathering and analysing user feedback on the functioning and usability of the app, as well as a summary of the citizens' experience about their possibility to contribute to institutionalised processes, here particularly related to IAS early warning and monitoring in the Danube region.

[49] http://digitalearthlab.jrc.ec.europa.eu/mygeoss/apps_jrc.cfm

8. Achievements and challenges

The DRDSI can be seen as **both an infrastructure and an activity**, as well as a response of the JRC to support the EUSDR. This has included several elements, where the core product has been the creation of an Open Data platform but other aspects of developing a data infrastructure have been exposed through the activities and these are also explored below.

The development goal of the platform has been to create an informative, user-friendly, stakeholder-engaging site. The approach has involved incremental developments, in part responding to the needs of the EUSDR but also involving stakeholders in its creation to ensure that it can fulfil several purposes beyond pure research to be operational. From a basic interface and dispersed information about data in the region, the three years of the DRDSI project have created a **mature platform** holding more than 9,000 data resources (as of November 2016).

8.1 Technical developments

The platform was also developed to provide **specific technical functionalities** to capture, store and display metadata (including map visualisations). The developments were reported at key events where the team discussed successes and challenges. Such openness is not trivial and mirrors the 'user-centricity' for software development that the EC Directorate-General for Informatics (DIGIT) is currently encouraging. The approach has allowed the project to focus on key areas of development and streamline data management processes both in the JRC (to receive new content) and in organisations across the region, as shown through the DRDSI's demonstrator pilots, discussed above.

Moreover, the platform is built on **open source technologies**, meaning that developments can be more readily be reused and adapted by other organisations and the transfer of the infrastructure to new governance groups be more easily achieved (as there is not technical lock-in). The platform's technology also produced reusable components for open geospatial data visualisation outside of its CKAN environment. In addition, **new data management approaches** were explored, where rather than offering a simple catalogue of metadata/data, contributions were sought that brought together collections of metadata and descriptions of how data were used through User Stories, offering a richer description of the role of data in research, policy and related processes while also demonstrating some of the value of sharing Open Data. Although a focussed group of examples was selected for the project, the platform can support the inclusion of many more examples.

Many websites and portals are developed with a 'built it any they will come' attitude. This can be seen as a poor approach in all but the most advanced cases and the **relationship between the platform and its stakeholders** is a key thread of the project's activity. Platform users expect support, interaction and a community surrounding online resources. The investment the DRDSI project made in the **Danube_NET** experts demonstrates why this socio-organisational dimension is important. Their key task was to investigate the status and availability of data for the EUSDR that could be accessed via the DRDSI platform but they also had duties to engage others, promote the platform at national events and act as ambassadors for the project in each country.

8.2 Building a community and capacity around the DRDSI

At the beginning of the project, the platform was wholly the work of the JRC but the regular engagement of these experts and the targeting of advice from them to, for example, identify gaps in their data infrastructures, led to **increased sense of their ownership** in the project and subsequent joint collaboration and the formation of a mature networking who are, themselves, seeking to maintain activities after project closure. This is not only a technical activity and the means to focus efforts around a project have created a vehicle for collaboration across the Danube region, including staff in key organisations sharing experiences and creating common resource for the macro-region. The main research element in this context is the nature of capacity-building when we consider data infrastructures and the longer-term, non-tangible benefits that emerge from such exercises. The efforts and interest from those actors coming from **neighbourhood countries** help illustrate the value of the work done, especially as work with the JRC would also help them to better understand initiatives related to INSPIRE and the tools, resources and skills needed to contribute to such activities, including as candidate countries.

In addition to such networking, the JRC added a **discussion forum or collaborative space** to the platform to allow the Danube_NET and other stakeholders exchange information related to their activities and related news about data-sharing in the region. Although interaction is often not intensive, the passive consumption of shared news items provided weekly reminders of the project's efforts for all involved, as well as acting as a unique entry point to share event-related materials including slides, reports and group photographs.

In addition, communication within the regions and between the experts was also established via a number of successful avenues using social media and classic communication channels, including workshops, training sessions and leaflets in local languages, leading to over **700 stakeholders** being directly informed or fully participating in the DRDSI project. Such resources provided also a means for the Danube_NET to organise local events that, again, were seen to be particularly effective in countries of the neighbourhood for capacity building.

Such capacity building has been a focus of the work and, therefore, merits some further discussion in terms of what this implies in creating capacity a shared data infrastructure from both technical and organisational perspectives for the region. This aspect has been underlined in the literature, as there is a need to be sensitive to issues of stakeholder fragmentation or limited collaboration that geospatial data-sharing can sometimes face (Castelein *et al*. 2013).

SDIs are composed of standards, policies, tools, software and online services so people can access and use geospatial data (Rajabifard and Williamson 2001). It is important to recognise, including from a social sciences and ICT perspective, that people are at the core of any SDI development, either as SDI implementers or users and that the develop of SDIs foster the creation of communities of practice (de Andrade *et al*. 2011, Wehn de Montalvo 2004). In some sense, SDIs also offer the ability to create an 'information commons' as a resource with shared ownership for all parties across the macro-region. Capacity building is, therefore, also an engagement exercise involving regular dialogue and the bringing together of ideas not only from the key implementer's perspective (in this case the JRC) but also from all parties actively contributing to its implementation. It is not a top-down process but it does require leadership and appropriate resourcing.

Engagement with various stakeholders at an early stage is key to SDI development (Castelein *et al*. 2013, Akinyemi 2011). A first line of engagement can be seen through the creation of the Danube_NET members, whose network role allowed DRDSI to be promoted and content obtained from many other organisations within EUSDR countries. It can be argued that awareness-raising is a first step to capacity building, alongside the opportunity to improve resource efficiency by building on and collaborating with recent and ongoing initiatives. It is in not trivial to state that good and open communication is crucial, and the DRDSI has supported capacity building through the methods noted above, as well as and one-to-one support for the creation of stakeholders' key deliverables. A key step witnessed in this process, however, was when Danube_NET members became more self-organising, interacting offline and sharing opinions with less need for guidance and intervention from the JRC. In these cases, it can be seen that capacity building requires a sense of project ownership by the participants and should not only be seen as a training/informing activity.

Capacity building is also recognised as having a fundamental role for SDIs as it requires fundamental changes in the institutional context of Geographical Information (GI) creation and management (Akinyemi 2011). Moreover, SDIs are evolving from the notion of sharing a product to supporting processes of creating and sharing geospatial data (Masser 2004). The focus of DRDSI can be seen through one of the pilots, where the objective was not only to create a common and harmonised administrative boundary map for the Ukraine and Moldova but also build their capacity in data transformation techniques and technologies to ideally share more standardised and reusable data for other data themes in the future and offer experience and lessons for other countries in the region.

Capacity building has also had a long history with the creation of SDIs, including the development of cookbooks which not only focussed on technologies but also organisational aspects. One such example from over ten years ago (Wehn de Montalvo, 2004) considers five lessons that can be contrasted with the work in DRDSI, helping to illustrate where socio-technical processes may be changing.

Table 4. Re-examining Lessons for SDI Capacity Building

Lesson	Observations in the context of DRDSI
Build a consensus process: build on common interests and create a common vision	It has not been possible to reach all relevant actors in the creation of the DRDSI but steps were made to involve all countries and create a network. The consensus process was not formalised in the sense of voting but a steer was given by creating common and comparable deliverables such as state-of-play reports and shared metadata for the DRDSI platform's data catalogue as a destination for the work. Workshops helped to build a shared vision of where DRDSI could be used and suggested pilots from Danube_NET led to concrete examples. The variations in technical and organisational setting of the participants made it difficult to formalise a governance approach to take decisions. Formalising the objectives and benefits with a broader group of stakeholders at an early workshop in the project helped to set targets and demonstrate progress.
Clarify the scope and	The policy context of the EUSDR helped to define the scope of the data and who could be involved, while participants recognised that there would be

Lesson	Observations in the context of DRDSI
status of the SDI	benefits for their home organisations and countries. The INSPIRE Directive, and work towards Open Data through the PSI Directive, helped to define what data could be targeted to quickly populate the platform with examples from existing INSPIRE catalogues from the EU Member States and Open Data catalogues from all EUSDR countries. Creating early releases of the DRDSI catalogue built on these and other metadata a resources (such as European research project datasets) created ready to use resources and illustrated the scope and ambition of the DRDSI to outsiders. Flexibility in the scope, but with a fixed objective to maximising data-sharing for the EUSDR, allowed the project to adapt to shifting demands from stakeholders and to include new data sources that would foster innovation, including the participation in a hackathon in the region that would help identify value-added products using the DRDSI platform (and ultimately another pilot to demonstrate this).
Exchange best practices locally, regionally and globally	A key contribution of the DRDSI is clearly the networking activity of Danube_NET and the organisations they managed to engage with through the course of the platform. Collaboration was mainly fostered through meetings and formalised through report but the creation of online resources, especially a facilitated discussion forum with regular news on related topics and funding opportunities has supported the exchange of opinion across the region. Alongside presentations at key meetings and conferences, this report, itself, acts as a key artefact for this capacity building objective, allowing our lessons to be learned at all levels
Establish broad and pervasive partnerships across private and public sectors	We had an interest in the data value chains that the DRDSI could help to expose, where data coming from the public sector would feed research activities and, in turn, create both input and output data for potential reuse by others, including potentially businesses wanting to make use of data with an open licence for, for example, end-user applications. Some of this has been achieved through the pilots, although full-scale uptake of the data assets in platform will require all processes to be fully operational and for wide awareness to be raised to achieve such private sector involvement. It is, however, worth noting that the composition of the Danube_NET involving public sector data owners, researchers and private sector experts created a helpful dynamic in formulating how DRDSI could be implemented and involved.
Develop clearinghouses and use open international standards for data and technology	This was perhaps one of the most challenging early activities of the DRDSI in terms of capacity building. It is common to perform a data audit to help populate metadata catalogues but the broad scope and geographical coverage already meant that not all actors would be addressed in the course of the project. The creation of a metadata template based on INSPIRE ensured that some metadata records could be reused from EU Member States' INSPIRE metadata but there was a need for a lot of manual work by Danube_NET to create metadata. The project, by taking into consideration Open Data, needed to make a

Lesson	Observations in the context of DRDSI
	selection of INSPIRE standards and technologies and combine it with others. As a research project this allowed some steps to be taken to learn about the non-INSPIRE approaches and see how they could be combined with the infrastructures being established, without interfering in their implementation pathways. The use of open source technologies to create the platform has allowed us to not only establish a platform open for further development but also the creation of open source components to handle geospatial data in other Open Data platforms based on CKAN and to package the complete resource for re-deployment and reuse (following configuration) as potential nodes in other locations, potentially including other macro-regions. Arguably, an important factor in how we have viewed the DRDSI as an SDI, is not only the elements shown above in terms of data-sharing but also the important step to consider data use and to demonstrate this through the pilots.

In addition to the above lessons, the DRDSI project has undertaken more formal training with the Danube_NET in all aspects of using the platform and gathering content for it. A focus on producing prefilled examples of the content being sought and sharing early reports from Danube_NET members helped to show the level of ambition for all those involved. In turn, this was thought to help refine project scope, maximise the resources available and reach comparable outputs for potential further analysis or development. Such sharing of materials in development was appreciated by project members and helped to build relationships between them. One of the best examples is the *State of Play reports* section of the DRDSI which provides an overview of the data landscape in each country of the Danube Region[50]. Annex III synthetises the main lessons brought to the DRDSI by each Danube_NET representative for his/her own country. Such capacity building should not only be viewed from the point of view of geospatial data-sharing but also where efforts may be needed for other data sources (for example, for official and, perhaps, open statistical data or observations from the regions environmental volunteers). Moreover, the experience of the DRDSI in engaging such varied actors from across the region helps to show why such efforts are needed and, in particular, where even simple and basic awareness-raising could be needed with partners from the outset for EC-led initiatives, their governance structures and financing mechanisms.

8.3 Data in the context of macro-regional development

Beyond these general approaches to the successful socio-technical development of platform, the project also explored the **nature of open (including geospatial) data and its role in macro-regional development**, leading to six main cases of both achievements and ongoing challenges.

[50] http://drdsi.jrc.ec.europa.eu/state-of-play

8.3.1 Support to research and policy making

Firstly, the DRDSI project has been a means to explore the notions and ideals of Open Data in support of research and policy making for the EUSDR, following the policy evolution of the PSI Directive and related policies. It has been clear from our experts' studies on data policy and the way datasets are labelled in the platform that **data licencing**, whether open or otherwise, is highly varied. It is reasonable to assert that data-sharing is not in a mature state in the macro-region. The consequence of this for the platform is that **content is not as reusable as it should be**, as end-users cannot be certain about their ability to reuse platform content in their applications/analyses.

Despite the recognised benefits of Open Data and of the Digital Transformation, the **Open Data maturity** in the Danube Region, therefore still presents a contrasted picture, with countries setting the trend and countries following or even initiating their Open Data policies.

Furthermore, the responsibility for the Open Data policy is not clear in some countries or scattered across several departments, making it difficult to defend and promote an Open Data culture. The lack of evidence of the impact of an advanced legislation in terms of access to public data is certainly contributing to the low uptake of the Digital Transformation.

In the less advanced countries, there is relatively low awareness, at senior and policy levels, concerning the value of Open Data. The benefits are understood essentially by individuals in response to specific challenges. Involving decision makers could help to address this aspect. This work has begun through our network of experts, sharing best practices and the organisation of workshops in the region. More work however is still needed.

The consequence for the project of not having Open Data also meant that the DRDSI could not fully explore value-added applications for economic benefits and growth in the region (towards the objectives of Priority Area 7). This meant that the creation of harmonised/comparable cross-border datasets became a matter of pilot activity rather than full-scale implementation as a key resources for the EUSDR. Although the project has been able to raise **awareness** of these issues, a more structured approach and follow-on actions are needed in key areas, potentially through large scale pilots or cross-border research initiatives to make data more open and reusable.

The DRDSI platform has provided a destination, the metadata and harmonisation pilots have offered proofs of concept but a **political will is needed** to make such transformative processes commonplace, particularly for the public sector but also for researchers as both data consumers and producers.

