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Development of new active teaching practices

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Short Description:
This report presents a set of active teaching practices developed and implemented in the SPIDER project, on topics related to the establishment of Open Spatial Data Infrastructures.

Keywords:

Spatial Data Infrastructures (SDI), Open SDI, education, academic courses

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1 Introduction

1.1 The SPIDER Project

In the past 20 years, European public authorities have invested considerable resources in the development of spatial data infrastructures (SDIs). With the European INSPIRE Directive as an important driver, national SDIs were developed throughout Europe to facilitate and coordinate the exchange and sharing of geographic data. These SDIs initially focused on data sharing among public authorities. Together with the implementation of open data policies to make government data available and reusable without any restrictions, public administration started to make a shift towards the establishment of an open SDI, in which also non-government data and actors are considered as a key to the performance of the infrastructure.

The concept of Open SDI is about openness to new stakeholders in the spatial data ecosystems, besides the traditional mapping agencies that have been dominant for many years. SDI development and implementation should not only involve the traditional data producers, but also key stakeholders outside the government. These stakeholders can be citizens, companies with small and medium-sized enterprises (SMEs) in particular, NGOs, and education and research institutions. These stakeholders can be both producer and user of spatial data. Open SDI also is linked to developments and trends in other domains and fields, such as open government, open data, open science, open data, and open software. This new paradigm on SDI means that new, specific skills are required, which currently are not offered by traditional SDI education. Open SDI education requires a shift in both the ways of teaching and learning, which should become more active, and in the content of education, include new concepts and topics. Furthermore, collaboration between higher education institutions (HEIs) is essential, since implementing - and teaching on - Open SDI requires a multidisciplinary approach, involving experts from different fields.

The main objective of the SPIDER project is to promote and strengthen active learning and teaching towards Open SDI. Sub-objectives of the project are 1) to explore, develop and implement the concept of Open SDI as a new paradigm to SDI education; 2) to promote and facilitate active and multidisciplinary learning and teaching on Open SDI; and 3) to drive the exchange and update of Open SDI teaching and learning resources by teachers and students.

1.2 Development of new active teaching practices

This report provides a set of newly developed active teaching practices on new topics related to Open SDI. These practices apply the methodologies on active teaching and learning on Open SDI that were developed in the SPIDER project. The identification of these new topics was supported by the Open SDI Curriculum Toolkit, which aims to support trainers, teachers, and students in developing and implementing Open SDI curricula in which learning outcomes, teaching and learning activities, and assessment methods are fully aligned. The Open SDI Curriculum Toolkit defines a set of learning outcomes, teaching activities and assessment methods for various topics related to – Open – SDI.

The active teaching practices presented in this report mainly deal with topics that are currently less or not addressed in Open SDI Education and Training. This means they will be very useful and valuable for teachers, trainers, students and other stakeholders looking for teaching or learning material on new and emerging topics in the domain of Open SDI. Teachers and trainers can use this report to further develop their own teaching practices on this topic – or just reuse the practice as it is – while students and other people with an interest in SDI can use the report to be introduced to and learn more a particular topic.

The new practices were used – and tested – in the Open SDI Summer School held in Zagreb in the Summer of 2022. In addition, the MOOC Open SDI, developed in the context of the SPIDER project, builds on some of the activities presented in this report.

1.3 Structure of the document

The document is structured as follows: after this introductory chapter, the second chapter discusses the methodology for developing a series of new active teaching practices on Open SDI and related topics. The third chapter presents a series of practices focused on a specific topic. The fourth chapter presents a cross-cutting and interdisciplinary teaching activity, in which various aspects of Open SDI are covered in the context of a group assignment involved students with different background. The fifth and final chapter provides a short conclusion.

2 Methodology

2.1 Selection of the topics

The first step in the design and preparation of the new active teaching practices was the selection of topics these practices should cover. This selection process was initiated by a critical review of the topics currently included in the Open SDI Curriculum Toolkit developed by the SPIDER project. The Open SDI Curriculum Toolkit aims to support trainers, teachers, and students in developing and implementing curricula on SDI and/or open data in which learning outcomes, teaching and learning activities, and assessment methods are fully aligned. The Toolkit provides an easy-to-use overview of well-developed learning outcomes and effective teaching and assessment methods for core concepts of open SDIs. This review resulted in the identification of a set of new and emerging topics, which are insufficiently addressed in current SDI education and/or for which active teaching practices are missing.

For the identification of additional relevant topics, a literature review was executed based on a set of key publications dealing with new trends and developments related to SDIs and the future evolution of SDIs. These publications included:

- **EUROGI (2021). Towards a sustainable geospatial ecosystem beyond SDIs**: This position paper is the outcome of a series of discussions about a future vision beyond spatial data infrastructures among key experts in the geospatial domain. The paper takes some first steps towards a 'future vision' on geospatial information and aims to initiate a re-thinking and re-imagining of the way in which geospatial information is shared, analysed and used in the rapidly changing environment of today and into the future. It provides thoughts and ideas to enable the global geospatial community to be more adequately prepared and to drive and facilitate the transition to a sustainable geospatial ecosystem beyond SDIs.

- **Kotsev, A., Minghini, M., Tomas, R., Cetl, V., & Lutz, M. (2020). From spatial data infrastructures to data spaces—A technological perspective on the evolution of European SDIs:** This article addresses emerging technological trends and considers the role of other actors such as the private sector and citizen science initiatives in the future development of SDIs. The article positions SDI-related developments in Europe within the broader context of the current political and technological scenery. In doing so, it pays particular attention to relevant technological developments and emerging trends that are seen as enablers for the evolution of European SDIs. The article proposes a high-level concept of a pan-European (geo)data space with a 10-year horizon in mind.

- **United Nations Statistics Division (UNSD) & Geospatial World (2021). White Paper on Geospatial Knowledge Infrastructure: The Power of Where.** The aim of this Paper is to set out the concept of a Geospatial Knowledge Infrastructure that supports governments and industry deliver sustainable economic, social and environmental benefits to Planet Earth and its people, as part of emerging digital and knowledge ecosystems and infrastructures. The paper builds on a July 2020 discussion paper, the GKI Summit held in February 2021 and a series of consultations with key stakeholders. The paper provides a geocentric view and delivers the basis for an infrastructure that integrates government, industry, citizens, and academic geospatial capabilities with the wider digital drive to better the world economy, society, and environment.

- **Open Geospatial Consortium (2021) Modernizing SDI: Enabling Data Interoperability for Regional Assessments and Cumulative Effects CDS (OGC):** This report presents the results of a Concept Development Study (CDS) on Modernizing Spatial Data Infrastructure (SDI), sponsored by Natural Resources Canada, and executed by the Open Geospatial Consortium (OGC). The focus of this study was to understand how to best support the modernization of SDI(s) by enabling increased data interoperability for Regional Assessments (RA) and Cumulative Effects (CE), to advance the understanding of stakeholder issues, and serve stakeholders' needs in these contexts. The study was completed through stakeholder engagements including the collection of external international positions and opinions on the optimal setup and design of a modernized SDI and a stakeholder Modernizing SDI Workshop providing in-depth information on requirements and issues related to stakeholders, architecture, data, and standards of current and future SDI.

Based on the review of the concepts in the Open SDI Curriculum Toolkit and the literature review of these key publications, a set of new and emerging topics related to Open SDIs was identified. These topics covered four main categories: new – sources of – data, emerging technologies and standards, new organisational principles and approaches and new 'data' concepts. Table 1 shows the classification of new topics into these four categories.