8.3.2 Identification of data associated with the EUSDR Priority Areas

Secondly, a notable advantage of the DRDSI's efforts to identify research and public sector data associated with the EUSDR Priority Areas has been to understand what is present and what appears to be missing. The DRDSI project obtained resources to fill some gaps, not only by aiming to access data and metadata from missing organisations (as seen in the Serbian pilot) but also harmonise data across borders (as seen in the Moldova and Ukraine pilots). These demonstrators have been successful but the difficulties in putting them in place should be mentioned.

The first issue faced in this context is the **comparability of data** and knowing which content is in scope. JRC and Danube_NET explored details of the sort of data the EUSDR could be expected to consume and produce, including in key areas such as the Actions and targets of the Strategy. A large part of the evidence set well in the needs of the INSPIRE Directive, allowing a lot of existing resources (e.g. metadata and links to data services to access the data) to be readily used in the platform. Moreover, the data harmonisation effort of INSPIRE meant that ongoing activities such as the European Location Framework and OneGeology Europe could be immediately used (as presented in the platform's User Stories) but the effort to bring more comparable data together across the region presented a number of challenges.

For example, the creation of a harmonised transport network map in the Western Balkans, that could have supported other research in the JRC, had very limited input data in terms of spatial resolution and the costs of creating better data for harmonisation were well beyond the resources of the DRDSI. Partly as a consequence, less formal Open Data sources were explored in the pilots, including OpenStreetMap, JRC data from smart specialisation and other sources to create new statistical indicators. These examples have shown that it is feasible to make macro-regional data but priority setting and investment is needed in data (either opening existing sources or creating new datasets) for key multiple topics across the macro-region.

The reference data are still largely collected on a national basis, which implies a large variety of scales, taxonomies, quality, leading to substantial efforts to bring them together and make sense out of them. For geospatial data, the INSPIRE Directive and the Copernicus programme are progressively changing the picture, but both those programs focus on Member States and/or countries of the EIONET partnership[51]. It remains difficult to find comparative data and statistics covering the candidate and potential candidate countries in the Western Balkans or geospatial datasets offering the same level of accuracy/quality in Moldova or Ukraine.

8.3.3 Cross-border and multiscale issues

Thirdly, although challenges in data comparability/interoperability and missing data have been partially addressed, it is also worth recognising that the DRDSI engaged in a relatively new topic of **sharing data for a macro-region**. The nature of geography and the data related to geographical phenomena is something the project partners had some expertise in. The DRDSI has not only shown what can be done with such data but also provided lessons that other macro-regions may wish to explore. The policy dimension of the EUSDR had offered some focus for data themes in scope but also relevant applications.

A clear dimension to this topic is the notion and issues associated with geographical scale. Although not formally addressed in the project, the project meetings often involved what constitutes a European or macro-regional dataset, on the one hand, and what data is more interesting for cross-border activities, as seen in some User Stories (Annex IV). This was addressed in some detail in the DRDSI by considering additional representations of data other than the NUTS 3 areas.

Although having certain strengths to aid comparative analyses, as political boundaries they are likely to create some distortions for real activities on the ground that local

[51] http://www.eea.europa.eu/about-us/countries-and-eionet

actors may not recognise as reflecting their situation. Therefore, aerial units based on the characteristics of a particular locale, as evidenced by the research and DRDSI pilot led by the University of Salzburg, offered an alternative approach. Such 'reference data' may offer the region's partners a means to **compare issues across borders** and for the region as a whole and follow-on work could look into validating this modelled approach with various stakeholders. In exploring the use of such data, however, it should also be understood that this would involve an educational process, and there is likely to be a need to address people's capacity to make best use of geospatial data through efforts to promote, for example, spatial literacy.

8.3.4 Transferability to other macro-regions

Fourthly, we can expand on this view of macro-regions and geography in more detail and consider what may be applicable to macro-regions beyond the EUSDR, or similar initiatives. The DRDSI's technical approach for the EUSDR has been implemented as a large-scale pilot activity that has now matured into, what is likely, a **reusable approach**. Reusability comes from, initially, the software involved and the expert-supported processes mentioned above. A common approach to creating data infrastructures in different macro-regions should be considered.

In particular, it should be recognised that several countries belong to more than one macro-regional strategy and, for example, if Slovenia were to share data for the Danube, Alpine and Adriatic & Ionian Strategies, administrative burdens should be avoided by encouraging data to be provided in similar ways to different Strategies. Considering such a common approach would also be an opportunity to capture details about the status of the macro-region from a common base before or during early stages of implementation, as well as regular monitoring and evaluation. Such data can act as a means to measure, for example, where extra investment is needed based on key evidence from the region's comparable data. Within this context, policy processes can be key sources to create comparable data.

A good example of where challenges remain in this context is the application of European planning policies such as **Environmental Impact Assessments** (EIA; based on Directive 85/337/EEC[52]) and **Strategic Environmental Assessments** (SEA; based on Directive 2001/42/EC[53]). Their associated reports require the intensive use of geospatial data and interaction with a range of stakeholders to ensure that local and regional developments are not going to have adverse effects on the environment, a topic of interest to macro-regional strategies and a process all policy should go through (in the case of SEA).

Moreover, experts from the private and public sector are often required to find data about development areas or analyse the impacts of proposed policy. This data may exist in public administrations and be well managed but it can also be well hidden. Given the needs to share the inputs and results of such activities with stakeholders, including in many cases citizens, it could be argued that macro-regional strategies could form a means to coordinate methodologies to make best use of such data. Least of all, the strategies themselves should explore a **rigorous approach to finding, analysing and**

[52] http://ec.europa.eu/environment/eia/eia-legalcontext.htm

[53] http://ec.europa.eu/environment/eia/sea-legalcontext.htm

sharing such data, especially when associated with regional investments. Importantly, INSPIRE is already providing part of the approach to support such data-sharing.

An initial review of the other macro-regional strategies shows how such data may also be within scope, where the more detailed approach of **EUSAIR** helps to highlight some specific themes and the broader approach of **EUSALP** may offer more opportunity to define where focus is needed regarding data assets. Further analysis would be needed in both cases to ensure that these assessments would both relate to the scope and objectives, as well as the interests of the key stakeholders as both data providers and users, of the Strategies. The topics of EUSAIR can be seen as easier to interpret from this point of view (See Table 5), whereas more interpretation is needed for the EUSALP (See Table 6).

As these macro-regional strategies are still in the process of being established it is advised to further evaluate the usefulness of INSPIRE data and models in the short term, so that ex-ante and ex-post monitoring and assessments can be performed, potentially helping to measure the impact of the Strategies.

Table 5. Initial mapping of EUSAIR Pillars and Topics to INSPIRE Themes

Pillar / Topic	Possible link to DRDSI's approach and INSPIRE Themes
1: Blue Growth	**Although INSPIRE mainly focuses on terrestrial data objects, some maritime and marine topics are covered. Complementary data from INSPIRE may also aid such activities, including in the area of marine spatial planning or the Marine Strategy Framework Directive[54]**
Topic 1 - Blue technologies	Limited opportunity to learn from DRDSI/INSPIRE, unless research, innovation and business opportunities would cover such geospatial data
Topic 2 - Fisheries and aquaculture	INSPIRE Themes: Agricultural and Aquaculture Facilities already offer potential data and data models. Other themes may offer contextual or reference/positioning data.
Topic 3 - Maritime and marine governance and services	INSPIRE Themes: (i) Oceanographic Geographical Features and (ii) Sea Regions may already offer some data or data models depending on how this topic will be addressed. Other themes such as (iii) Area Management Restriction Regulation Zones and Reporting units and (iv) Protected Sites could offer contextual mapping, as well as and (v) Statistical Units offering building blocks for thematic maps, where appropriate
Pillar 2: Connecting the Region	**Transport networks are within the scope of INSPIRE and basic geospatial objects / data models can be extended or combined with other data to cover key features and attributes for transport. Energy is a topic within the scope of INSPIRE.**
Topic 1 - Maritime transport	INSPIRE Themes: Transport Networks are designed to cover handling geospatial data related to this topic, including for

[54] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056

Pillar / Topic	Possible link to DRDSI's approach and INSPIRE Themes
	maritime transport
Topic 2 - Intermodal connections to the hinterland	INSPIRE Themes: Again, Transport Networks cover marine data but also road, air, water and rail transport infrastructures
Topic 3 - Energy networks	INSPIRE Themes: Depending on the focus of energy production and distribution data and data models could include (i) Mineral Resources, (ii) Utility and Governmental Services and (iii) Energy Resources. If natural sources of energy are of interest, then (iv) Agricultural and Aquaculture Facilities, (v) Land Cover and (vi) Land Use data may be of interest
Pillar 3: Environmental Quality	**As INSPIRE is designed to help share geospatial data related to environmental policy, including broad policy topics such as Environmental Impact Assessments and Strategic Environmental Assessments, a large part of INSPIRE should be of concern to this Pillar's activities**
Topic 1 - The marine environment	INSPIRE Themes: Solely from an environmental status perspective INSPIRE helps to share data on (i) Protected Sites (including Natura 2000), (ii) Environmental Monitoring Facilities, (iii) Land Use (including coastal areas where data are available), (iv) Oceanographic Geographical Features and (v) Sea Regions that can contain contextual as well as specific data, (vi) Agricultural and Aquaculture Facilities that can help identify potential pressures on the ecological status from terrestrial/inland and off-shore activities. From the waste flows to the sea, (i) Land Cover and (ii) Land Use, (iii) Production and Industrial Facilities and (iv) Agricultural and Aquaculture Facilities may offer indications where there may be particular pollution or nutrient pressures in coastal areas or certain river basins, alongside waste measurement details that could be captured through (v) Utility and Governmental Services.
Topic 2 - Transnational terrestrial habitats and biodiversity	INSPIRE Themes: As well as those mentioned above (i) Species Distribution and (ii) Habitats and Biotopes focus more on ecological characteristics of certain locations relevant to this topic.
Pillar 4: Sustainable Tourism	**This topic is further from the scope of INSPIRE but there are some elements that could be used to support tourism in relation to cultural heritage.**
Topic 1 - Diversified tourism offer (products and services)	INSPIRE Themes: although the main aspects of this topic are economic, location plays an important role in understanding where there is seasonality of demand. Mapping (i) Population Distribution - Demography or sharing details of tourism sites in terms of their (ii) Addresses can support some analyses or tourism applications, as well as details of any eco-tourism

Pillar / Topic	Possible link to DRDSI's approach and INSPIRE Themes
	sites related to information in Pillar 3 Topic 2 (above).
Topic 2 - Sustainable and responsible tourism management (innovation and quality)	Similarly, sustainable tourism management may take into account environmental conditions but INSPIRE also offers details on cultural heritage through (i) Protected Sites and if the tourism destination involves a house, castle, cathedral etc. then the (ii) Buildings theme's data models could be re-purposed.

Table 6. Initial mapping of EUSALP Pillars and Topics to INSPIRE Themes

Pillar / Topic	Possible link to DRDSI's approach and INSPIRE Themes
Pillar 1. Fostering sustainable growth and promoting innovation in the Alps: from theory to practice, from research centres to enterprises.	**The main focus of this pillar will probably involve knowledge transfer and activities to boost the macro regional economy. Should geospatial data and products feature in these activities, then the implementation of INSPIRE could offer data resources for value-added products. Such Geo-ICT developments are, however, likely to only feature as a small percentage of this pillar.**
(1) Developing innovation and research capacity and transfer into practice	INSPIRE Themes: No specific INSPIRE theme would link to this topic.
(2) Improving and developing support for enterprises	INSPIRE Themes: As above
(3) Promoting high levels of employment, with the aim of ensuring full employment in the Region	INSPIRE Themes: In measuring progress in this topic is could be useful to gather baseline data and monitor data related to the (i) Administrative Units, (ii) Population Distribution – Demography and (iii) Statistical Units themes to create comparable maps about where there are areas with high employment (with possible lessons for other regions) and lower levels helping to show where there is a need for intervention and a group of regions that could be networked to share experience in tackling employment issues. The same analysis could be applied to the knowledge transfer topics, above.
Pillar 2. Connectivity for all: in search of a balanced territorial development through environmentally friendly mobility patterns, transports systems and communication services and infrastructures.	**An investigation into transport, population distribution and environmental impacts would benefit from the comparable data INSPIRE is aiming to share and reuse of the data models the Directive already provides. The optimal roll-out of Internet infrastructure across the region (and across borders) that takes into account environmental concerns would also rely on large scale data (i.e. 1:10,000) for the siting of masts and cables etc. across borders. Knowing the locations of demand**

Pillar / Topic	Possible link to DRDSI's approach and INSPIRE Themes
	for ICT could also be useful
(1) Better overall transport systems in terms of sustainability and quality;	INSPIRE Themes: (i) Transport Networks, (ii) Population Distribution – Demography, (iii) Administrative Units and (iv) Statistical Units could all be used to map transport networks and areas of demand. In addition, (v) Land Use could help to refine some of the details of economic activity and demand, with (vi) Land Cover providing some initial indications of environmentally sensitive areas, plus most of the other domain-specific environmental data themes.
(2) Improve sustainable accessibility for all Alpine areas;	INSPIRE Themes: As above (at least for transport and Internet infrastructure)
(3) A better connected society in the region	INSPIRE Themes: (i) Population Distribution – Demography, (ii) Statistical Units and (iii) Administrative Units could all be used as a framework to map and analyse comparable data across borders.
Pillar 3. Ensuring sustainability in the Alps: preserving the Alpine heritage and promoting a sustainable use of natural and cultural resources.	**The protection of the environment and appropriate use of natural resources are built within the data models of INSPIRE, alongside data to help address natural disasters or some of the impacts of climate change. This pillar is likely to have the strongest ties with INSPIRE, especially as the pillar aims to establish efficient management systems which are likely to require could quality (geospatial) data.**
(1) Reinforcing Alpine natural and cultural resources as assets of a high quality living area.	INSPIRE Themes: Understanding where there are locations of tourism and centres of population (with related data) could involve the use of the (i) Population Distribution – Demography, (ii) Statistical Units and (iii) Administrative Units themes. Preserving and utilising key resources would include data from (iv) Hydrography, (v) Mineral Resources and (vi) Geology; whereas landscape and biodiversity measures could be obtained from (vii) Elevation, (viii) Land Cover, (ix) Protected Sites, (x) Bio-geographical Regions, (xi) Species Distribution and (xii) Habitats and Biotopes, amongst others
(2) Building further on the position of the Alpine Region as world-class in terms of energy efficiency and sustainable production of renewable energy;	INSPIRE Themes: In general, (i) Energy Resources (ii) Utility and Governmental Services and (iii) Hydrography (for hydroelectric or cooling etc.) are key themes for production and distribution of energy. Target areas can be mapped using (iv) Administrative Units, (v) Population Distribution – Demography and (vi) Statistical Units, with (vii) Protected Sites data models and/or datasets providing one example of data that would help to ensure potentially damaging activities were not taking place in environmentally sensitive areas. Mapping all together would give a good holistic picture of energy at a regional level. In addition, the energy efficiency

Pillar / Topic	Possible link to DRDSI's approach and INSPIRE Themes
	of buildings could involve using INSPIRE data and/or models at different scales, including the local level, including (viii) Buildings, (ix) Addresses and (x) Land Use.
(3) Alpine risk management including risk dialogue, to tackle potential threats, such as those of climate change	INSPIRE Themes: (i) Natural Risk Zones, (ii) Area Management Restriction Regulation Zones and Reporting units, (iii) Administrative Units and (iv) Statistical Units would all provide reference data (and models) for risk management. INSPIRE could also be used for risk assessment and calculation such as (v) Hydrography, (vi) Geology, (vii) Soil, (viii) Elevation, (ix) Land Cover and (x) Land Use could be used in assessments of flooding or landslides, where other themes could not only be used to assess impacts on sensitive environmental sites and populations at risk but also the location of sensitive industrial sites which could lead to secondary incidents, such as chemical spills or limits to energy supply. In addition, most INSPIRE data could also form the basis of public consultations and other discussions with stakeholders related to risk management in the macro-region.

INSPIRE has been designed to be a multi-purpose infrastructure, as shown by these initial assessments. In addition to the above, it should be noted that the Directive is based on and can be applied to a range of European environmental policies, including Environmental Impact Assessments (based on Directive 85/337/EEC[55]) and Strategic Environmental Assessments (based on Directive 2001/42/EC[56]), which both require the use geospatial data from local levels (e.g. for the construction of a new rail bridge) to macro-regional levels related to assessing the environmental impacts of policies and plans, respectively.

8.3.5 Management of information in a global context

Fifthly, the DRDSI has not developed independently of other actors in the region, and some of its activities have taken place in collaboration with the UN's Food and Agriculture Organisation and the World Bank. The main reason for this work is that their interests include **improving the management of information related to land ownership**, which in turn provide a means to improve, for example, taxation and anti-fraud mechanisms.

Such cooperation has provided useful case studies for the workshops the project has organised and advice about topics several of the countries are dealing with in this context, especially those from neighbouring countries. It can be seen that as mainly existing resources are being used for EUSDR development, such a partnership offers important perspectives for investors in larger scale infrastructures related to spatial data. By investing at the national level, and by promoting common UN guidelines, more data should be made available in the future in the region. The DRDSI has been

[55] http://ec.europa.eu/environment/eia/eia-legalcontext.htm

[56] http://ec.europa.eu/environment/eia/sea-legalcontext.htm

complementing such work by giving shape to EU needs in terms of policy interests in the frame of the EUSDR and INSPIRE, in particular, which have, in turn, better focussed the planning and deployment of resources in those countries who had limited capacity. Such priority setting is not trivial and by working in a cross-organisational context, the DRDSI has been able to reach a much larger audience, where recent workshops also received interest and support from, for example, other countries bordering the Danube region.

8.3.6 Long-term sustainability

Lastly, although a good sense of ownership has emerged with the Danube_NET and participating organisations, the **sustainability** of the DRDSI is a known challenge. The last year of the pilot project has been discussing and exploring different avenues to support ongoing and new topics related to the project's objectives. Work is in place to already build on the lessons of the DRDSI within other JRC projects but, given the interest of project partners, the DRDSI should ideally become a macro-regional resource governed by an international actor in the Danube Region. Voices of support have been made from many quarters, including decision-makers at national and European levels but a champion may be needed to ensure all the progress made for the region is consolidated and allowed to develop further, with the appropriate technical expertise.

The first months of 2017 will see additional work on analysing various handover scenarios of handover of the platform and its related service links to the Danube Region, looking at aspects such as long-term sustainability and quantification of costs and benefits, as an aid to planning but also a means to further research on data-sharing policies and technologies as part of a digital economy.

Although the DRDSI project will soon end, the JRC will be undertaking activities to help with its hand-over and sustain some of its components as ongoing support. The seed money invested in the pilots already offers opportunities for new projects to invest and extend their successful outcomes to create more operational products and services and the DRDSI team can provide advice about where work could be developed. Importantly, the JRC is also maintaining the platform in the medium term and offering it as a specific resource for macro-regional data as part of the JRC's newly formed Knowledge Centre for Territorial Policies[57]. Plans are also being made to continue the involvement of Danube_NET in data infrastructure projects, including the work already underway with citizen science actors (see Section 7.3.4).

Similarly, the findings and experience of the DRDSI are feeding back into ongoing JRC projects and initiatives, especially the JRC's own developments in Open Data policies and technologies and DIGIT's ISA and ISA^2 Programmes to develop interoperability solutions for public administrations, businesses and citizens. Lastly, INSPIRE has played a fundamental role in the conception and implementation of the DRDSI. The results of this re-purposing are also providing details for research topics as well as highlighting a means to transfer some of the knowledge of the project to other parts of Europe, where INSPIRE is being considered as the *lingua franca* for geospatial data-sharing in Europe.

[57] https://ec.europa.eu/jrc/en/territorial-policies

9. Conclusions

The DRDSI Pilot Project has mainly involved the management and sharing of geospatial data, based on the JRC's experience of coordinating the design and implementation of the INSPIRE Directive. The inclusion, however, of technologies and approaches from Open Data initiatives has introduced new aspects to this work, where research and development was needed to, for example, remodel some of the catalogues used to capture details about datasets (i.e. metadata) and the addition of map technologies to an Open Data portal so that geospatial data could be visualised and explored. In addition, the work has been a cross-sector activity, aiming to combine data from public administrations and from research (including outputs of the JRC), with more emphasis placed on the former due to more mature policy frameworks aiding access to data in many countries, both within the EU and with countries of the neighbourhood within the Danube region.

Another key aspect of the research dimension of the DRDSI is the policy context of the EUSDR. Already, INSPIRE has a large scope covering some 34 data themes in the Directive's annexes but the EUSDR includes other topics more related to social data. The project, therefore, has also been an opportunity to explore how INSPIRE principles, technologies and existing datasets can be 'reused' to support the EUSDR. This work is not necessarily grounded in any theoretical approach but it importantly helps to demonstrate in practice the ability to generate and manage data for one purpose and reuse it for many, with additional benefits and evidence for making such investments.

A challenge for this work has also been exploring the establishment of a data infrastructure for a macro-region, including issues of scale and the data in scope. It can be argued that there is a natural cohesive force stemming from the shared catchment of the Danube by the countries who are members of the EUSDR. This natural collection certainly applies to many issues that the EUSDR is aiming to address but it can also be recognised that macro-regions are very large territories with notable differences in local geographical context, environmental dynamics, political composition, law-making and policy development, EU membership, accessibility to resources and economic development, to name a few. These differences clearly create challenges in implementing an infrastructure, compounded by the fact that nearly all stakeholders involved are starting from highly varied levels of experience in the project's key topics and capacity to reach key objectives. These issues are reflected in both our experience for any further strategic and operational concerns.

Due to this diversity, the creation of a network of experts has been a key factor of success of the project, having contributed to the establishment of a community of stakeholders within and between countries, representing a strong asset for the Danube Region to further develop the culture of openness and streamline access to knowledge. Having the DRDSI project has not only helped to create the key components of a data infrastructure but also a vehicle for collaboration for organisations across the region and support a process of, sometimes, marked organisational change in how they can work internally and with others.

9.1 Data are crucial for macro-regional strategies

The main aim for the DRDSI to help better share the data relevant to the EUSDR. The project has uncovered a range of data-related issues that not only relate to technical issues but also socio-organisational ones. As interest in the project grew the rhetoric for

the need for data also increased, including from key voices in the Commission and Priority Areas. Readily available and shared data resources should for the base for more transparent policy. Better data management touches the whole policy, including policy formulation, monitoring and evaluation. Given our interests in geospatial data and the nature of territorial policies, we also recognised and provided evidence that data is an asset transferred between actors across borders, towards common resources for the region such as indicators and is reusable at local, regional and macro-regional scales. Data-sharing should not be seen as an objective in its own right but a means to support such aims but, equally, it should also be valued as part of the strategic processes that macro-regions engage with. The DRDSI has brought stakeholders together from across the Danube Region and the topic of data has provided a focus. Within this context it should, therefore, also be acknowledged that data can also be viewed as having worth as a policy, organisational and, perhaps, cultural artefact, where all stakeholders at all levels need to best understand their relationship with it to ensure its optimal use and long-term preservation.

9.2 The best use of investments and the targeting of resources require data

In exploring the data that could be included in the scope of the DRDSI the project looked into the EUSDR key policy documents and asked experts to identifying ongoing research activities within their countries that could provide further avenues for development. As the EUSDR, like many policies, aims to use existing resources it is important to know what details are already available about the condition of the macro-region. Such underpinning data has varying characteristics and the validity of different sources requires more examination. The projects attempt to bring research data into the infrastructure were limited to collaborating European projects.

Issues such as data author citation and restrictive data policies meant that some facts remained within organisations. Sharing data reflects the relationships between sectors, including between public administrations and research bodies and the gap we identified will remain a difficult one to close until research funders encourage more data to be made available online and in standardised means, both technically and in terms of data licencing, otherwise some of the most valuable facts will not be available.

A related consequence uncovered through the DRDSI's research has been that some decision-making is not being based on territorial data, or at least data coming from the sub-national level. There are clearly important issues about data being used from official sources but further debate is needed about the value of Open Data coming from the efforts of citizens, such as geospatial data shared through OpenStreetMap and how, rather than competing with official data, such data may help to complement it. Setting in place the right plans for data and exploring the value of varied sources could help to make the most of data infrastructure efforts in the future.

Discussions and preparations for the next Multiannual Financial Framework, most likely to cover the period 2021 – 2027 have already begun. In a period of increased budget restrictions, solid fact and figures will more than ever be needed. It is expected that an increased availability and access to Open Data will positively contribute to the building up of a solid knowledge base. However, concrete figures on the costs and benefits of Open Data require further investigation, in part to validate the notions of a European information society to make the most of the possibilities of ICT but also to provide much

needed evidence to convince decision-makers that, for example, creating more harmonious data policies that free up data can lead to better decision-making, including across borders, and an opportunity for tax revenues stemming from the creation and sale of value-added and innovative products, from either local or cross-border business The emergence in the last few years of an 'apps' market for smart phones offers a direct example in this context, as comparable data sources could foster the development of a relatively new and large market. Beyond economic arguments, the development of indicators such as the GODI, and the subset explored here for Danube countries, should also be explored further so that other elements of progress can be explored, including any regional specialisation that offers any additional economic benefits.

9.3 Countries face similar challenges, so experience should be shared

The idea to establish the Danube_NET group of experts not only helped to implement the technical infrastructure and identify data and missing information but also provided various avenues for exchanging opinion and providing comparable evidence. The creation of macro-regions has, at its hard, notions of spaces that share common values, history, culture, economic challenges and, perhaps most importantly, a will to achieve common solutions. On the one hand, the studies and pilots the DRDSI put in place allowed a certain amount of knowledge exchange from the west of the region to the east but, significantly, some important lessons for the whole region were also found in countries such as Moldova who were making good in-roads to Open Data policy and technologies. A shared feature such as the region's water resource and how to best manage it across borders is a common challenge that requires collaboration and timely access to comparable data.

The DRDSI's close collaboration with coordination bodies such as the ICPDR in their data infrastructure developments was one avenue which allowed common approaches to evolve and illustrated an important cycle of data from JRC research feeding into pan-national policy processes and, in a new turn, the results transferred back to the region through the DRDSI platform and a related User Story. The DRDSI, through workshops and online tools, also aimed to facilitate the sharing of more experience, including with a wider international audience by involving the World Bank and FAO in their related land management initiatives. This report allows us to sketch some of the experience gained but a more structured approach could also be explored. For example, Priority Areas appoint data ambassadors so that both EUSDR countries and the Priority Areas' topics and key actions can be examined together in order to come to a common understanding of common methodologies and what (existing and new) data that can be involved in addressing them. Moreover, as noted above, there is a crucial need to harmonise data policies across the EUSDR to make data more accessible and reusable. A macro-regional strategy should be a good arena for policy discussions on such matters to take place, both drawing on and providing feedback to the objectives of wider EU policies such as the PSI Directive and INSPIRE.

9.4 Common solutions developed to address them to continue collaboration

The DRDSI planned to fill gaps in existing data resources from the outset but the approach also aimed to undertake pilots that would offer demonstrators for the better

use of data and improvements to the region's data-sharing activities. The notion of common solutions should be understood from two main perspectives.

Firstly, the use of open source software allows technology to be redeployed, re-purposed and readily adapted, provided the right technical skills are available. As promoted by DIGIT, the reusability of technology is felt to provide these and other benefits and all investments made by the DRDSI have followed this approach, which would also allow the DRDSI platform to be exported from the JRC, if necessary. A related aspect is the need to build activities incrementally and favour an approach that involves 'learning by doing'. No partner in such activities has all the knowledge and a readiness to stop, re-configure and focus on new needs has certainly aided the development of the DRDSI with its partners.