Table 1 Classification of new topics

Categories	Topics
New – sources of – data	Crowdsourced GI & Citizen Science Internet of Things (IoT) Mobile data Data from EO Platforms Private sector data Open Research Data
Emerging technology and Standards	AI/Machine Learning Cloud Technologies OpenAPI/OGC API 3D Standards GeoSemantics/Ontology and Linked Data GeoPackage with embedded metadata Linking to IoT Technologies New portals and platforms Push based communication flows Blockchain
Organisational principles & approaches	Integrated digital governance Modern data licensing Authoritative data FAIR data Co-design & co-creation Collaborative innovation Changing legislative and policy context Geospatial ethics
'Data' concepts	Data spaces

	Data ecosystems Data economy Data platforms Data markets Data cubes Datafication Data-driven innovation Data-driven transformation High-value data

In January 2022, the multiplier event 'Building SDI Education Curricula Fit for the Future' was organized by the SPIDER project. The main aim of the event was to show the Open SDI Curriculum Toolkit to relevant stakeholders in the GI/SDI community, and collect feedback on how to improve the toolkit. The second part of the event focus on new topics to be covered in SDI education fit for the future, i.e., topics that could be added to the Toolkit at a later stage. A set of topics, derived from the literature review of documents, was proposed to the participants, asking them to assess the relevance of these topics to education on SDI. More than 50 experts in SDI and SDI education participated in the multiplier event and provided input to the selection of new topics for SDI education. Figure 1 and Figure 2 show some of the results of the assessment of the relevance of topics by the participating experts.

Figure 1 Assessment of the relevance of 'technology' topics

Figure 1 shows that among the most relevance 'technology' topics are cloud technologies, openAPI/OGC API and GeoSemantics/Ontology and Linked Data. Figure 2 shows that the non-technology topics considered to be most relevant, include geospatial ethics and the changing legislative and policy context. The results of these interactive polls were complemented with a vibrant discussion among the participants on new topics for future SDI education.

Figure 2 Assessment of the relevance of 'non-technology' topics

The SPIDER consortium used this input for the selection of topics for the design of new active teaching practices on Open SDI. Each partner individually developed at least two practices, and all partners contributed to the development of a problem-based group work activity on Open SDI.

2.2 Development of active teaching practices

The development of the active teaching practices was driven by the Methodology on Active Teaching and Learning on Open SDI developed in the SPIDER project. For each of the identified and selected topics, the responsible partners first provided a short introduction on the relevance and importance of this topics and afterwards defined a set of related learning outcomes.

These learning outcomes formed the based for the definition of active teaching and learning practices, aligned with these learning outcomes. Teaching and learning activities were designed so that students are optimally engaged in achieving these predetermined learning outcomes. For the selection and design of active teaching and learning activities, we relied on the list of active learning and teaching activities identified and presented in the SPIDER Methodology on Active Teaching and Learning on Open SDI. This methodology included various active teaching and learning activities, that could be implemented in different environments (on-campus, online, outside teaching) and targeted different learning levels. An overview of these activities is presented in Table 2.

After the selection of the most suitable teaching practices and activities per topic, these practices were further developed by the responsible partners. This included the preparation of selection of related teaching materials, but also the design of a step-by-step guide to implement the teaching practice.

Table 2 Overview of active teaching and learning activities (Source: Welle Donker et al. (2022))

Learning level according to Bloom's Taxonomy	On-campus teaching session	Online teaching session	Outside teaching sessions
Remember	demonstrations examples guest speakers in-class quizzes/polls	demonstrations examples guest speakers in-class quizzes/polls	clips podcasts class recordings short quizzes/ self-tests
Understand	asking questions active listening / paraphrasing one-minute paper / one-sentence summary brainstorm / brainwrite jigsaw in-class quizzes/polls mind map	asking questions active listening / paraphrasing one-minute paper / one-sentence summary brainstorm / brainwrite jigsaw in-class quizzes/polls mind map	literature / reader short quizzes / self-tests mind map
Apply	debate student presentations concept map	debate student presentations concept map	exercises serious games concept map
Analyse	muddiest point concept map / mini map active writing class discussions cases / role play / simulation think-pair-share / turn & talk / snowball group investigation as collaborative learning	muddiest point concept map / mini map active writing class discussions cases / simulation think-pair-share group investigation as collaborative learning	concept map
Evaluate	peer instruction peer review peer tutoring classroom quizzes	peer instruction peer review peer tutoring classroom quizzes	self-tests portfolio
Create	formulation of exam questions mini lectures	formulation of exam questions mini lectures	research paper case study / project formulating exam questions

2.3 Testing of the teaching practices

Testing of the newly developed active teaching practices took place during the SPIDER Summer School on Open SDI, which was organized in Zagreb from 22 to 26 August 2022. During this 5-day Summer School, attended by more than 20 students, the SPIDER partners implemented several of the new teaching practices, in order to introduce students into the concept of Open SDI and increase their knowledge and understanding on the technological and non-technological aspects of Open SDIs. During this Summer School, feedback was collected from the participants on the relevance, quality, and impact of the new teaching practices, which was used to further modify and improve them.

In this report we present the new active teaching practices on Open SDI in a structured manner, providing information on the background, learning outcomes, materials, learning activities and implementation.

3 Active teaching practices

3.1 Geospatial data ecosystems (KU Leuven)

3.1.1 Introduction

Ecosystems deals with relations dynamics, in the form of collaboration or competitions, independence or dependence, between actors (individuals or organization) acting as an involuntary community in pursuit of general/frame purpose(s). In the context of geospatial data, it refers to the cycles/loop of relation and feedback between the different stakeholders (producers, publishers, infomediaries, intermediate, end-user) allowing the data to be produced and integrated for a particular goal.

The notion of geospatial data ecosystems emerged recently with the multiplications of data sources (i.e., not just produced by governments) and needs (e.g., for "smart" cities, digital twins …) increasingly pushing to adapt geospatial data infrastructures toward this ecosystem architecture. Establishing, identifying, or maintaining an ecosystem poses many challenges starting with the fact that they are currently no standardized definition of its scope (Coetzee *et al*, 2021). To overcome those issues a study conducted by the European Commission as proposed a frame based on three dimensions that are components, values dynamics, and data flows:

- Components refers to the apparent frame of the ecosystem. It can be found by answering the so-called "wh" questions: Why (goal), Who (stakeholders), where (geographic components), how (legal and technological components) (Coetzee *et al.*, 2021)
- Values dynamics refer to the dynamics within the ecosystem's structures i.e., which resources (i.e., value) stakeholders are exchanging, how thew are exchanging it and if there are barriers (legal, economical …) for this exchange (Coetzee *et al.*, 2021)
- Data flows refer to the technical cycles of the data within the ecosystems (Coetzee *et al.*, 2021)

References

Coetzee, S., Gould, M., McCormack, B., Mohamed Ghouse, Z., Scott, G., Kmoch, A., Alameh, N., Strobl, J., Wytzisk, A. and Devarajan, T. (2021). Towards a sustainable geospatial ecosystem beyond SDIs. 10.13140/RG.2.2.22555.39203. Beyond SDI draft paper for UN GGIM (28 7 21) GS edits (1) (with SOME track changes & comments)-SC zs-SC-changes accepted

3.1.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Explain what a (geospatial data) ecosystem is and how it functions
- LO2: Provide and explain examples of existing geospatial data ecosystems
- LO3: Discuss dynamics and trends in geospatial data ecosystems

3.1.3 Materials

Recommended literature	– Mohr, B. and Dessers, E. (2019). Towards a Socio-Technical Framework for Designing Integrated Care Ecosystems. 10.1007/978-3-030-31121-6_20. Designing Integrated Care Ecosystems | SpringerLink – Coetzee, S., Gould, M., McCormack, B., Mohamed Ghouse, Z., Scott, G., Kmoch, A., Alameh, N., Strobl, J., Wytzisk, A., and Devarajan, T. (2021). Towards a sustainable geospatial ecosystem beyond SDIs. 10.13140/RG.2.2.22555.39203. Beyond SDI draft paper for UN GGIM (28 7 21) GS edits (1) (with SOME track changes & comments)-SC zs-SC-changes accepted – Davies, T. (2011). Open Data: infrastructures and ecosystems. Open Data Research, 1-6. https://www.emergentworks.net/sites/default/files/ikmemergent_archive/Social_Life_of_Data_-_Infrastructure_and_Ecosystem_Paper.pdf
Videos	ELISE Workshop: Data Ecosystems for Geospatial Data https://www.youtube.com/watch?v=f_fHdyKoLFk
Data	/
Software	/
Case study	API-Agro (smart-agriculture) https://joinup.ec.europa.eu/sites/default/files/document/2021-03/JRC124148_jrc124148_jrc124148_asteroid_report_accepted.pdf