Secondly, the development of most of the pilots involved the collaboration of more than one organisation towards joint outputs. This can be seen from the researchers at the University of Belgrade helping to bring metadata online from several public administrations and German private sector partners providing support to the transformation of Moldovan and Ukrainian map data to fit the data model requirements of INSPIRE. This and related training activities, especially with partners outside the EU, form part of a capacity building package that has been one of the key achievements of the project. Moreover, it should be emphasised that the end products of these pilots as online metadata and data were the main objectives to be achieved but that a shared sense of contribution to the infrastructure and the resources that this would offer collectively to the region was welcomed by all stakeholders. As noted above, the selection of EUSDR most valuable datasets to create harmonised content across the region is work that requires further investigation, especially as new priorities are emerging in the course of the strategy's implementation.

9.5 Seed investments create sustainable and transferable results

In a shifting technical context, it is important to be agile and provide results quickly. Three of the pilots, with some initial funding, were able in the course of the project to show how Open Data can readily support new data products and services, whose outputs can also be reused by others as well as offering opportunities for innovation and new ways of working. The rapid design of an application for citizens interested in urban agriculture in Slovakia based on Open Data and the developments at a hackathon engaged people from different backgrounds, including a non-governmental organisation interested in taking this application to a wider base across the region. Given the common input data, only small investments would be needed to transform the prototype into a more mature solution for other countries.

Similarly, the pilot with the University of Salzburg to develop indicators that better reflect the nature of issues at a local level (rather than only using political boundaries) offered the opportunity to not only further an interesting line of research but also offer reference material that could be used by investors to better understand the impacts of, for example, regional economic policy, where the methodology could be extended to cover more variables, such as the details being used to drive and help monitor other important JRC initiatives such as Smart Specialisation. In addition, the nature of geospatial data allows information to be brought together from different sources into a single analytical frame. This was a driver for the pilot that explored the natural hazards of the region and the cultural heritage sites that were at risk from them. This interdisciplinary approach based on Open Data, which also brought elements of INSPIRE

out of the purely environmental and science context to include the arts and humanities, can also be seen as a starting point to discuss the consequences of such findings with those aiming to protect such sites and, for example, to better involve citizens in this context but supporting them in the use of the pilot's data to both indicate if the risks were known and if any important sites, from the perspective of the local population, had been overlooked. Data is an enabler for discussion and maps can be an important vehicle for collaboration.

References

- Akinyemi, F.O., Evaluating Access to Spatial Data Information in Rwanda. URISA Journal , Vol. 23, No. 2, 2011, pp31-40.
- Castelein, W. T., Bregt A. K., Grus, L. (2013): The Role of Collaboration in Spatial Data Infrastructures. URISA Journal, Vol. 25, No. 2, 2013, pp. 31-40.
- Cetl, V., Tóth, K., Abramić, A. and Smits, P. (2013): Report on the Status of INSPIRE in the Balkan Countries. JRC Technical Reports, European Commission Joint Research Centre, EUR EUR 26392 EN, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC86293/lbna26392enn.pdf
- de Andrade, F.G., de Souza Baptista, C. and Leite, F.L., Using Federated Catalogs to Improve Semantic Integration among Spatial Data Infrastructures. Transactions in GIS, Vol. 15, No. 5, 2011, pp. 707–722.
- Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) (OJ L 108, 25.4.2007, p. 1–14), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0002:EN:NOT
- Directive on the re-use of public sector information (2003/98/EC), revised by Directive 2013/37/EU, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:175:0001:0008:EN:PDF
- Lang, S., Kienberger, S., Tiede, D., Hagenlocher, M., Pernkopf, L. (2014). Geons - domain-specific regionalization of space. Cartogr Geogr Inf Sci. 41 (3): 214-226. 10.1080/15230406.2014.902755,
- Löhrer, R., Reichling, J. and Behrens, L. (2014) Service "www.GeoLizenz.org" - reliable and standardized licensing of geodata in Germany. INSPIRE Conference 2014, Aalborg, Denmark
- Masser I., GIS worlds: creating spatial data infrastructures. ISBN: 1-58948-122-4. ESRI Press, Redlands (CA), 2004.
- Masser I., Crompvoets J. 2015. Building European Spatial Data Infrastructures. ESRI Press (Redlands, USA)
- Nebert, D. D., editor (2004). Developing Spatial Data Infrastructures: The SDI Cookbook v 2.0. Global Spatial Data Infrastructure, http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_GSDI_2004_ver2.pdf
- Rajabifard, A. and Williamson, I. P., Spatial data infrastructures: concept, SDI hierarchy and future directions. Proceedings of GEOMATICS'80 Conference, Tehran, Iran, 2001.
- Smith, R.S., Kotsev, A., Gerlach, H. and Dusart, J. (2015) Danube Region data projects. JRC Technical Report ISBN 978-92-79-54245-9
- Scientific Support to the Danube Strategy, Concept paper. 2014 http://ec.europa.eu/dgs/jrc/downloads/events/20130516-danube-strategy/jrc-20130516-danube-strategy-concept-paper.pdf
- Tóth K., Portele C., Illert A., Lutz M., Nunes de Lima V. A. 2012. Conceptual Model for Developing Interoperability Specifications in Spatial Data Infrastructures. JRC Reference Reports, European Commission, Joint Research Centre, EUR 25280 EN,

http://publications.jrc.ec.europa.eu/repository/bitstream/JRC69484/lbna25280enn.pdf

- Wehn de Montalvo U., Outreach and Capacity-building. In: Developing Spatial Data Infrastructures: The SDI Cookbook v. 2.0, D. Nebert (Ed.) Global Spatial Data Infrastructure (GSDI), 2004, pp. 96-117.

List of abbreviations and definitions

Abbreviations

Abbreviation	Meaning
ARE3NA	A Reusable INSPIRE Reference Platform
CKAN	Comprehensive Knowledge Archive Network
CORINE	"Coordination of information on the environment" programme
CSP	Citizen Science Platform
CSW	OGC Catalogue Service for the Web
DAE	Digital Agenda for Europe
DG	Directorate-General
DG REGIO	EC Directorate-General for Regional and Urban Policy
DIGIT	EC Directorate-General for Informatics
DRDSI	Danube Reference Data and Services Infrastructure
DSM	Digital Single Market
EASIN	European Alien Species Information Network
EC	European Commission
EEA	European Environment Agency
EFTA	The European Free Trade Association
EIA	Environmental Impact Assessments
EIONET	European Environment Information and Observation Network
EP	European Parliament
ESPON	European Observation Network, Territorial Development and Cohesion
EU	European Union
EULF	European Union Location Framework
EUPL	European Union Public Licence
EUSAIR	European Union Strategy for the Adriatic and Ionian Region
EUSALP	European Union Strategy for the Alpine Region
EUSDR	European Union Strategy for the Danube Region
F/OSS	Free and Open Source Software
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GI	Geographical Information
GIS	Geographical Information Systems
GML	Geography Markup Language
GODI	Global Open Data Index
GSDI	Global Spatial Data Infrastructure Association
HALE	Humboldt Alignment Editor
IAS	Invasive Alien Species
ICCROM	International Centre for the Study of the Preservation and Restoration of Cultural Property
ICPDR	International Commission for the Protection of the Danube River
ICT	Information and Communication Technologies
INSPIRE	Infrastructure for Spatial Information in the European Community
IPA	Instrument for Pre-Accession Assistance
IPR	Intellectual Property Rights
ISA	EU Programme on Interoperability Solutions for European Public Administrations
JRC	Joint Research Centre
LUCAS	Land use and land cover survey
MS	Member States of the European Union

Abbreviation	Meaning
NMA	National Mapping Agency
NMCA	National Mapping and Cadastral Agencies
NUTS	Nomenclature des unités territoriales statistiques
OECD	Organisation for Economic Co-operation and Development
OGC	Open Geospatial Consortium
PA	EUSDR Priority Area
PSI	Public Sector Information
RGA	Republic Geodetic Authority of Serbia
SDI	Spatial Data Infrastructure
SEA	Strategic Environmental Assessments
SEIS	Shared Environmental Information System
TAIEX	Technical Assistance and Information Exchange instrument of the European Commission
TJS	Table Joining Service
UNECE	United Nations Economic Commission for Europe
UNGGIM	United Nations Committee of Experts on Global Geospatial Information Management
WCS	OGC Web Coverage Services
WFS	OGC Web Features Services
WMS	OGC Web Map Services
XML	Extensible Markup Language

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Annexes

Annex I Comparison of key geospatial Map GODI themes, EUSDR Priority Areas and INSPIRE Data Themes

EUSDR Priority Area	INSPIRE Themes	Examples of use
PA1: Mobility and Multi- modality	Transport Networks	Spatial data on transport networks should aid cross-border and macro-regional analyses on mobility. Accessibility data may also be used in other studies, such as the JRC Bioenergy Nexus product transport studies and the Air Quality Nexus modal shift studies between road and water transport
PA2: Sustainable Energy	Utility and governmental services Agricultural and aquaculture facilities Energy resources	Energy supply and waste data (relevant to the Bioenergy Nexus) are within the scope of utility and government services. Agricultural residues are also of interest to Bioenergy Energy resources include data on renewable resources including bioenergy, solar and wind
PA3: Culture and Tourism, People to People	Protected Sites Buildings	The specific conservation objectives of Protected Sites can include archaeological and cultural heritage sites In some cases, details of buildings may also be relevant for cultural heritage and tourism A pilot is running in the DRDSI on analysing cultural heritage sites at risk from natural hazards in the Danube region
PA4: Water Quality	Hydrography Geology	Water quality is influenced by biological, chemical/physical and morphological factors. The specific water course details of the river, its tributaries and other water bodies are covered in the Hydrography theme. In addition, the geology theme covers details for groundwater. Specific details of the water quality

EUSDR Priority Area	INSPIRE Themes	Examples of use
	Environmental Monitoring Facilities (Other themes)	monitoring can be contained in the data associated with Environmental monitoring facilities. Many of the other INSPIRE themes would also provide data for modelling and analysing water quality, including Land Use and Land Cover.
PA5: Environmental risks	Natural risk zones Hydrography Environmental Monitoring Facilities Geology Atmospheric conditions Meteorological geographical features Human health and safety Population distribution — demography Buildings	Existing data may already describe known risks and outputs can be shared through INSPIRE according to Natural risk zones Hydrography may also help in the assessment of flood related risks, as could Environmental Monitoring Facilities. As Geology also includes geomorphology, some natural hazard data may be found here. Atmospheric conditions and Meteorological geographical features are also important data to help assess risks, including modelling issues by the JRC's Water Nexus and the extension of the CarpatClim data. Lastly, in measuring the impacts of environmental risk analysts may wish to know what specific Buildings could be affected or obtain data on Human health and safety and, more specifically in risk events, Population distribution - demography.
PA6: Biodiversity, Landscape, air and soil quality	Protected sites Area management/restriction/regulation zones and reporting units Species distribution Habitats and biotopes Bio-geographical regions Environmental monitoring facilities Land use	As INSPIRE focusses on environmental data, this PA can be seen to contain many of the themes which can be seen to cover both measurement data as well as policy boundary datasets such as Protected sites, Area management/restriction/regulation zones and reporting units. Biodiversity is specifically covered with Species distribution, Habitats and biotopes and Bio-geographical regions, alongside relevant data for Environmental monitoring facilities. Landscape can also be included

EUSDR Priority Area	INSPIRE Themes	Examples of use
	Land cover Geology Orthoimagery Elevation Atmospheric conditions Meteorological geographical features Production and industrial facilities Mineral resources Soil Oceanographic geographical features Sea regions (Other INSPIRE Themes)	through themes such as Land use, Land cover and Geology (again as geomorphology). The visualisation of landscapes may also include data from Elevation and Orthoimagery themes. Land Use and regional planning issues are also of interest to the Air Quality Nexus and the examples in the DRDSI platform related to LUISA. Atmospheric conditions and, potentially, Meteorological geographical features can be linked to air quality, as well as Environmental monitoring facilities, certain reporting units (noted above) and sources of pollution, including Production and industrial facilities or Mineral resources The Soil theme clearly relates to soil quality (where topics related to ecology, geology and hydrology could also be considered as well as themes dealing with industrial emissions, not specifically mentioned here). Lastly, Oceanographic geographical features and Sea regions are somewhat out of scope for the EUSDR but some data related to the Black Sea coastline of EUSDR countries and the Danube Delta may be found in these data themes.
PA7: Knowledge Society PA8: Competitiveness PA9: People and Skills PA10: Institutional capacity and cooperation	Coordinate reference systems Geographical grid systems Elevation Geographical names	Reference data themes in INSPIRE may also be included as topographic data found in the GODI's "National Map" and could form the basis of organising data relevant to the work of these PAs or offer data products that could boost the region's economy as part of the Digital Single Market, of potential interest to PA7, PA8, PA9 and PA10.

EUSDR Priority Area	INSPIRE Themes	Examples of use
PA11: Security	Addresses Administrative units Orthoimagery Cadastral parcels Statistical units	Coordinate reference systems, Geographical grid systems, Elevation, Geographical names and Addresses specifically allow other data sources to be linked to positions on the Earth's surface at different scales. Administrative units show the specific extent of a country or other territory and could be of interest in general to mapping progress in regional development in specific regions/countries or for issues of security in PA11, alongside Orthoimagery which would include earth observation data such as the satellite data services being developed through Copernicus. Cadastral parcels (and sometimes Addresses) can be used to build other reference datasets, including mapping census data such as Statistical units (an example discussed below). Cadastral data is also important for the property market and can play an important part of some economies, linked to PA8.

Annex II Comparison of Thematic GODI themes, EUSDR Priority Areas and INSPIRE Data Themes

Other GODI themes and DRDSI Relevance	EUSDR Priority Area	INSPIRE Themes	Examples of use
Pollutant Emissions (**High**)	PA6: Biodiversity, Landscape, air and soil quality (PA4: Water Quality)	Environmental monitoring facilities Human health and safety Population distribution-demography Area management/restriction/regulation zones and reporting units Atmospheric conditions Meteorological geographical features Production and industrial facilities Buildings	Depending on the scale of analysis, pollutant information may be served through INSPIRE services, including near real time monitoring data for air quality directives Pollutant emissions may also relate to discharge or dispersion to water bodies (see below)
Water Quality (**High**)	PA4: Water Quality (PA5: Environmental risks)	Hydrography Geology Environmental Monitoring Facilities (Other themes)	As noted above for PA4, details of water bodies and hydrographic networks are defined by INSPIRE. Quality monitoring measurements should be contained in Environmental Monitoring Facilities datasets. A range of other themes may be impact on the multi-thematic and interdisciplinary nature of dealing with water quality which would range from ground water quality conditions which may naturally have higher than expected

Other GODI themes and DRDSI Relevance	EUSDR Priority Area	INSPIRE Themes	Examples of use
			concentrations of, for example, heavy metals; the impacts of land use on sediment load in rivers (impacting on freshwater ecology), the leachate from solid waste sites, the deposition of atmospheric pollution in lakes, the discharge of waste waters from mineral extraction or other industrial facilities, the possible impacts of waste from aquaculture, the level of treatment of urban waste waters and the possible impacts of environmental hazards including chemical spills related to PA5.
Weather Forecast (**High / Med**)	PA4: Water Quality PA5: Environmental risks PA6: Biodiversity, Landscape, air and soil quality	Atmospheric conditions Meteorological geographical features	This data can be seen as valuable data on a daily basis for citizens in the region but well managed and detailed meteorological data can be used as inputs for a range of modelling tasks related to water quantity (and quality) issues from droughts to flooding. Air quality concerns may also benefit from some weather data as certain pollutants respond differently to temperature, sunlight and for local cases, wind direction. Lastly, weather and broader atmospheric and climatic conditions help to define the limits of most species.
National Statistics (**High**)	PA3: Culture and Tourism, People to People PA7: Knowledge Society PA8: Competitiveness PA9: People and	Statistics Administrative units Population distribution — demography	The mapping of existing statistical data to well managed statistical map units, such as census areas related to Population distribution — demography or political boundaries in the form of Administrative units. Such geostatistical data supports a

Other GODI themes and DRDSI Relevance	EUSDR Priority Area	INSPIRE Themes	Examples of use
	Skills PA10: Institutional capacity and cooperation		large number of decision-making tasks in many public administrations. They can be used for benchmarking progress in the implementation of policies, including the EUSDR, and can be seen in the work of the Smart Specialisation Nexus where regional indicators are being used to aid competitiveness. They can also be used in complex modelling activities of territories, especially when combined with land use data for regional planning activities. Combining official statistical and geospatial data can also provide a sustainable source of information for the development of value-added applications.
Land Ownership (**Med**)	PA3: Culture and Tourism, People to People PA7: Knowledge Society PA8: Competitiveness PA9: People and Skills PA10: Institutional capacity and cooperation	Cadastral parcels	Land ownership is important for the economic development of an area (related to PA8), including the tax raising powers of a country and the subsidies for agricultural activities. Work by the World Bank and FAO on land tenure, and promoted by the DRDSI, has highlighted the importance of this activity in the EU's neighbouring countries. This includes modernising e-government systems to manage cadastral information (of potential interest to PA7) and giving local people the chance to quickly map their properties using technologies such as GPS and camera-enabled drones, of potential interest to PA3, PA9 and PA10.

Annex III Country profiles

Austria

Coordination role in EUSDR

- PA 1a "To improve mobility and intermodality"
- PA9 "To invest in people and skills"
- PA10 "To step up institutional capacity and cooperation"

A. Facts and figures	
GODI ranking[58]	23
Datasets in DRDSI (total)	1 824
Open Data portal	994
INSPIRE Discovery service	830
Danube_Net inventory	0

Danube_Net Austria:

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B. Key findings

B1. Policy

- Austria has a well developed data infrastructure mainly based on the open government data and INSPIRE platforms. These two data sources are highly related to each other. Most datasets in INSPIRE and as well in the Open Data context have standardised licencing for access(cc-by-sa AT) . During the last years the amount of available datasets as well as the metadata quality have risen.
- One of the challenges is the federal structure in Austria. Directives have also to be implemented in federal states' law. It can be seen that different regulations (INSPIRE, PSI) are not in conflict with each other, in contrast they support the availability of data. However the INSPIRE directive is seen as cumbersome. Improvement is a long-lasting process. Whereas the used standards of open government data is based on general agreement nationwide.

B2. Technological

- There already is a vide range of data available. Data harmonisation and validation of metadata is still seen as a challenge. Further the access and registration process of some base data is time consuming. Search algorithms should improve.
- Many data providers linked INSPIRE and open government data platforms. Through the INSPIRE directive the availability of viewservices (WMS) as well as downloadservices (especially WFS) have improved. Additional information of already realised projects on the website of the (metadata-)platform are a proof of reuse of data and a possibility to present outcomes.

B3. Organisational

- The collaboration between the authorities works well on the technical level of publishing of data. There is an greement of a metadata standard of the open government data. The reusability of many data is limited because of the heterogenic structure of datasets in the federal states and other authorities. There is a need of harmonised data within Austria as well as beyond national boarder.
- Spatial data infrastructures exist on federal states and other authorities. There are also geoportals which try to work supra-regionally. - Nethertheless there is a challenge to promote sustainable ressources to develop and maintain plattforms as well as the quality of existing data. A national registry is under development.

Open Data portal: https://www.data.gv.at

National Geoportal: http://www.inspire.gv.at

[58] Global Open Data Index ranking (data for 2015 out of 122 countries).

Bosnia and Herzegovina

A. Facts and figures	
GODI ranking[59]	n/a
Datasets in DRDSI (total)	162
Open Data portal	0
INSPIRE Discovery service	0
Danube_Net inventory	162

Danube_Net Bosnia and Herzegovina:

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B. Key findings

B1. Policy

- In Bosnia & Herzegovina, the INSPIRE Directive is not binding. However, in order to create a legal framework for its implementation in Federation Bosnia & Herzegovina and to enforce Regulation on IPP, the Strategy SDI was adopted, established by the Council of SDI. In the Republic Srpska part of the Law on Real Estate Cadastre covers the SDI area. So, the INSPIRE Directive is not binding, but they are working on creating a framework (legal, technological and financial) for efficient information exchange and for implementing the rules of the INSPIRE Directive.
- The difficulties are reflected in the complex structure of the Bosnia & Herzegovina (two entities and Brcko District), which causes the different dynamics in the creation of the preconditions for a successful exchange of information and Open Data.

B2. Technological

- Data collected in the traditional way are updated once a year. Some institutions that follow international trends update their data daily - and publish them weekly. The main problem is the overlapping responsibilities in the collection and presentation of data, and a lack of authority for specific topics (e.g. Geographical names, Sea regions, Land cover, etc.).
- Geoportal Administration for Geodetic and Property Affairs of the Federation of Bosnia & Herzegovina (FGA) is one of the good examples of publication and sharing of data. FGA served as a demonstrative example to other institutions of this entity as a positive example of publishing their data. After that, obtaining data through the portal started with other institutions in the entity as well. Geoportal Administration for Geodetic and Property Affairs of the Republic Srpska (GARS) have trouble in maintaining its Geoprotal. We will mention projects currently under implementation: IMPULSE project IPA Adriatic CBS program, Via Dinarica, Remediation risk of natural disasters (DRR), Green Economic Development - GED, Natura 2000, Erasmus +: BESTSDI, etc.

B3. Organisational

- Organizations in Bosnia & Herzegovina are not yet ready to share their data. They are not even willing to publish them, regardless of the existence of legal obligations for data exchange between state institutions and the right of access to information to individuals. Many institutions are not technologically ready nor have the staff to improve the situation.
- Most organizations in Bosnia & Herzegovina are not ready to use the DRDSI platform. They should work on improving the capacity (staff) which is now impossible since the prohibition of employment in government organizations is enforced. They should work on training the existing staff, and on networking the institutions that have a predisposition to exchange data. They should also work on the publication of the existing registers and data.

Open Data portal: N/A

National Geoportal: http://www.katastar.ba/geoportal

[59] Global Open Data Index ranking (data for 2015 out of 122 countries).

Bulgaria

Coordination role in EUSDR

- PA3 "To promote culture and tourism, people to people contacts"
- PA11 "To work together to tackle security and organised crime"

A. Facts and figures	
GODI ranking[60]	16
Datasets in DRDSI (total)	220
Open Data portal	56
INSPIRE Discovery service	20
Danube_Net inventory	144

Danube_Net Bulgaria:

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B. Key findings

B1. Policy

- There are recent positive changes in terms of policy, strategies and legislation. There is good existing policy (and legislation) on data provisioning, regulations for paid data, etc. However there is still no "data market" in terms of one-stop-shop for spatial data as the national geoportal holds minimum set of services. Good example for single data market is the Open Data portal.
- Recent policy changes will require more time to be fully implemented; Inherited issues with data quality, proprietary data encoding and software systems prevent the timely policy implementation;

B2. Technological

- Overall estimation is that software availability is not an issue - many licenses are available in all key data providers. There is recent notion to start using open source software products (desktop and server platforms, which was not the case several years ago). Majority of the software is in English language, which is not an issue. All governmental application information system (GIS and non-GIS) are in Bulgarian language. From hardware and network view point there is good foundation in terms of data centres, governmental network, servers, workstations, etc. Variety of spatial data is existing, however there are still many issues with data quality in terms of spatial accuracy, complete country coverage/data fragmentation, data redundancy, obsolete data, lack of metadata, etc. Usually good quality data is only the one reported under EU requirements (e.g. WFD reporting requirements, etc.). There are no technical obstacles on data publishing and sharing, however the impression is that agencies are not willing to share data due to poor data quality. Another technical limitation is that many of the existing information systems are proprietary and there are many contractual and maintenance license limitations on opening and further developing
- There has been great progress in the past two years in the Open Data movement in Bulgaria - Open Data hackathons, workshops, setup of Open Data portal, government regulations, legislation, strategies, etc. Since June 2016, the Electronic Governance Act specifies the usage of open source software for governance. Also in the past year Bulgaria managed to overcome the long delay in the implementation of INSPIRE and has now a clear implementation road map, national geoportal with increasing number of INSPIRE compliant web services.

B3. Organisational

- Organizations are ready to share some of the spatial data, which they consider accurate and up-to-date and for which they receive constant requests from NGOs, academia, open public or other agencies. However the legacy data and data quality is the strongest obstacle for opening and sharing the data and therefor the organizational and management constrains.
- Overall the country expertise is good in terms of spatial data management and exploitation. However the government employee's turnover is quite high and expertise is difficult to be maintained in house. There is strong necessity for dedicated trainings on SDI/INSPIRE, networking activities, aiding communications.

Open Data portal: http://opendata.government.bg

National Geoportal: http://inspirebg.eu

[60] Global Open Data Index ranking (data for 2015 out of 122 countries).

Croatia

Coordination role in EUSDR

- PA6 "To preserve biodiversity, landscapes and the quality of air and soils"
- PA8 "To support the competitiveness of enterprises"

A. Facts and figures	
GODI ranking[61]	n/a
Datasets in DRDSI (total)	416
Open Data portal	84
INSPIRE Discovery service	133
Danube_Net inventory	199

Danube_Net Croatia:

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B. Key findings

B1. Policy

- SDI was already regulated in 2007 with the Law on State Survey and Real Estate Cadastre (Official Gazette 16/07, 124/10). In 2013 a NSDI Act (Official Gazette 56/13) fully transposed INSPIRE into national legislation. This is the mainstream of regulative on sharing the data in Croatia. Besides that, there is cronology of attempts on developing Open Data sharing principle. In 2011. Republic of Croatia sent letter of intention to participate in Open Government Partnership. Since then, through acceptation of Action plan for implementation of Partnerhip for the open government in Croatia, then introducing Law on right to acces information of public sector ((Official Gazette 25/13), and it's amendments by which it incorporated obligation to publish information in machine-readable form, the attempts resulted in creating Open Data Portal in Croatia, which was published in 2015. So, the policy is in place, but relatively young. Also, pricing and licencing policies are not so clearly defined.
- Open Data is a relatively young issue in Croatia, so, although the policy is in place it takes time for stakeholders to embrace the principles. Recent political instability and often leading staff changes put this issue lower on priorities list. Since the economic recesion took place, the main leverage for making decision are cost/benefit efficiency. As stated in Croatia INSPIRE Member State Report: Croatia 2016, from May 2016, almost no (quantitative) examples of benefits of the INSPIRE implementation can be given, so this presents one more chalenge for Open Data development.

B2. Technological

- The fact is that there is lack of reliable software on Croatian language, but I don't think this presents barrier, since English software is widely accepted in Croatian GIS community. Validation of certain data quality is questionable for some data out of INSPIRE scope. Also, data in larger scales, in higher level of details exists, but are difficult to discover and harmonize, since they are heterogeneus in authority.
- Positive outcomes of INSPIRE in Croatia can already be seen. E.g. recent actuality is that BESTSDI project is selected for financing from ERASMUS + KA2 Capacity Building. The Lead partner is Faculty of Geodesy in Zagreb, and it gathers 18 partners (universities and institutions) from Europe, mostly western Balkans countries. The goal is to enhance university curriculum by implementing concept of SDI and e-government in partner universities

B3. Organisational

- The SDI and Open Data concept is present on Internet media only on web sites designed mainly for experts. It would be more efficient if part of dissemination would be through mainstream media. Also, there are lot of legal entities that produce data (large number of cities and smaller municipalities) with different staff structure and heterogeneous work processes.
- Institutions on national level have the capacity to implement and exploit DRDSI since it can be applied and transfered from INSPIRE implementation, while local and regional bodies, lack the capacity. Complicated administration overloads employees in local administration, and takes time for progressive projects and work.

Open Data portal: http://data.gov.hr

National Geoportal: http://geoportal.nipp.hr/en

[61] Global Open Data Index ranking (data for 2015 out of 122 countries).

Czech Republic

Coordination role in EUSDR

- PA2 "To encourage more sustainable energy"

A. Facts and figures	
GODI ranking[62]	21
Datasets in DRDSI (total)	1 534
Open Data portal	73
INSPIRE Discovery service	1 461
Danube_Net inventory	0

Danube_Net Czech Republic:

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Short bio: Research activities related to infrastructures for spatial information, spatial planning and data integration. Coordinator of large EU projects in the field of geomatics.