3.1.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Research on Geospatial data ecosystems: preparatory reading and 1-minute summary, students presentation and breakout discussion
- Geospatial data ecosystems in Practice: demonstration and asking questions, guest speaker(s)
- Dynamics and trends in geospatial data ecosystems: ask question and case study paper

3.1.5 Implementation

Unit 1: Ecosystems: Definition

Activity 1.1 - Research on the definition of ecosystems: preparatory reading and 1-minute summary: Prior to the main teaching session, students are invited to read the 2019 article on Designing Integrated Care Ecosystems by Bernard Mohr and Ezra Dessers. This article reviews the different definitions of ecosystems starting from the ecological bases of the term. Afterward, the authors provide a definition, of ecosystems “as dynamic and co-evolving communities” and characterize its purpose(s) and actions relations within it. Finally, the authors provide a clear distinction between the notions of network and ecosystems. Students should be able to summarize the paper in 1 minute by answering the following question: What is an ecosystem? What is the difference between an ecosystem and a network? Why are ecosystems emerging? At the start of the teaching session, students are asked whether they did read the paper and to what extent they were able to provide an answer to the proposed questions. Students are invited to read the paper again and redo the 1-minute summary exercise after the course detailed description.

Activity 1.2 - Student Presentations- breakout discussions: Based on a case provided by the teacher students are asked, in smaller groups, to identify new geospatial data sources and services and how they are related to the presence of an ecosystem. Students are given 10 minutes to discuss in smaller groups and prepare a one-minute presentation for the rest of the class. After the presentations, a class discussion can be led to discuss to findings.

Unit 2: SDI and geospatial data ecosystems

Activity 2.1 – Ecosystems in Practice: example and asking questions: The teaching session itself starts with an example of an ecosystem in practice, to illustrate the added value of ecosystems. Local examples (smart cities, smart agriculture) can be used as concrete and concrete for the student's ways of visualizing the role of ecosystems for the citizens. Press articles and videos can be used.

Activity 2.1 – Guest speaker(s): One or several guest speakers are invited to the class to present a particular ecosystem they are working with/within i.e., interactions with other groups, data sharing and data creation process etc.

Unit 3: Dynamics and trends in ecosystems

Activity 3.1 - Ask questions: Students are asked to formulate questions on possible evolutions in geospatial data ecosystems.

Activity 3.2 - Case Study Paper: Students have to write a paper on the structure and evolutions based on a case study of their choice. The paper should identify the framed purpose of the ecosystems, the type of relations between the actors, and what solutions/improvement/new development result from that ecosystem. Format: Length: maximum 1000 words including footnotes and excluding bibliography

3.1.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1.1	Remember Understand	preparatory reading and 1-minute summary	Explain what an ecosystem is and who constitute it
Activity 1.2	Apply	Student Presentations-breakout discussions	Explain how an ecosystem is functioning
Activity 1.2	Understand analyse	example and asking questions	Provide examples of existing geospatial data ecosystems
Activity 2.2	Remember	guest speakers	Explain how an ecosystem is functioning

			Provide examples of existing geospatial data ecosystems
Activity 3.1	Create	Ask questions	Discuss dynamics and trends in geospatial data ecosystems
Activity 3.2	Understand analyse	Case Study Paper	Discuss dynamics and trends in geospatial data ecosystems Explain how an ecosystem is functioning

3.2 Co-creating Open SDIs (KU Leuven)

3.2.1 Introduction

Collaboration, as defined in the Oslo Manual, is a coordinated activity in which different parties contribute to a jointly defined problem. The requirement for all parties to contribute differentiates collaboration from cooperation, where participants merely agree to take responsibility for a task. In more formal cases, cooperation can involve contractual arrangements. When this happens, one party can supply another with ideas or inputs but without being actively engaged in their further development.

Against this backdrop, co-creation is best viewed through the prism of four overlapping concepts as outlined by Osborne et al (2016)

- ***Co-production*** occurs when users co-produce, often involuntarily, the service experience together with public service staff. The elderly living in a residential home is an example of co-production.
- ***Co-design*** happens when individuals partially customise a service for their own use. These user-led innovations (Svensson 2018) can be taken up by a public sector organisation and further developed using co-creation techniques.
- ***Co-construction*** happens when an individual helps to construct a service by using, for example, an app or a website, whether knowingly or unknowingly (Schembri 2006).
- ***Co-innovation*** assumes that users are the most profound source of innovation (Lee *et al* 2012). As such, it tries to promote user involvement in different stages of service creation e.g., problem formulation, data collection, evaluation.

References

Lee, S.M., Olson, D.L., & Trimi, S. (2012). Co-innovation: convergenomics, collaboration, and co-creation for organizational values. *Management Decision, 50*, 817-831.

Schembri, S. (2006). Rationalizing service logic, or understanding services as experience? Marketing Theory, 6(3), 381–392

Svensson, Peter O. and Hartmann, Rasmus Koss, (2018), Policies to promote user innovation: Makerspaces and clinician innovation in Swedish hospitals, Research Policy, 47, issue 1, p. 277-288.

3.2.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Explain the difference between the notions of co-production, co-design, co-construction, co-innovation
- LO2: Provide and explain examples of co-production, co-design, co-construction, co-innovation

3.2.3 Materials

Recommended literature	– Schembri, S. (2006). Rationalizing service logic, or understanding services as experience? Marketing Theory, 6(3), 381–392. – Lee, S.M., Olson, D.L., & Trimi, S. (2012). Co-innovation: convergenomics, collaboration, and co-creation for organizational values. *Management Decision, 50*, 817-831. – Svensson, P.O. and Hartmann, R.K., (2018), Policies to promote user innovation: Makerspaces and clinician innovation in Swedish hospitals, Research Policy, 47, issue 1, p. 277-288. – OECD/Eurostat (2018), Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://doi.org/10.1787/9789264304604-en.
Videos	/
Data	/
Software	/

3.2.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- **Activity 1 Introduction and definition:** Research on the definitions: preparatory reading and 1-minute summary; student Presentations- breakout discussion
- **Activity 2 Case studies:** Co-designing and co-creating SDIs in Practice: example and asking questions; Guest speaker(s), Case study paper

3.2.5 Implementation

Unit 1: Introduction and definition

Activity 1.1 - Research on the definitions: preparatory reading and 1-minute summary: Prior to the main teaching session, students are invited to randomly read one of the following articles:

- Schembri, S. (2006). Rationalizing service logic, or understanding services as experience? Marketing Theory, 6(3), 381–392.
- Lee, S.M., Olson, D.L., & Trimi, S. (2012). Co‐innovation: convergenomics, collaboration, and co‐creation for organizational values. *Management Decision, 50*, 817-831.

- Svensson, P.O. and Hartmann, R.K. (2018), Policies to promote user innovation: Makerspaces and clinician innovation in Swedish hospitals, Research Policy, 47, issue 1, p. 277-288.

Students should be able to provide in written form a definition of co-design, co-construction and co-innovation. Students are then paired in groups depending on the articles they read, and compare their findings. Each group present their definition in class and compare with the other groups to acknowledge common points and differences.

Activity 1.2 - Student Presentations- breakout discussions: Based on several cases provided by the teacher students are asked, in smaller groups, to identify which type of “co” apply and its impact on the governance of the infrastructure.

Unit 2: Case studies

Activity 2.1 – Co-designing and co-creating SDIs in Practice: example and asking questions: The teaching session itself starts with an example Co-designing and co-creating SDIs in practice, to illustrate the added value of each approached. Press articles and videos can be used.

Activity 2.2 – Guest speaker(s): One or several guest speakers are invited to the class to present a particular example of co-designing and co-creating approaches

Activity 2.3 - Case Study Paper: Students have to write a paper on based on a case study of their choice. The paper should identify the “co” that applied to that case study and how it has impacted the overall infrastructure and its evolution. Format: Length: maximum 1000 words including footnotes and excluding bibliography

3.2.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1.1	Remember Understand Apply	preparatory reading 1-minute summary Student Presentations-breakout discussions	Explain the difference between the notions of co-production, co-design, co-construction, co-innovation
Activity 1.2	Apply	Student Presentations-breakout discussions	Provide and explain examples of co-production, co-design, co-construction, co-innovation
Activity 1.2	Understand analyse	example and asking questions	Explain the difference between the notions of co-production, co-design, co-construction, co-innovation
Activity 2.2	Remember	guest speakers	Provide and explain examples of co-production, co-design, co-construction, co-innovation

Activity 2.3	Understand analyse	Case Study Paper	Provide and explain examples of co-production, co-design, co-construction, co-innovation

3.3 High Value Datasets (TU Delft)

3.3.1 Introduction

Making data available as open data across the EU Member States has proven to be a key factor in leveraging economic and societal value. Open data can be reused for many applications, such as research, data-driven decision-making or developing new products and services. Research has shown that the impact of open data depends on factors such as costs, quality of the data, accessibility, and harmonised reuse conditions. To increase the impact of open data and to reduce market entry barriers for start-ups and Small to Medium-sized Enterprises (SMEs), these factors need to be addressed. To do that more effectively, the European Commission (EC) decided that efforts to increase the impact of open data should be targeted at those datasets that have the biggest potential for society and the economy, the so-called High Value Datasets (HVDs). In the Directive on open data and the re-use of public sector information (EU) 2019/1024, the EC has identified six themes of HVDs in Annex I of the Directive. These six data themes are: geospatial, earth observation and environment, meteorological, statistics, companies and company ownership, and transport. The geospatial thematic category includes datasets within the scope of the INSPIRE data themes Administrative units, Geographical names, Addresses, Buildings and Cadastral parcels as defined in Annex I to the INSPIRE Directive 2007/2/EC as well as Reference parcels and Agricultural parcels as defined in Regulation (EU) No 1306/2013 and of Regulation (EU) No 1307/2013 and the related delegated and implementing acts.

Thanks to the Open Data Directive, EU member states must take the first steps towards creating a unified EU open data space, in which data product and services can be created that are usable EU-wide. This should alleviate the current situation in which it is often the case that a dataset provided in one EU state is not available at all in other states or is not available as open data. The identification and implementation of harmonised HVDs should address this current fragmentation of open data, and at least create a minimum level of data quality. It may also act as a lever to increase the quality of data governance of other open datasets.

However, between intentions and implementation are practical concerns. It took until May 2022 for the EC to draft an implementing regulation for consultation. The implementing regulation lays down a list of the specific HVDs and the arrangements for their publication and reuse. This implementing regulation specifies that organisations falling within the scope of the Directive will have to make these datasets available with minimal legal and technical restrictions and free of charge. This means that the datasets should be published in a machine-readable format and via application processing interfaces (APIs), and, where relevant, as a bulk download. Member states may exempt individual public sector bodies from the requirement to make HVDs available free of charge for another two years after the date that the implementation regulation comes into force. In addition, some specific HVDs held by public undertakings are also exempted from publishing these datasets free of charge where that would lead to a distortion of competition in the relevant markets (European Commission 2022, p.3).

The delay in publishing an implementation regulation creates a lot of uncertainty about how to flesh out the intentions of the Open Data Directive. Member States have different perceptions and expectations around HVDs, and in many cases, the value is determined by the government authorities that are the data holders of candidate HVDs. The findings of Huyer & Blank (2020) raise several vital aspects, challenges, and questions, such as that the value of datasets very much depends on the point of view of the Member States, as are the specifications and (geographical, sectoral) scope of impact. There is no clarity on any other standardised base for value assessment, therefore, each Member State has their own slant on identifying candidate HVDs. To assess the value of a potential HVD is no mean feat. Merely using metrics, such as number of downloads, into account is not sufficient to assess the value and potential impact of a candidate HVD as not all candidate datasets are available as open data.

This is the second challenge for implementing HVDs. Not all Member States publish candidate HVDs as open data yet for several reasons. In the case of geospatial data, this is often for financial reasons. Many of the geospatial data suppliers are self-funded government bodies that, by law, rely on generating income from licence fees for (re)using geospatial datasets to cover a substantial part of their operating costs (Welle Donker & Van Loenen, 2018). To switch from supplying fee-based data to supplying HVDs as open data and available via APIs and bulk download services in line with the Open Data Directive, the data supplier has to incur extra costs, such as extra Infrastructural costs, data transformation costs and operational costs (cf. Welle Donker and Van Loenen, 2018; Deloitte *et al*. 2020), and extra human resources to ensure that the services are guaranteed to run 24/7. According to an impact assessment study on HVDs carried out by Deloitte *et al*. in 2020 for the EC, these costs can be significant depending on the county. The initial extra infrastructural costs for the establishment of the API and bulk download, adaptation of the IT infrastructure to real-time provision are in the range of EUR 250,000 to 3,000,000 depending on the solution. There are probably additional costs such as extra data storage devices, which may be around EUR 450,000. Data transformation costs, such as data cleansing, adding metadata, aggregation and anonymisation, can be in the order of EUR 100,000-200,000 per year. Operational costs, such as data updates, replies to user feedback, correction errors, could amount to EUR 150,000 to 200,000 per year (Welle Donker & Van Loenen, 2018). Currently, Member States employ different dissemination channels for geospatial data, with some Member States using national SDIs, others use INSPIRE web services or the national data portal. Not all Member States will have the required technical and financial resources to make large quantities of data available in a machine-readable format and via APIs. On top of these costs, there may be the loss of income for data suppliers that now rely in income from licence fees. Depending on the country, the loss of income can be significant, e.g., for Sweden this could be in the order of SEK 90 million. Having to implement HVDs will require an adaptation of the business model of the geospatial data supplying bodies who are currently charging for data. Sustainable funding, both to implement HVDs as well as long-term funding must be addressed (EuroGeographics, 2022).

Finally, the roles and responsibilities in the process of specifying, implementing, and maintaining HVDs are not clear nor supported by a mandate or designated resources. In addition, the macro-economic benefits of the HVDs, especially for 'heavy-duty' users will not necessarily flow back to the data suppliers having to incur the micro-economic costs of supplying their key asset (data) for free and via APIs. This lack of a governance framework and unequal division of costs and benefits creates a high level of uncertainty. It took nearly three years for the EC to publish a draft list of HVDs and their specifications, and this list was open to consultation until June 2022. Until this list is final, HVD suppliers will be hesitant to start the implementation process.

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Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009, *OJ L 347, 20.12.2013, p. 608–670,* http://data.europa.eu/eli/reg/2013/1307/oj.

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3.3.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Understand the concept of High Value Datasets
- LO2: Identify the challenges of implementation of High Value Datasets according to the EU Open Data Directive 2019/1024
- LO3: Identify the opportunities of implementation of High Value Datasets according to the EU Open Data Directive 2019/1024
- LO4: Apply and discuss implementation of High Value Datasets from supplier's perspective and from SME perspective

3.3.3 Materials

Recommended literature	• Huyer, E. and Blank, M. (2020) Analytical Report 15. High-value datasets: understanding the perspective of data providers. Luxembourg: European Data Portal. • Zylstra, T. (2022). A look at the EU High Value Data List. Independent Thoughts Blog. https://www.zylstra.org/blog/2022/05/a-look-at-the-eu-high-value-data-list/ (accessed June 3, 2022) • EuroGeographics (2022). EuroGeographics' feedback on "Commission proposal on Implementing Regulation laying down a list of specific high-value datasets (HVD) and the arrangements for their publication and re-use". • European Commission (2022). COMMISSION IMPLEMENTING REGULATION (EU) …/… laying down a list of specific high-value datasets and the arrangements for their publication and re-use. • European Commission (2022). Annex to the Commission Implementing Regulation laying down a list of specific high-value datasets and the arrangements for their publication and re-use. https://www.zylstra.org/wp/wp-content/uploads/2022/05/EUHVDLeersteversie.pdf (accessed June 3, 2022)
Videos	/
Data	/
Software	/

3.3.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: Reading articles on the potential impact of High Value Datasets.
- Activity 2: Carrying out desk research of the impact of one HVD in one country
- Activity 3: Watching video clip or guest lecture of a private sector SME to understand the need for HVDs to stimulate the creation of cross-border open data products and services.
- Activity 4: Preparing and carrying out a class debate in which the pros and cons of a quick implementation of HVDs versus a slower implementation.