B. Key findings

B1. Policy

- Key strategies and guidelines for Open Data sharing by public administration of the Czech Republic are emerging. Several national research projects are being funded to create guidelines for open (geographic) information sharing. A large amount of Open Data is already available through various platforms including the INSPIRE geoportal, the geoportal of the national mapping agency, basic registries and various Open Data portals run by different communities. In comparison with other European countries, the availability of Open Data is good.
- The Czech Republic has adopted the Strategy for the Development of the Infrastructure for Spatial Information in the Czech Republic (GeoInfoStrategy) in which Open Data should play an important role.
- The implementation of the strategies for Open Data sharing takes time due to historical and cultural development. The legal framework still requires significant improvements. There is an existing gap in standardisation, mainly of application schemas, of spatial data (including the INSPIRE data) and non-spatial data (Open Data initiatives) leading to difficulties in data reuse.
- In many cases, licencing of Open Data sources is not clear. This is a crucial point for data reuse. There are guidelines on licencing but these are not properly reflected in the legislation.

B2. Technological

- Both the INSPIRE and the PSI directives triggered a new era of data sharing in the Czech Republic. A number of EU projects focused on technical aspects of data sharing were sucessfully implemented by Czech partners (e.g. Plan4business, SDI4Apps, OpenTransportNet).
- There are no major technological obstacles to make data available and interoperable. The problems are mainly in organisational and legal aspects.

B3. Organisational

- There is a huge potential for data reuse in the Czech Republic. Companies and NGOs are ready to exploit and reuse public sector information. However, there is a lack of cooperation between national governmental bodies which results in delaying the entire process of data sharing.
- There are already som examples of of public-private partnership which will hopefully flourish in next years.
- Publishing Open Data and making them interoperable with other data sources is costly. More financial resources to support the interoperability and quality of Open Data would be of benefit. This includes both the research and the implementation sides.
- New ways for commercial exploitation of public sector information should be explored, taking into account succesful examples aborad (e.g. Ordnance Survey in the UK). Appropriate business models should then be adopted.

Open Data portal: http://linked.opendata.cz

National Geoportal: https://geoportal.gov.cz

[62] Global Open Data Index ranking (data for 2015 out of 122 countries).

Germany[63]

Coordination role in EUSDR

- PA6 "To preserve biodiversity, landscapes and the quality of air and soils"
- PA8 "To support the competitiveness of enterprises"
- PA11 "To work together to tackle security and organised crime"

A. Facts and figures	
GODI ranking[64]	26
Datasets in DRDSI (total)	614
Open Data portal	214
INSPIRE Discovery service	273
Danube_Net inventory	127

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Short bio: Professional background in geoinformation, standardization, SDIs. Representative for the German Surveying and Mapping Authorities in national and international standardization organizations (SDI Germany, OGC, ISO/TC 211, CEN/TC 287, etc.). He is also project coordinator of the working group "SDI Standards" of the AdV dealing with data modelling and the semantic harmonisation of the official surveying data in Germany.

B. Key findings

B1. Policy

- Due to the ongoing implementation process of INSPIRE the spatial data infrastructure (SDI) is already quite advanced in Germany, even if the data is still fragmented and often still not available for the public. The Spatial Data Infrastructure Germany (GDI-DE) is a national network with coordination structures within the meaning of the second sentence of Article 19(2) of the INSPIRE Directive

B2. Technological

- Considering the potential data sets for DRDSI it became obvious that by going beyond viewing services (raster data) there is a lack of data models. Sometimes data models are missing at all (e.g. statistical data which is mainly available in tables only). There is no common approach in describing vector data, no com-mon data encoding solution and so on. DRDSI is supposed to provide semantically enriched data which means to promote also the use of the model driven approach. This would be very helpful in areas which are not yet covered by INSPIRE.
- Missing metadata remain an issue. Even if the data providers are willing to create corresponding metadata, it was not possible to do that practically. The SDI in Bavaria provides tools and guide-lines for collecting metadata. The same issue arises when it comes to providing the data, for which a web map server is needed.

B3. Organisational

- Politically and technically, the implementation of the GDI-DE is managed within the context of e-government. The e-government initiative is the more general approach for all public administrations, the SDI initiative is a part of e-government, tackling geographic information.
- DRDSI data offering as well as the SDI activities are basically driven by data providers. Therefore, good quality data sets and services are available but often not sustainably used.
- For a long-term sustainability plan a strong link to the Bavarian Geoportal should be established. This will allow the users to search for DRDSI relevant data in the existing Geoportal since this will be up and running as well as maintained according to legal obligations, even the current DRDSI activities has been end-ed. Therefore, the content of the metadata could be adjusted to the DRDSI requirements allowing the search of DRDSI relevant data with the Bavarian Geoportal.
-

Open Data portal: https://www.govdata.de

National Geoportal: www.geoportal.de

[63] Baden-Württemberg and Bavaria only.

[64] Global Open Data Index ranking (data for 2015 out of 122 countries).

Hungary

Coordination role in EUSDR

- PA2 "To encourage more sustainable energy"
- PA4 "To restore and maintain the quality of waters"
- PA5 "To manage environmental risks"

A. Facts and figures	
GODI ranking[65]	n/a
Datasets in DRDSI (total)	75
Open Data portal	26
INSPIRE Discovery service	0
Danube_Net inventory	49

Danube_Net Hungary:

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Short bio: With over 25 years experience in the private and public sectors; including serving in government and on the board of large companies, founded and manages CTI an entrepreneurial project development.

Dr.Tech, civil engineering, Budapest University of Technology and Economics; MBA, Yale University, USA.

B. Key findings

B1. Policy

- Comprehensive policy framework and regulatory regime are not in place. While access to information for the public and the private sector in form of processed data has been evidently pursued, access to and reuse of public data is constrained mostly to actors in public sector. Although pricing has been regulated, in practice it is very fragmented as institutions are encuraged to generate revenues from data sharing, even within the public sector. The major barrier to data sharing (both public and private) is that the development of a well defined data market is still in progress.
- A recent government resolution (1310/2015) implies strong commitment, including to build a comprehensive overview of the public data domain that can lay the foundation of a coherent regime to regulate search, access, sharing and pricing. There are signals that the government considers public data a national asset.

B2. Technological

- ICT development is high on the agenda of the government. Government resolution 1561/2015 allocated €58 million to the e-Cadastre Project aiming at harmonization and making data from different sources interoperable. A similar amount was allocated to finance the creation of the NDI to directly serve public administration, economic development and the public, at large. There is a clear tendency of the evolution of various thematic GIS operated by public authorities and academy, many of which address topics of interest for thematic PAs of the EUSDR. As these GIS tend to have access to data from various sources (public and non-public) in an organized manner, it can be foreseen that these GIS could become the most feasible data contacts for EUSDR structures.
- Open Data: a draft White Book of National Data Policy prepared by the National Council for Telecommunications and Information Technology, a government advisory, has been publicly consulted and is due to be endorsed by the government.
- INSPIRE: as a direct result, a harmonization of INSPIRE data has been ongoing supervised directly by the Ministry of Agriculture, managed and hosted by FÖMI, which is assigned to build the national data portal. FÖMI is thought to become the potential technical access to EUSDR regarding access to and reuse of public data.

B3. Organisational

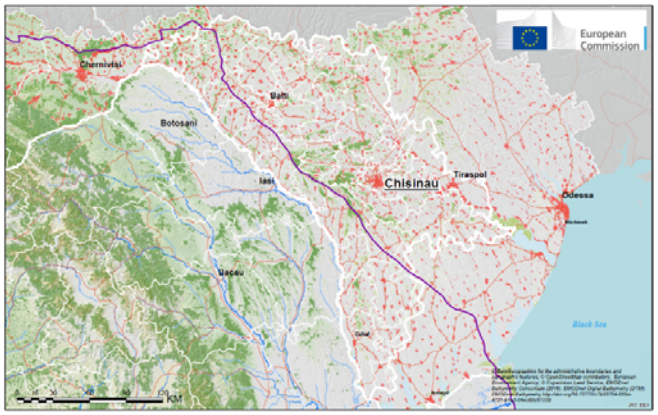
- While GIS by academy and public authorities have been using public data extensively in their thematic fields, it is thought that private re-use is still very limited. There is a need to pursue the development applications on public data for direct commercial use for industries and private individuals. Collaboration between government and the private sector is still limited, but not unprecedented. Actors of the public data domain are still nationally focused; integrating transboudary data into the data policy and relevant competences would be needed. Also cross -border communication is fragmented, which could be enhanced by joint workshops of actors in charge for building national data/Open Data platforms.

Open Data portal: http://opendata.hu/dataset

National Geoportal: http://www.inspiregeoportal.hu

[65] Global Open Data Index ranking (data for 2015 out of 122 countries).

Moldova



Coordination role in EUSDR

- PA9 "To invest in people and skills"

A. Facts and figures

GODI ranking[66]	22
Datasets in DRDSI (total)	438
Open Data portal	349
INSPIRE Discovery service	38
Danube_Net inventory	51

Danube_Net Moldova:

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Short bio:

Graduated the Faculty of Geodesy, Mapping and Aerial Survey of the MIIGAiK, Moscow. Maria holds a PhD at the Technical University of Civil Engineering, Bucharest and has more than 30 years of experience in Geodesy, Mapping, GIS and Remote Sensing. Her current research interest is related to infrastructures for spatial information, spatial planning and data integration.

B. Key findings

B1. Policy

- Moldova is currently revises its legal framework toward the organization of the management of geo-reference data in line with the provisions of the EU INSPIRE Directive. The regulatory framework of Moldova is currently based on the Law on Geodesy and Cartography no. 778-XV of 27.12.2001, however the approach for sharing, using and updating of geo-graphical data is under modification.
- Specifically, a new "Umbrella Law" has been drafted and it is currently discussed in the Parliament. This Law will approximate Moldova regulatory framework towards the EU INSPIRE Directive.

B2. Technological

- The public orgnisations of the Republic of moldova have limited capacity to implement a Spatial Data Infrastructure. Moldova is lacking a national metadata catalogue. Today, not all organisations are aware of what datasets are available within other organisations.
- Human resources are lacking. There is also lack of competence within several organisations as related to the use of GIS.

B3. Organisational

- Frameworks that regulate the ownership and responsibility of the systems that contain data are requested. Currently, many systems are put up because a need for more efficient handling of data within an organisation arises.
- Formal agreements as related to the exchange of data seem to be incomplete (have gaps). It appears that data may be exchanged on slightly different conditions, depending on organisation.
- No licensing conditions apply, or at least are followed. Data that only can be acquired for a fee from one organisation may be acquired free of charge from another organisation, yet the data source is the same.
- Thare are missing some key skills that would help build capacity in Moldova specially regarding network services and data modeling.
- At the moment in Moldova there is no formal framework for sharing GI between public institutions. Within an ongoing EU Twinning project for ALRC/ARFC Organization, Streamlining and Computerization Process in Mapping in the Republic of Moldova (2014-2016), the government would like to adopt an e-Governance regulatory framework according to international best practices, including opening governmental data. Such a framework would offer an opportunity to clarify how data can be made available to initiatives such as the EUSDR, although the policy may not reach a mature stage during the lifetime of the DRDSI project.

Open Data portal: http://data.gov.md/ckan

National Geoportal: http://geoportal.md

[66] Global Open Data Index ranking (data for 2015 out of 122 countries).

Montenegro

A. Facts and figures	
GODI ranking[67]	n/a
Datasets in DRDSI (total)	63
Open Data portal	0
INSPIRE Discovery service	0
Danube_Net inventory	63

Danube_Net Montenegro:

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Short bio: His professional experience is mostly from work in the cadaster and mapping Authority of Montenegro. He manages the development and maintenance of information system and IT infrastructure, and coordination of SDI activities. Božiar also has six years of experience at the University of Montenegro as teaching assistant in computer sciences and GIS.

B. Key findings

B1. Policy

- Policies regarding geospatial data sharing are just partly in place in Montenegro and implementation is very fragmented for now. But, activities are going in right direction to have good, comprehensive policies adopted in following period. Montenegro, as EU candidate country is committed to EU integration process. Transposition and implementation of EU environment acquis have highest priority, and fully transposed INSPIRE Directive in new NSDI Law (currently in draft phase) will be available by the end of 2016. Accompanying regulations and implementing roadmap will follow. Open Data strategy should be adopted in year 2017.
- PSI Directive principles are well known in Montenegro, and, in some form, exists in legislation. Geospatial and other data are shared among public institutions mostly for free, but when general public wants to access data approach is not consistent. There are positive examples which promote free access to data, as well as negative ones.

B2. Technological

- The biggest challenge in Montenegro is the lack of human resources for implementation of infrastructure elements. There are variety of software platforms available, commercial and open source, lot of phases can be outsourced, but strong expert base is necessary for adopting the new platforms. Montenegro, as a small market in the region, needs to focus on necessary capacity building.
- National Geoportal, developed by Real Estate Authority (geoportal.co.me) and eGovernment portal (www.euprava.me/en) by Ministry of Information Society and Telecommunications are positive examples from Open Data and INSPIRE context. Real Montenegro Open Data portal should be a product of eGovernment further development in next year or two. IMPULS project (4-year project for Western Balkan Countries) has objective in building regional as well as national SDIs and INSPIRE Directive implementation in beneficiary countries. After half of project implementation time, technical progress in data-sharing has been achieved in most of countries including Montenegro.

B3. Organisational

- Just part of organisations in Montenegro are currently ready to share and reuse data. Main barrier is low level of national infrastructure development, caused by insufficient human resources and incomplete legislation in this area. Opportunities can be found in fact that Montenegro is small and in that it is usually easier to build good infrastructure from the scratch. Also, best practice and experience from region can be used to avoid common mistakes and obstacles.
- Capacity of organisations in Montenegro to fully implement and exploit a spatial data infrastructure like the DRDSI is currently limited. Experience and knowledge should be raised, but there is good chance to do it right from the start because it is sort of emerging area in Montenegro. Help in this activities in form of trainings and membership organisation aiding communication would have positive effects, not just for Montenegro, but for whole region. SDI in Montenegro is in early phases of development and evolving policies and technologies should be introduced in this stage, because in later phases changes can cause bigger problems.