3.3.5 Implementation

Activity 1: Research on the challenges and opportunities provided by the publication of High Value Datasets in the EU in a harmonized way. Students are tasked to read the Analytical Report on HVDs and summarise the main take aways from this report.

Activity 2: Groups of 3 students are assigned one EU Member State and carry out desk research related to the current state of the identified spatial HVDs 'Administrative Units', 'Geographical Names', 'Addresses', 'Buildings', 'Cadastral Parcels', 'Reference Parcels' and 'Agricultural Parcels' in terms of compliance to the granularity and geographical coverage according to the "ANNEX to the Commission Implementing Regulation laying down a list of specific high-value datasets and the arrangements for their publication and re-use" document. Each student picks two of the six HVDs and makes an inventory of the current state of these HVDs and whether these datasets already comply to the proposed requirements. The desk research will be summarised in a 1-minute paper.

Activity 3: Short lecture on new development. Lecture, preferably as a guest lecture by private sector SME on opportunities of implementing High Value Datasets. Lecture will continue with two students presenting their 1-minute paper summarising the findings of Activity 1 and Activity 2. Two student groups will present their findings of Activity 3.

Activity 4: Lecture will finish with class debate in which students are divided into two camps: one group in favour of quick implementation of HVDs in order to achieve the aims of the Open Data Directive as soon as possible to facilitate the private sector, and one group arguing a slower implementation to allow HVD suppliers more time to find the necessary resources to adapt their business model and to focus on quality rather than speediness.

3.3.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1	Remember Understand Apply	preparatory reading 1-minute summary	Understand the concepts of HVDs Identify the opportunities of implementation of High Value Datasets according to the EU Open Data Directive 2019/1024
Activity 2	Understand analyse	Desk research 1-minute paper Student presentation	Identify the challenges of implementation of High Value Datasets according to the EU Open Data Directive 2019/1024
Activity 3	Remember Understand	Lecture Guest speaker Student Presentations	Identify the opportunities of implementation of High Value Datasets according to the EU Open Data Directive 2019/1024
Activity 4	Apply	Class debate	Apply and discuss implementation of High Value Datasets from suppliers' perspective and from private sector perspective

3.4 Private sector data in the SDI (TU Delft)

3.4.1 Introduction

In the context of SDI, the role of the private sector has mostly been discussed as one of a user of the infrastructure, and foremost as (re)user of public datasets provided through the SDI. As a consequence, discussions evolving around the concept of spatial data infrastructures (SDIs) almost always consider SDIs as typical public infrastructures: by (and for first and second generation SDIs also for) the public sector.

This view is neglecting the other roles the private sector may play in SDI: not only as a (re)user of public sector spatial data, but also as a provider of spatial data and as a manager/owner/provider of the infrastructure itself (see Vancauwenberghe et al., 2018; Martin et al., 2021). Eminent examples of the private sector as a manager/owner/ provider of the infrastructure were typically present in major data collecting companies in the gas and oil industry (e.g., Shell, BP, Texaco etc.) and related sectors (e.g., Fugro).

Since the thrive of the data economy other companies started to create their own spatial data infrastructures with the Google spatial suite (Google Maps/Google Earth/Google Streetview) and Microsoft (BingMaps) as prominent examples, but also Wave, TomTom and Telecom operators are frequently processing terabytes of spatial data. That in addition to companies that included data delivery to their traditional spatial planning, routing and profiling software portfolios (e.g., Esri) & the LBS business sector (see Location Based Marketing Association LBMA).

Due to the critical role spatial data has for companies, access to and reuse of the spatial data is typically strictly limited to authorised personnel of the company with some notable exceptions for trusted third parties. Others may obtain access by submitting specific requests and signing a contract prohibiting use other than the specified use, waiving liability claims, and claiming intellectual property rights. Similar to the traditional view on public SDIs, the private SDIs are managed and controlled by the company involved.

In many emergency response and disaster management operations around the world, government and the private sector have closely worked together in sharing each other's infrastructures and spatial data to provide first aid and response to the emergency as adequate as possible. Notable examples are the Haiti hurricane in 2010 and the bush fires in Australia in 2021. It is common practice that these data sharing efforts and initiatives will dissolve and disappear once the emergency lessens (and with it the public relations impact).

However, private companies may provide others access to their infrastructure on a permanent basis as well. For example, Google's mapmaker, launched in 2008, was one of the bigger platforms enabling volunteers to provide and share their spatial data with a wider community for nearly a decade (McQuire, 2019). In 2017, however, Google Mapmaker was retired and merged with Google Maps.

Open government data has stimulated the use of public spatial data in commercial operations: public sector spatial data is more than ever part of private sector SDIs (although exact numbers are unknown). Google, and also Esri, are harvesting open government data on a frequent basis to update their own datasets and/ or use the open government data as the framework datasets to build their software and applications on.

In addition, some companies have started to provide their data openly. The Dutch company AND, for example, donated their entire topographic database of China, India, and the Netherlands to OpenStreetMap. This way, it generated significant PR exposure for their company and the products it sells. On the same page Microsoft Maps donated 129,591,852 computer generated building footprints of the United States to OpenStreetMap in 2021. In addition, Fugro contributed more than 2,000,000 square kilometres of high-resolution bathymetry data in the North Atlantic Ocean to the Atlantic Ocean Research Alliance (AORA) and The Nippon Foundation-GEBCO Seabed 2030 Project (Seabed 2030) (https://www.fugro.com/media-centre/seabed-2030).

The European Union envisions a major role for G2B and B2G mechanisms and has introduced the concept of common data spaces that should ensure that more data becomes available for use, "while keeping the companies and individuals who generate the data in control" (see also High-Level Expert Group on Business-to-Government Data Sharing, 2020). This approach of common data spaces has also been discussed in the context of SDI (Kotsev *et al.*, 2021).

A more extreme approach to enlarge the user groups of private sector data is in enforcing private companies to share their (spatial) data (see e.g., Morten, 2022). In this way the concept of open SDI with open non-government data would obtain a huge impulse. Whether or not that could be implemented in a durable manner is subject of future research.

Towards an open SDI: Examples of open private sector data

- Mapping the sea floor: https://www.fugro.com/media-centre/seabed-2030
- AND and OpenStreetMap: https://blog.openstreetmap.org/2007/07/04/and-donate-entire-netherlands-to-openstreetmap/
- Microsoft Maps and OpenStreetMap: https://github.com/Microsoft/USBuildingFootprints
- Google open buildings: https://sites.research.google/open-buildings/

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3.4.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: identify and explain the different roles the private may play in the SDI.
- LO2: analyse how the private sector may contribute to public interest objectives of the SDI.
- LO3: discuss what governance options exist to increase the participation of the private sector in (public) SDIs.