Open Data portal: http://www.open-data.me

National Geoportal: http://geoportal.co.me

[67] Global Open Data Index ranking (data for 2015 out of 122 countries).

Romania

Coordination role in EUSDR

- PA 1a "To improve mobility and intermodality"
- PA3 "To promote culture and tourism, people to people contacts"
- PA5 "To manage environmental risks"

A. Facts and figures	
GODI ranking[68]	13
Datasets in DRDSI (total)	381
Open Data portal	109
INSPIRE Discovery service	225
Danube_Net inventory	47

Danube_Net Romania:

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Short bio: Graduated Faculty of Mathematics, Informatics Department of the University of Bucharest and holds a PhD in GIS at the Technical University of Civil Engineering, Bucharest. More than 25 years of experience in GIS and Remote Sensing, and was involved in several national and international projects. His current research interest is related to remote sensing techniques for urban and regional development as well as "citizen request" applications based on web-GIS.

B. Key findings

B1. Policy

- Romania's accession to the Open Government Partnership (OGP) in 2011 created a reliable framework (http://ogp.gov.ro/) for developing and promoting national Open Data policies. On August 10, 2016, the third National Action Plan (NAP) 2016-2018 was adopted by the Romanian Government. The way the second NAP 2014-2016 was implemented will be discussed on September 15, 2016 during a special event organized by the OGP Romania. As far as geospatial data are concerned, the opening data process is subordinated to the INSPIRE Directive implementation.
- The development and maintenance of Open Data policy is a work in progress. The main instrument for opening data consists in NAP, which is constantly improved through its participatory implementation. Involvement of civil society might be considered as one of the main challenges related to NAP implementation.

B2. Technological

- The main technical challenges are related to quality of data and metadata.
- From the technical perspective, the Guide for Publishing Open Data released in April 2015 represents the main instrument for supporting opening data.

B3. Organisational

- The "Open Data" culture is not yet an important component of Romanian organisations. There is still a lack of awareness concerning the advantages of publishing and promoting Open Data.
- Public administration organizations have the technical potential to implement and exploit a spatial data infrastructure like DRDSI but, in spite of that, the legal framework is still too recent in order to face complex bureaucratic issues. In this context, the newly approved legal provisions concerning INSPIRE Directive transposition and implementation are a sound basis for encouraging the development of such activities.

Open Data portal: http://data.gov.ro

National Geoportal: http://geoportal.gov.ro

[68] Global Open Data Index ranking (data for 2015 out of 122 countries).

Serbia

Coordination role in EUSDR

- PA 1b "Rail, road and air"
- PA7 "To develop the knowledge society (research, education and ICT)"

A. Facts and figures	
GODI ranking[69]	n/a
Datasets in DRDSI (total)	163
Open Data portal	0
INSPIRE Discovery service	163
Danube_Net inventory	

Danube_Net Serbia:

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Short bio: Graduated in 1993 as geodetic engineer at the Department for Geodesy on the Faculty of Civil Engineering in Belgrade. She joined Republic Geodetic Authority in 1994 working in local cadastre office. Since 2008 she was involved in the INSPIRE implementation, performing activities on development of institutional framework, spatial data management and geoportal maintenance, participation in international SDI projects, coordination of national activities under the EuroGeographics umbrella. Currently, she works on supervision of REC data.

B. Key findings

B1. Policy

- Generally, policy for data sharing heterogeneous and depending on high-level political climate. It is evident unstable policy for geospatial data sharing, where conditions are very often changed. Key reason for such a variable data policy is based on lack of support for funding of data and services provision with respect to both 'supply side' and 'demand side'.
- The first step to open governmental data is taken by collaboration of World Bank, UNDP and Directorate for E-Government (Ministry of Public Administration and Local Self-Government) during 2015 by conducting an Open Data Readiness Assessment (ODRA). The Electronic Government Development Strategy 2015-2018 and the Action Plan for the Implementation of the Strategy 2015-2016 underpin the role and impact of Open Data.

B2. Technological

- Where data is only available in paper form it will be hard to make it available in reusable format quickly and cheaply. No general requirements concerning technological formats and standards for data providers apply across the government. In general, IT capabilities are scarce within the public sector, while retention of skilled civil servants is hard. No overall general ICT coordination across the whole of government has been found.
- Currently ithe lack of implementation of standards to achieve interoperability and electronic communications is notcieable. Implementation of the INSPIRE Directive is considered a driving force for better cross-sector cooperation and stimulation for development of technical capacities.

B3. Organisational

- The lack of explicit information on licensing for use of data as well about their publication is evident. The Law on Access to Information provides rights to examine and copy, but does not regulate re-use of such copies.
- For a sustainable and integrated role of public service delivery, the problems with retaining skilled staff and maintaining a sufficient level of IT knowledge across government are a significant obstacle. There is a general hiring freeze for government, and hiring IT staff is not an exception to that rule. To effectively carry out these responsibilities, agencies need to have (or develop) clear business processes for data management as well as staff with adequate ICT skills and technical understanding of data (e.g., formats, metadata, APIs, databases).
- A need for regional interoperability of data sets and services from Serbia and surrounding countries exists. Such a position for the regional cooperation is potencial for implementation of the EUSDR objectives by stronger cross-border collaboration that will allow successful data sharing.

Open Data portal: N/A

National Geoportal: http://www.geosrbija.rs

[69] Global Open Data Index ranking (data for 2015 out of 122 countries).

Slovakia

Coordination role in EUSDR

- PA4 "To restore and maintain the quality of waters"
- PA7 "To develop the knowledge society"
- PA10 "To step up institutional capacity and cooperation"

A. Facts and figures	
GODI ranking[70]	50
Datasets in DRDSI (total)	1855
Open Data portal	799
INSPIRE Discovery service	664
Danube_Net inventory	392

Danube_Net Slovakia:

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Short bio: Works for the Slovak Environment Agency, covering various aspects of geoinformatics, standardization with focus on activities connected to the SDIs and eGovenment. From 2008 - 2012 he worked for the JRC on INSPIRE data specifications. He is also involved in activities on the utilization of Open and Linked data to better exploit the linkages of geospatial data on environmental protection with other domains.

B. Key findings

B1. Policy

- Current legal framework provides incentives for data sharing, but still some work towards overall consistency will be needed. eGovernment data sharing shall be driven by the National Concept of eGoverment, whilst Open Data is driven as by eGovernment as well as by Open Governance Partnership. INSPIRE provides the guidance for harmonised spatial data and services sharing (Open and specific access regime). Pricing policies still remains an issue, although some initiatives are upcomming to address the value for the (public) money investments.

B2. Technological

- Technological aspects doesn't represent significant barriers. More challenging is the availabilty of certain refence data (e.g. cadaster, land use, orthoimagery) in machine readable form and overal topic of data quality and possibility to use the data for legal purposes. Temporal and possitional accuracy of the data is also challenge in many cases, where systematic and more detailed update is still quite rare as for spatial as well as non-spatial data resources.
- From Open Data perspective significant contribution have been made from the technical point of view by the eDemocracy and COMSODE projects. For INSPIRE, partial development have been supported with the INSPIRE Re3gistry in case of the Ministry of environment of Slovak republic. Recent development of the Spatial Information Registry is also foreseen to support Geo-DCAT-AP.

B3. Organisational

- Important role in increased awareness about the need to support harmonised and re-usable data sharing is played by the European authorities as well as relevant initiatives. Many public organisations still share data resources via ad hoc non harmonised agreements and it will require significant technical, organisational and educational effort to bring harmonised licensing frameworks in to the regular practice.
- DRDSI provides the unique possibility to rapidly discover and use the resources from the region with crossborder potential. The current capacities of the organisations in Slovakia limited, comparing the workload for the priority tasks driven by the legislation requirements and the needs of the practice. DRDSI offers unique regional data infrastructure, stimulating the national demand for the data resources missing in one country and available in another one. From the capacity building perspective the most significant missing skills relates to the technology, data processing as well as capabilities for further data mining, analysis and proper communication of various phenomena and trends. Very important is also demand for benefits and added value generation.

Open Data portal: https://data.gov.sk

National Geoportal: http://inspire.enviroportal.sk

[70] Global Open Data Index ranking (data for 2015 out of 122 countries).

Slovenia

Coordination role in EUSDR

- PA 1b "Rail, road and air"
- PA 10 "To step up institutional capacity and cooperation"

A. Facts and figures	
GODI ranking[71]	n/a
Datasets in DRDSI (total)	584
Open Data portal	255
INSPIRE Discovery service	154
Danube_Net inventory	175

Danube_Net Slovenia:

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Short bio: Public sector and spatial data specialist with extensive experience in geodetic authority, geoinformation, land cadastre, SDI and governmental reform. He is acting as deputy general manager at Surveying and Mapping Authority and member of UN GGIM Europe executive commettee. In addition he is acting as the national contact point for coordination of INSPIRE implementation with the European Commission.

B. Key findings

B1. Policy

- Data policies are in a good place to help share data. Regarding Law about public sector information all spatial data produced and managed by governmental bodies must be frely available for all purposess . There are some minor exeptions until 1.1.2018 but after those date we could speak about Open Data policy in spatial data and services domain. There are clear policies for data users and data providers and there are also clear pricing policies for data when they still have to be paid for commercial purposess at the moment. Only barriers to a 'data market' in Slovenia is related with spatial data where personel data are include (personal data protection policy).
- There are no other existing challenges, becouse those data policy is in place already several years. In addition, are their individual organisational policies which are protecting useful data sources or charging for data that could potentially be freely available under, for example, the principles of the PSI Directive.

B2. Technological

- There are always some challenges regarding availability of appropriate software but apropriate infrastructure is already in place. Data are not always a good quality or quality is not good enough for all purposess of use data. Some problems could occure at non mapping and cadastral data abut descriprions and documentations of data models and other technical details, becouse data provider for those mainly environmental and natural data sets sometimes do not have enough technical equipment.
- The positive developments/outcomes of the Open Data movement and/or INSPIRE in Slovenia is mainly in higher transparency of many formal procedures and much higher data quality becouse of raising awarenes about that at user comunity. There are also other initiatives worth mentioning that illustrate technical progress in data-sharing for example newly established cloud computing platform for governmental sector. This task was realised recently by the Ministry of public administration.

B3. Organisational

- Organisations are generaly ready to share and reuse data, and there are no bigest barriers regarding this. Of course some minor organisational problems always could occure when you start sharing and re using spatial data in practise. With establishing more concrete elements of spatial data infrastructure colaborations between ministries and governmental agencies in those area was improved in Slovenia. many overlaping and duplicated activities are now eliminated regarding this.
- Organisations still have limited capacity to fully implement and exploit a spatial data infrastructure. At the moment we identify that there are missing some key skills or other activities that would help build capacity in Slovenia specialy regarding network services and data modeling.

Open Data portal: http://nio.gov.si/nio/data

National Geoportal: www.geoportal.gov.si

[71] Global Open Data Index ranking (data for 2015 out of 122 countries).

Ukraine[72]

A. Facts and figures	
GODI ranking[73]	54
Datasets in DRDSI (total)	193
Open Data portal[74]	0
INSPIRE Discovery service	0
Danube_Net inventory	193

Danube_Net Ukraine:

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B. Key findings

B1. Policy

- Today Ukraine works on transparent and understandable policies for Open Data. In February 2015, the government launched a public-private partnership called ProZorro to increase transparency by publishing contracting information. The initiative makes any document or information related to public procurement open and available online, including the estimated value of the contract, tender documentation and the decisions of evaluation committees. This system works in full power and is obligated for any members of public procurement.
- The "Access to Public Information" act defines the procedure for the right of everyone to have access to information of public interest, which is owned by government agencies and other organizations providing public information defined by this Law. The Law contains specific rules for access and re-use of public sector information in Ukraine (not only for GI - sector).
- The State Land Cadastre is the most advanced informational system that works with geographic data. The system has several levels of security to protect personal data and discussions are being held regarding opening those resources.

B2. Technological

- The current state of IT requires the establishment of constant-working system of topographical monitoring that will ensure the publication of geospatial data in real time almost simultaneously with the changes on the ground.
- Duplicating of topographic - geodetic and cartographic works that carried out at the expense of budget funds. In most cases, geoinformational resources generated by departmental basis. For the most part of geospatial data, metadata are not created in Ukraine.
- An Open Data portal is Developed a single state portal for Open Data It makes available more than 6,000 data sets from 700+ administrators. An official portal for public finances is also launched (E-Data). It publishes information about the use of public funds and implementes the idea of "Transparent budget".

B3. Organisational

- At present, the majority of data are stored on paper. A very important task is to digitize available data following European standards and EU Directives.
- The Ukrainian legislation doesn't give a definition for "information" in its modern meaning, and there is no clear subdivision of roles and responsibilities between the individual data providers.
- The implementation of the National Cadastral System has shown, that public autorities are ready for the implementation of systems, which will are fully automated and follow strictly defined data sharing principles. Obstacles are therefore from legislative, and not from technical nartre.

Open Data portal: http://data.gov.ua

National Geoportal: n/a

[72] Odessa, Chernivetska, Ivano-Frankivska and Zakarpatska Oblast

[73] Global Open Data Index ranking (data for 2015 out of 122 countries).

[74] The Ukrainian Open Data portal, available at http://data.gov.ua is at the time of writing of this report in the process of being harvested by DRDSI.

Annex IV User Stories

The concept of 'user stories' in DRDSI is established with the overall idea to share good practices from the Danube region (Figure 19). In general, user stories explain in an understandable way how:

A) particular dataset(s) have been used to create policy-relevant content, or
B) datasets have been 'unlocked' as result of a targeted intervention on behalf of the DRDSI project.

This annex provides an extract of all user stories that are available at http://drdsi.jrc.ec.europa.eu/user-story.