3.4.3 Materials

Recommended literature	• European Commission, Directorate-General for Communications Networks, Content and Technology, 2021. *Towards a European strategy on business-to-government data sharing for the public interest : final report prepared by the High-Level Expert Group on Business-to-Government Data Sharing*, Publications Office of the European Union, Luxembourg. • Kotsev, A., Minghini, M., Cetl, V., Penninga, F., Robbrecht, J. and Lutz, M., 2021, INSPIRE - A Public Sector Contribution to the European Green Deal Data Space, EUR 30832 EN, Publications Office of the European Union, Luxembourg, doi:10.2760/8563, JRC126319. • Martin, S., Gautier, P., Turki, S. and Kotsev, A., 2021, Establishment of Sustainable Data Ecosystems: Recommendations for the evolution of spatial data infrastructures, EUR 30626 EN, Publications Office of the European Union, Luxembourg, doi:10.2760/04462, JRC124148. • Morten, C., 2022, Publicizing Corporate Secrets for Public Good, University of Pennsylvania Law Review, Vol. 171, Forthcoming • Vancauwenberghe, G., K. Valeckaite, B. van Loenen & F. Welle Donker (2018). Assessing the Openness of Spatial Data Infrastructures (SDI): Towards a Map of Open SDI. *International Journal of Spatial Data Infrastructure Research, 13,* 88-100.
Videos	/
Data	/
Software	/

Additional references:

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Towards a common European data space (COM(2018) 232 final of 25.4.2018).

European Commission, 2020, A European Strategy for Data, COM/2020/66 final https://digital-strategy.ec.europa.eu/en/policies/strategy-data

European Commission, 2022, Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on harmonised rules on fair access to and use of data (Data Act). COM/2022/68 final.

Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724 (Data Governance Act). OJ L 152, 3.6.2022, p. 1–44

3.4.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- **Activity 1:** Readings on the role of private sector in SDI.
- **Activity 2:** Lecture on the role of the private sector in the traditional SDI and its foreseen role in an open SDI
- **Activity 3**: The role of the private sector in the SDI and effective ways to stimulate their participation
- **Activity 4:** Guest lecture of a private sector company/ geo business association to understand their perspective.
- **Activity 5**: Roleplay

3.4.5 Implementation

Activity 1: Research on the role of the private sector in SDI. Students are tasked to read one of the five papers. The work will be split among the students. They have to summarise the main take aways from the papers they have studied and present to the other students. Together they draft a small report (max 2,000 words) on their findings from the literature.

Activity 2: Lecture on the role of the private sector in the traditional SDI and its foreseen role in an open SDI. During the lecture students will be asked to provide a one-minute summary of that part of the lecture.

Activity 3: In this activity students will brainstorm with each other the role of the private sector in the SDI and effective ways to stimulate their participation. Input for the brainstorm are the findings from the activities 1 and 2. The brainstorm should result in a list of open questions to be discussed in activity 4.

Activity 4: In the guest lecture, a representative of a geo company will explain their view on the role of the private sector in SDI. The students will be active in the following ways: two students shall moderate the session, one group shall prepare questions developed in activity 3, another group develop (provocative) propositions for discussion with the guest speaker, and the last group shall present at the end of the meeting a summary report of meeting. Example propositions to be discussed are:

1. “Public and private SDIs should never be linked or merged”
2. “All private sector data should be available as open data, and this should be enforced by government”
3. “Only with the private sector in the driver’s seat the SDI will endure”

Activity 5: roleplay (by TU DELFT and KU LEUVEN). In this activity students will experience themselves the issues and arguments of different stakeholders in the discussion which stakeholders to involve in the open SDI.

Roleplay 1: open SDI role play: how to get into the (open) SDI? 45 minutes

1. In a short lecture we explain the current situation: platform need more than public sector data
2. Description stakeholders (give sheet to each group, no sharing of the description)
3. In the description an attitude towards the challenge (positive/ against/neutral) and a task (only participate if compensated/ only allow participation if contribution/ etc) for the stakeholder group and a compromise result that would satisfy most of their 'stakeholders'.
4. Script: sell yourself and explain the conditions that need to be satisfied for you to participate.
5. Play the game with one representative of each group (five groups: why our group needs to be involved)
6. Intervene: ask the stakeholders groups what they observe, both in content, emotion and language/ attitude put forward
7. Ask the stakeholders groups to advise how their representative may intervene to "break the impasse".
8. Which of the other parties would you like to participate, and which parties rather not. List the order of importance. Explain.
9. Play the game II: EC: data space: the moderator explains that there is only budget for three or four parties. The group has to distribute the budget among the stakeholder groups (but at least one cannot be paid).
10. Intervene: ask the stakeholder group representatives what change they noticed in general and in the other representatives: was this identical to the advice of this representatives' group? Did they get out of the meeting what they planned?
11. Wrap up: brief link to open SDI: what problem did we tackle in the role play. Explain that the role play is a simplification of the real world which is even more difficult due to many more parties and interests in each of the sectors.

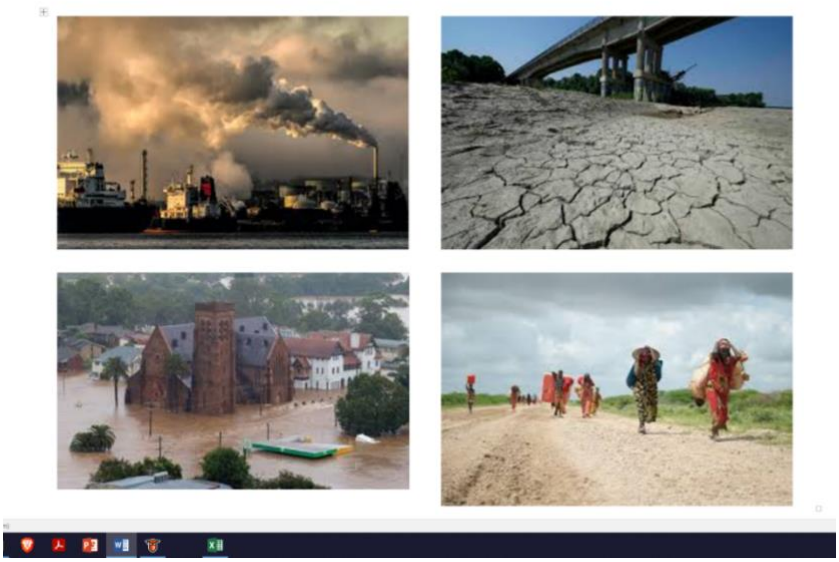

*Figure 3:**Several pressing challenges that open SDI can support to fight***

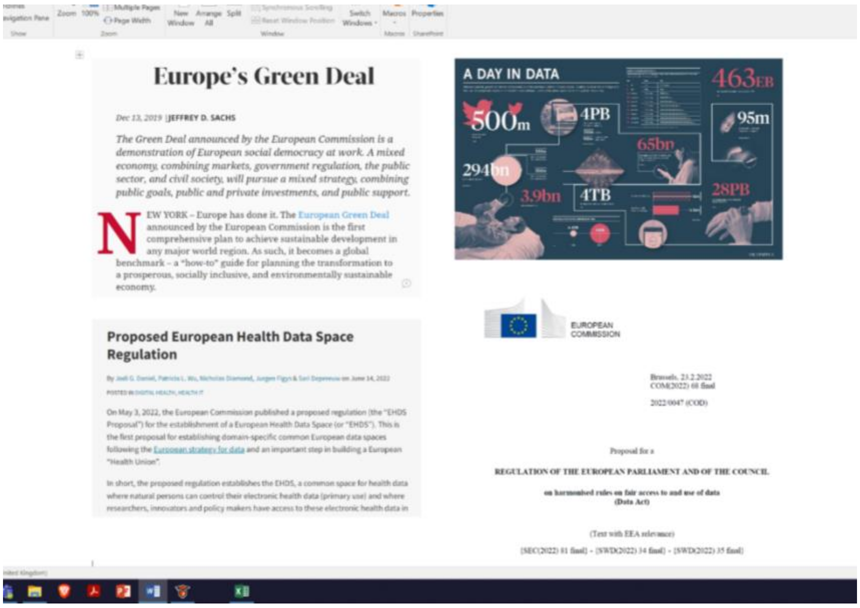

*Figure 4:**Developments that call for an Open SDI approach***

Overall description current situation

1. SDI platform 1.0 (INSPIRE) by and for the government: no involvement others: no data, no part in decision making in SDI/platform
2. EU (data spaces) policy aiming at Open SDI platforms 2.0 by and for all stakeholders/ SDI part of Data Space Green Deal: need for non-government sectors to step in.
3. The mismatch has to be overcome: how?

- BigTech has more data than ever and already have developed popular data sharing platforms
- SmallTech has a lot of data also and local knowledge
- Citizens science: more and better data
- Data commons on the rise
- EU Data space health not so voluntary as earlier announced
- Next step open data directive: more open data of companies
- Open data ecosystem: not circular: government pays, only businesses benefit
-

Interest groups/ stakeholders

a. Government: data providers
b. Private sector: SMEs in data products
c. Private sector: big tech
d. Civil society: citizens + NGO
e. Academia: AGILE representative

Government:

a. Senior policy makers in geo European Commission (DG Environment):

i. Attitude towards newcomers on the European INSPIRE platform of the government: yes please as soon as possible
ii. Responsible for budget data platform 1.0
iii. Coordinates activities all government partners in geo.
iv. Limited budget
v. [Pressure from the minister and departments to stop/ change open (government) data policy due to undetected benefits for government: why only government to provide open data?]
vi. Want, as their EC counterparts, also non-government data on their platform
vii. Providers of NGD should pay a fee (per Mb size dataset; per Mb downloaded by users, other) for the hosting
viii. Providers of NGD should comply with the platform policies: open data, open standards, metadata, etc

b. INSPIRE platform operators:
   i. Attitude towards newcomers on the platform: reluctant
   ii. Concerned with the potential impact of a change: extra work implies extra money/ people needed
   iii. Do want to maintain the current high-quality data in the platform: open standards, metadata, trusted contact persons, etc

Private sector:

- Attitude towards the current INSPIRE platform: typical government thing: lacking user friendliness, only a dashboard for policy makers
- Is not eager to contribute to the current government ran platform
- Has a lot of data available at a price
- Does have various platforms available for their clients (e.g., ESRI, Sweco, others) at a price
- Their platforms/technologies should be used in the SDI platform 2.0
- Does not want to provide their data for free to all
- If contributing, then also a say in the decision making
- If data providing, then 'as is': no additional 'quality impulse' to be made.

Civil society represented by OpenStreetMap (OSM):

- Does not understand the issue: OSM has been around as a platform since 2004 and very successfully serving many
- Anyone can already use OSM and contribute to OSM for free and ODbL 1.0 (=share alike)
- OSM data on Platform 2.0 is okay but only if adhering to the OSM licence restrictions
- OSM data on Platform 2.0 is okay but only if no additional requirements/ costs to be paid by OSM
- OSM is willing to contribute in kind in the development of the portal

Academia:

- Open data directive: publicly funded research has to be provided as open data +
- Open science is the standard: academia would like to contribute.
- Do not have any resources (even time is limited): only can provide data if it is free of charge/ no cost involved.
- Do want to provide their data as is: no metadata, in local formats, own unique standards.

European Commission (DG Connect):

- Key interest in improved data sharing between all SDI stakeholders
- Data spaces are embedded in the European data strategy & to the Green Deal Policy and for health data a health data space law was developed.
- Prefers to have voluntary contributions of non-government parties, but if seduction and education do not have an effect, may start processes for legislation on a data space for the green deal.
- Has no funding available.

Roleplay 2: simplified version of Roleplay 1: no predefined interest/ roles of the sectors.

Role play: students have to represent a community/ sector and convince the SDI platform to have their data published to become part of the SDI.

Students were distributed over 5 groups:

a. Government: data providers
b. Private sector: SMEs in data products
c. Private sector: big tech
d. Civil society: citizens + NGO
e. Academia

Two rounds of discussion. For each round:

- 10 minutes discussion within their own group
- 20 minutes discussion with representatives (1 per group)
- 5 minutes involving others

Round 1: European Commission (DG Environment) invites all parties to the meeting INSPIRE 2.0 as the Green Deal Data Space

Role: European Commission (DG Environment) would like to invite the government and non-government parties to explain why they should be part of the Green Deal Data Space with their data to contribute together as a spatial data community to the challenges identified by the Green Deal.

All groups will discuss why they should be part of the Green Deal Data Space and under what conditions and prepare a 2-minute elevator pitch for the discussion with the EC (10 minutes preparation).

- Square shape setting of chairs
- All groups have one representative at the table (inner circle).
- The rest is sitting in a circle around the ‘negotiation’ table (no communication between the inner circle and outer circle).

The moderator (i.c. one of the staff members plays the role of ‘Mr. Frans Timmermans’, responsible for the EU Green Deal) asks each of the parties why they need to be considered for the Green Deal

Data Space and what the conditions are that need to be taken into account and asks for clarification if necessary. The outer circle of each group is asked if their representative in the inner circle has provided all the arguments. The moderator summarises the pitch. (Total 20 minutes)

Round 2 of discussion

The moderator explains that there is only limited budget for the Green Deal Data Space and that unfortunately the EC cannot have all parties on board. The groups are asked to provide recommendations to the EC on the parties that should be included and parties that could not be. The groups have to propose at least one group for both categories (include in Data space/ exclude from Data space). (10 minutes preparation)

- Square shape setting of chairs
- All groups have another member of their group representative at the table (inner circle).
- The rest is sitting in a circle around the 'negotiation' table (no communication between the inner circle and outer circle).

The moderator (i.c. one of the staff members plays the role of 'Mr. Frans Timmermans', responsible for the EU Green Deal) asks each of the parties to explain which parties they like to be in and which parties to be out of the Green Deal Data Space. After each introduction, the moderator asks the Outer circle members of the party that is proposed to be excluded from the Data Space to counter argue. Moderator summarises meeting and announces that the EC will take the meeting outcomes in consideration in their decision on the Green Deal Data Space (Total 20 minutes).

Wrap up by the teachers: lessons learned and link the role play findings to the real world.

*Figure 5:**The implementation of Roleplay 2 during the SPIDER Summer School***

Alternatives to Roleplay 2:

- Round 2 of discussion

Intervention: ask the stakeholders groups what they observe, both in content, emotion and language/ attitude put forward

Ask the stakeholders groups to advise how their representative may "break the impasse".

- Round 3 of discussion

Intervention: European Commission (DG Connect) suggests that the European Commission is thinking of introducing a Green Deal Data Space Act that obliges any party to contribute needed spatial data to the Green Deal Data Space.

Activity 6: Lecture and exercise (by LU and BO). In the lectures, the lecturers will explain the theories and concepts on geospatial web services (e.g., Web map service, web feature service, web map tile service) and standard data formats (e.g., GML, KML, OSM, GeoJSON). In the exercise, the operations on viewing geospatial data with WMS and WFS links in QGIS.

3.4.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1	Remember/ Understand	Reading, summarising, and presenting	identify and explain the different roles the private sector may play in the SDI. understand how the private sector may contribute to public interest objectives of the SDI.
Activity 2	Remember/ Understand Analyse	Lecture, one minute summary	identify and explain the different roles the private sector may play in the SDI. analyse how the private sector may contribute to public interest objectives of the SDI.
Activity 3	Create	Brainstorm	discuss what governance options exist to increase the participation of the private sector in (public) SDIs.
Activity 4	Understand, and Create	Guest speaker, moderate session, ask questions, develop discussion statements, summarise meeting and present	discuss what governance options exist to increase the participation of the private sector in (public) SDIs.

3.5 Geospatial Research Data Management (HSBO)

3.5.1 Introduction

A demand and ambition to make the scientific process more trustworthy and transparent has put the concept of *Open Science* on the agenda of funding agencies, research organisations, and individual scientists. It is often used as an umbrella term for more specific practices enabling reproducibility and replicability, such as open access publishing, linking papers to code, making papers executable, publishing FAIR (Findable, Accessible, Interoperable, and Reusable) data (https://www.go-fair.org/fair-principles/), the use of persistent identifiers for datasets, their long-term archiving, and their description in data journals. *Research Data Management* (RDM) is part of the backbone that is required to make many of these concepts common practice and has therefore become a major point of attention across many scientific disciplines over the last few years. The financial backing of initiatives such as the European Open Science Cloud (EOSC) (https://www.eosc.eu) and the German National Research Data Infrastructure (Nationale Forschungsdateninfrastruktur, NFDI) (see https://www.nfdi.de/?lang=en and https://www.nfdi4earth.de) shows this development is not a mere niche trend but has full support up to the highest political levels.