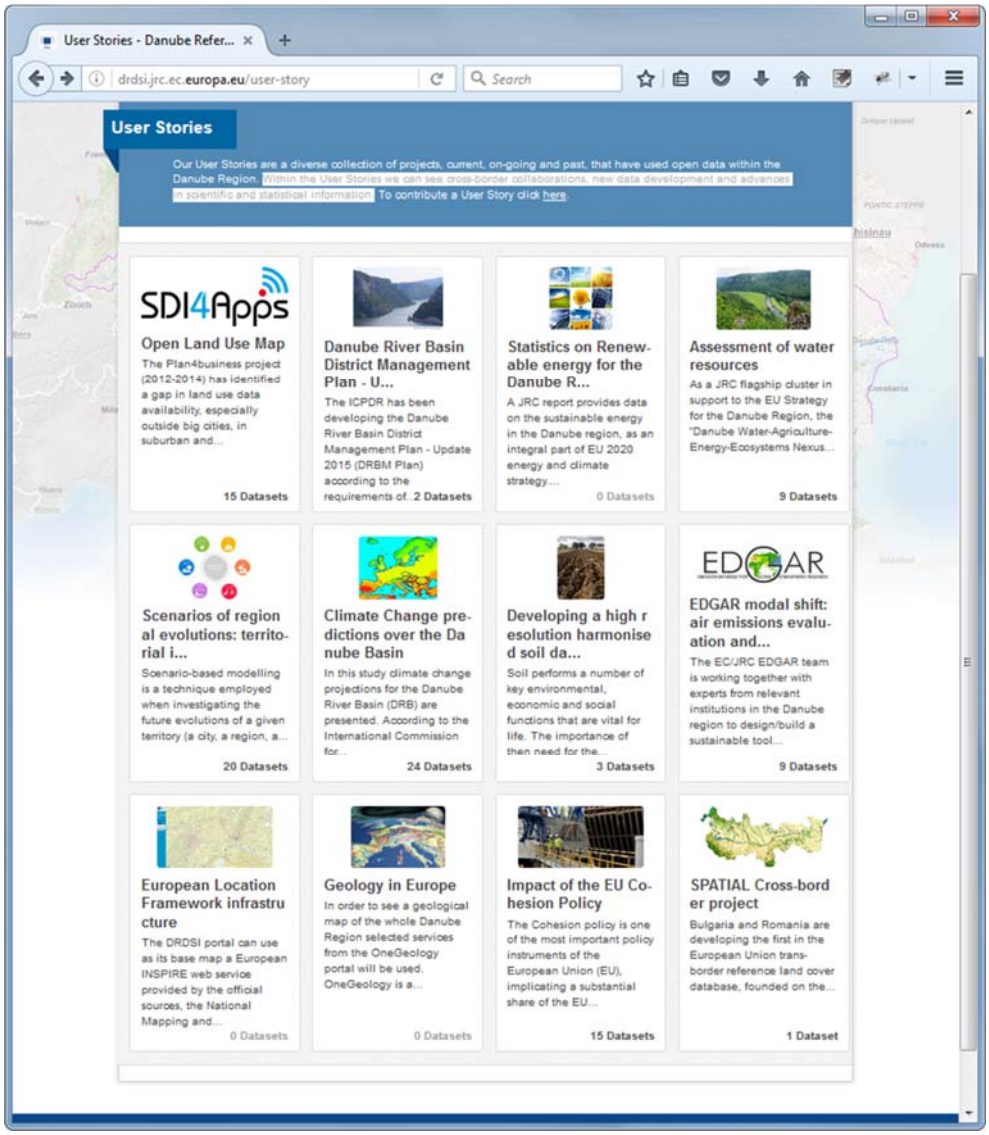

Figure 19 "User stories" within the DRDSI platform

EDGAR modal shift: air emissions evaluation and distribution for multi-modal transport shifts

Abstract

The EDGAR modal shift initiative of the Danube Air Nexus project shows that by involving emission experts from countries/institutions in the Danube region an innovative tool (**EDGAR.ms**) can be built based on a methodology that was developed specifically for the best use of the available information and expertise in this region. The EDGAR.ms, a macro-regional approach implemented in the JRC/EDGAR tool (info on http://edgar.jrc.ec.europa.eu/), is designed as an interactive instrument to explore the impact of modal shifts in transport on air emissions for different ex-post scenarios in the Danube region.

The final products of the EDGAR.ms are **modal-shift scenario air emission gridmaps** for transport sector in the Danube region, which have been created based on the country/region data (where not available, EDGAR gapfills). The added values of this approach is that the institutions/authorities/PAs in the region can provide their emission scenarios resulting from the macro-regional transport mobility policy as input to EDGAR.ms and assess the air emission pattern changes for different options and the benefits of a sustainable transport policy, freight transport in particular e.g. the effects of exchanging trucks by ships for freight transport exploiting the Danube river.

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Related datasets

- Transport emissions
- Network statement 2016
- Basic network of transport infrastructure of the Republic of Croatia
- Traffic counting on highways
- Danube navigation statistics
- National Data for Transport Sector (Rail/Shipping/Road)
- Annual Energy Report, Energy in Croatia 2013
- Statistical Yearbook of the Republic of Croatia 2014
- Emission Database for Global Atmospheric Research version 4.2

Impact of the EU Cohesion Policy

Abstract

The Cohesion policy is one of the most important policy instruments of the European Union (EU), implicating a substantial share of the EU budget and involving every region from each Member State.

Ex-ante economic impacts of the new Cohesion policy on EU's regions were evaluated by the European Commission's services using the Computable General Equilibrium (CGE) model 'RHOMOLO' (Brandsma et al. 2013). Along with the desired economic impacts, the investment induced by the Cohesion policy is, as well, likely to produce impacts on local environmental conditions and land use. Despite the appreciable investment in actual physical capital across the EU, their potential aggregate impacts on local land use and environment have never been analysed in a systematic fashion. This report is the result of a first 'pilot' assessment of such potential impacts. It was conducted by the Joint Research Centre (JRC)3, as requested by the DG REGIO, in the context of the collaboration between the two European Commission bodies. The following questions and concerns motivated this study:

- Could the Cohesion policy amplify unexpected and unwanted detrimental land use and environmental impacts?
- Could those impacts be avoided or mitigated with the correct set of land use/spatial planning policies?
- Can environmental friendly options contribute to Cohesion objectives like the reduction of social and territorial disparities between regions?

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Related datasets

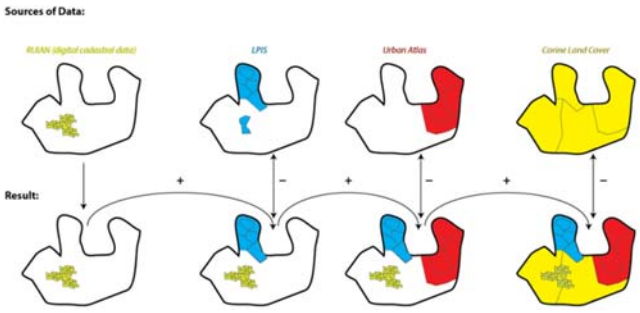
- CORINE Land Cover 2006 - refined version
- Assumptions - Cohesion Policy Compact Scenario
- Daily accessibility 2030 - Cohesion Policy Compact Scenario
- Distance to roads
- Elevation model
- Land use 2010 - Cohesion Policy Compact Scenario
- Slope
- Land use 2030 - Cohesion Policy Compact Scenario
- Land use 2020 - Cohesion Policy Compact Scenario
- Network efficiency 2030 - Cohesion Policy Compact Scenario
- Population density 2010 - Cohesion Policy Compact Scenario
- Potential accessibility 2030 - Cohesion Policy Compact Scenario
- Population density 2030 - Cohesion Policy Compact Scenario
- Protected areas

Open Land Use Map – SDI4Apps

Abstract

The Plan4business project (2012-2014) has identified a gap in land use data availability, especially outside big cities, in suburban and rural areas. The Urban Atlas of the European Environmental Agency covers only cities above 100,000 inhabitants. So for example in the Czech Republic, only 13 cities are covered. For the rest, there is the CORINE Land Cover, which can be used only for regional and national analysis.

The lack of land use data on local level led to an idea of combining data from various sources and of different levels of detail into a seamless map. This idea has been picked up by the SDI4Apps project and turned into a pilot application (Pilot IV: Open Land Use Map through Volunteered Geographic Information). The innovative aspect of the pilot is not only in the methodology of combining data into a seamless database, but also in using crowdsourcing for data collection and update. An important aspect is that data are available as open data.



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Related datasets

Input

- CORINE Land Cover 2006 revidovaná databáze České republiky (CLC06R_CZ)
- INSPIRE stahovací služba pro téma parcely (CP)
- Urban Atlas - Czech Republic:
  - Olomouc
  - Jihlava
  - Zlín
  - Liberec
  - Pardubice
  - Brno
  - Ostrava
  - Budweis (České Budějovice)
  - Carlsbad (Karlovy Vary)
  - Hradec Králové
  - Prague (Praha)
  - Ústí nad Labem
  - Pilsen (Plzeň)

Output

- Open Land Use map of the Czech Republic[75]

[75] At the time of writing of this report work is ongoing on extending the results to other Danube countries.

Scenarios of regional evolutions: territorial indicators of land functions (LUISA)

Abstract

Scenario-based modelling is a technique employed when investigating the future evolutions of a given territory (a city, a region, a country or even the entire world). Models can be employed to simulate the direct and indirect impacts of a policy measure (e.g. an investment in an economic sector, the definition of zoning plans, the construction of a road or the installation of a technological infrastructure) or of wider trends such as those related to climate or demography. Scenario modelling helps in combining effects of more matters simultaneously and also in evaluating the impacts of potential or possible alternatives of evolution.

Based upon the new concept of *'Land Functions'*, the Directorate General Joint Research Centre (DG JRC) of the European Commission (EC) has developed the Land-Use-based Integrated Sustainability Assessment (LUISA) Modelling Platform to contribute to the evaluation of impacts of policies and socio-economic trends on European cities and regions.

Land functions are instrumental to better understand territorial processes and to better inform on the impacts of policy options. A land function can, for example, be physical (e.g. related to hydrology or topography), ecological (e.g. related to landscape or phenology), social (e.g. related to housing or recreation), economic (e.g. related to employment or production or to an infrastructural asset) or political (e.g. consequence of policy decisions). Commonly, one portion of land is perceived to exercise many functions. Land functions are temporally dynamic, depend on the characteristics of land parcels, and are constrained and driven by natural, socio-economic, and technological processes.

LUISA simulates land functions described by means of spatially explicit indicators. The indicators are grouped according to 6 themes, projected in time until typically year 2030 or 2050, and can be represented at various levels (national, regional or other).

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Related datasets

- LF113 GDP/capita
- Land-use/cover maps
- LF443 - Location accessibility
- LF422 - ICS economic output per unit of ICS area (REF2014 LUISA Platform)
- Potential accessibility maps
- LF622 - Landscape Fragmentation
- LF411 - Share of residential areas over the total land area
- LF621 - Structural Green Infrastructures
- LF441 - Potential accessibility
- LF442 - Network efficiency
- LF211 - Recreation potential maps
- LF412 - Residential areas per inhabitant
- LF311 - Water Consumption
- LF522 -Soil retention
- LF522 -Soil retention
- LF444 - Daily accessibility
- LF521 - Capacity of ecosystems to avoid soil erosion
- LF433 - Built-up area per inhabitant
- Population distribution
- LF421 - Share of ICS areas over the total land area
- LF415 - Population density

Climate Change predictions over the Danube Basin

Abstract

In this study, the climate simulations are obtained from the FP6 ENSEMBLES project using a combination of several global and regional climate models, GCMs, and RCMs, respectively. By using the outputs of CGMs as boundary and initial conditions, limited-area, high resolution climate models (RCMs) are usually applied in order to obtain fine-resolution information that is essential to assess the impact of climate change, especially in regions of complex topography, or with highly heterogeneous land-cover.

The IPCC SRES scenarios are based on a set of socio-economic driving forces such as economy, population, technology, energy and agriculture, which drive the change in global greenhouse gases emissions. Climate simulations are forced by the A1B emission scenarios. The *A1B scenario depicts* a future world of very rapid economic growth, low population growth and rapid introduction of new and more efficient technology. Major underlying themes are economic and cultural convergence and capacity building, with a substantial reduction in regional differences in per capita income.

Image 5 Pelicans, Danube Delta, 2010 © Costel Slincu

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Related datasets

- Change in annual water availability by 2071-2100 relative to 1961-1990 in view of climate change for A2 scenario
- Rate of change of frost-free period map for Europe 1975-2010
- Bias corrected high resolution temperature and precipitation projection in daily temporal resolution from the C4I RCA3 regional climate model driven by boundary conditions from the HadCM3 global circulation model according to SRES A1B scenario, 1961-2099 (ENSEMBLES).
- Change in spring water availability by 2071-2100 relative to 1961-1990 in view of climate change for A2 scenario
- Bias corrected high resolution temperature and precipitation projection in daily temporal resolution from the DMI HIRHAM5 regional climate model driven by boundary conditions from the ECHAM5 global circulation model according to SRES A1B scenario, 1961-2099 (ENSEMBLES).
- Bias corrected high resolution temperature and precipitation projection in daily temporal resolution from the MPI REMO regional climate model driven by boundary conditions from the ECHAM5 global circulation model according to SRES A1B scenario, 1961-2099 (ENSEMBLES).
- Bias corrected high resolution temperature and precipitation projection in daily temporal resolution from the SMHI RCA regional climate model driven by boundary conditions from the ECHAM5/OMI global circulation model according to SRES A1B scenario, 1961-2099 (ENSEMBLES).
- Flood hazard change by 2071-2100 relative to 1961-1990 in view of climate change for B2 scenario
- Flood risk change by 2071-2100 relative to 1961-1990 in view of climate change for A1B scenario
- Change in winter water availability by 2071-2100 relative to 1961-1990 in view of climate change for A2 scenario
- Change in summer water availability by 2071-2100 relative to 1961-1990 in view of climate change for A2 scenario
- Change in autumn water availability by 2071-2100 relative to 1961-1990 in view of climate change for A2 scenario
- Rate of change of meteorological water balance map for Europe 1975-2010
- Bias corrected high resolution temperature and precipitation projection in daily temporal resolution from the CNRM RM regional climate model driven by boundary conditions from the ARPEGE global circulation model according to SRES A1B scenario, 1961-2099 (ENSEMBLES).
- Rate of change of flowering date for winter wheat map for Europe 1975-2010

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