The developments around RDM and Open Science intersect with Open SDI in four ways: (1) The idea of openness plays a major role both for Open SDI and for Research Data Management; (2) For disciplines dealing with geographic information, many of the relevant datasets are already available through SDIs; (3) core ideas of SDIs, such as service-oriented architectures and processing in the cloud can serve as blueprints for RDM in other disciplines; and (4) due to the overlap in functionality, provided data, and users, a certain degree of integration of SDI and RDM infrastructures is to be expected.

However, despite the commonalities and intersection points, RDM infrastructures are not the same as SDIs. RDM infrastructures have to work for a much broader range of data, that can be as different as genome sequences, air quality samples, or annotated linguistic corpora, to name but a few examples. Therefore, RMD infrastructures cannot be as specific as the service specifications and metadata standards known for SDIs but have to focus on more generic functionalities such as assigning identifiers to datasets, providing storage and compute capacities, and security through authentication and authorisation infrastructures. Domain-specific applications, such as virtual research environments for marine research (e.g., the Blue Cloud Virtual Research Environment: https://www.blue-cloud.org/services/blue-cloud-virtual-research-environment) or visualisation tools for pathogen mutations (https://clades.nextstrain.org), must then be built on top of the RDM infrastructure. Vice versa, the target group for SDIs is much broader, as many of the datasets there are potentially useful also for the general public, who may access them through Geoportals and mobile apps. Data in RDM infrastructures, on the other hand, is often only useful for domain experts who know how to work with this kind of data.

Recent developments in RDM and Open Science practices in general have already started changing research workflows involving geographic information. The emergence of spatial data science as a new interactive paradigm based on notebooks that is much more transparent and reproducible than workflows using traditional point-and-click interfaces is just one example that shows how work with data provided through SDIs is already being influenced by these novel developments. RDM practices are also being reflected in a new generation of geodata management tools such as GeoNode (https://geonode.org). Generally, is seems safe to assume that the advancement and proliferation of RDM further accelerates the trend towards free and open source software in the SDI context.

3.5.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Explain the FAIR data principles.
- LO2: Understand differences, commonalities and intersection points between Open SDI and RDM.
- LO3: Access geographic data through an RDM infrastructure.
- LO4: Set up a modern geospatial research data management tool.

3.5.3 Materials

Literature	Bernard, L., Braesicke, P., Bertelmann, R., Frickenhaus, S., Gödde, H., Keßler, C., Lorenz, S., Mahecha, M., Marschall, H., Hezel, D., Nagel, W.E., Reichstein, M., Sester, M., Thiemann, H., Weiland, C., Wytzisk-Arens, A., and NFDI Consortium Earth System Sciences. (2021). NFDI Consortium Earth System Sciences - Proposal 2020 revised (Revision 1 from 2021-10-01). Zenodo. https://doi.org/10.5281/zenodo.5718944 Petzold , A., Asmi , A., Vermeulen, A., Pappalardo, G., Bailo, D., Schaap, D., Glaves, H.M., Bundke, U. and Zhao, Z. (2019). ENVRI-FAIR-interoperable environmental FAIR data and services for society, innovation and research. 2019 15th International Conference on eScience (eScience). IEEE: https://helda.helsinki.fi/bitstream/handle/10138/325616/09041704.pdf?sequence=1 Budroni, P., Claude-Burgelman, J. & Schouppe, M. (2019). Architectures of Knowledge: The European Open Science Cloud. *ABI Technik*, *39*(2), 130-141. https://doi.org/10.1515/abitech-2019-2006: https://www.degruyter.com/document/doi/10.1515/abitech-2019-2006/html
Videos	- What is the National Research Data Infrastructure (NFDI)? https://www.youtube-nocookie.com/embed/uJ01g9m8uE4 - EOSC Portal YouTube channel: https://www.youtube.com/channel/UCHsaUFy5LJ3rJ28qDg2StGA
Data	/
Software	https://geonode.org

3.5.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: Reading and summary of the FAIR data principles
- Activity 2: Discussion of the commonalities and differences between Open SDI and RDM
- Activity 3: Obtaining research data from an RDM infrastructure
- Activity 4: Setting up a GeoNode instance

3.5.5 Implementation

Activity 1: Reading and summary of the FAIR data principles: Students read the FAIR data principles [1] and discuss it in the context of the EU template for data management plans (DMPs) [8]. The discussion is guided by the instructor to make sure that the links between the DMP template and the FAIR data principles are well understood. Students then develop a one-minute summary of the most important ideas behind the FAIR data principles.

Activity 2: Discussion of the commonalities and differences between Open SDI and RDM: Students review the current state of EOSC [2] and NFDI [3,4]. Based on their prior knowledge of SDIs, they split up in groups of 4–5 students and try to identify the main differences and commonalities between the two in terms of:

- Technical infrastructure
- Functionality
- Standards and specifications
- Governance and regulation
- Funding/business models
- Target user group
- Openness

Each group then briefly presents their findings to kickstart a final discussion in the whole group so the different findings from the small discussion rounds can be collected and complement each other.

Activity 3: Obtaining research data from an RDM infrastructure: Each student individually picks a theme of interest and tries to obtain relevant data for that theme from a platform in an RDM infrastructure. To make sure that the students are not completely "lost", the instructor briefly introduces the following entry points that the students can use to start looking:

- Data Journals:
    - Scientific data: http://www.nature.com/sdata
    - Data Science Journal http://datascience.codata.org
    - Data in Brief http://www.journals.elsevier.com/data-in-brief
- https://figshare.com
- https://zenodo.org

One of the key takeaways from this exercise should be that RDM infrastructures currently still share one of the main weaknesses with SDIs, namely the fact that searching for data for a particular theme is very cumbersome and in some cases entirely impossible.

Activity 4: Setting up a GeoNode instance: The goal of this activity is to familiarise students with a modern geospatial data management tool, namely GeoNode. For this purpose, the students perform the following steps on their own computer (or a lab computer at the university, if possible; however, some of the installation steps require admin privileges, which are often not available in campus computer labs):

- Install Docker
- Follow the installation tutorial to install GeoNode in Docker.
- Complete the basic configuration.
- Explore the admin options in GeoNode.
- Upload a dataset of their choice through GeoNode

Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1	Remember/understand	Reading and summarising, and presenting	Explain the FAIR data principles.
Activity 2	Understand, Analyse	Develop discussion statements, summarise meeting and present	Understand differences, commonalities and intersection points between Open SDI and RDM.
Activity 3	Analyse, Create	Peer instruction	Access geographic data through an RDM infrastructure.
Activity 4	Understand, Create	Peer instruction	Set up a modern geospatial research data management tool.

3.6 OGC API (HSBO)

3.6.1 Introduction

The world of spatial data infrastructures has in many ways been at the forefront of interoperability, service-oriented architectures, and standardisation, long before other domains have started to move into this direction. This pioneer role means that many of the specifications that are in use for the implementation of Application Programming Interfaces (APIs) of SDI services follow design patterns that are very specific to this application area from today's perspective. Software developers new to the world of geospatial web services will therefore have a very high barrier of entry before they can write working code. From a data integration point of view, the provision of data through APIs following these somewhat dated specs means spatial data is not a first-class citizen on the web, therefore counteracting the original intention of building SDIs in the first place.

Over the last few years, OGC has collaborated with other major players dealing with standardisation for the Web – most notably the World Wide Web Consortium (W3C) – to align access to spatial data with the ways other content is provided using the Hypertext Transfer Protocol (HTTP). While the most commonly used OGC services are already HTTP-based Web services, they do not follow the principles of Representational State Transfer (REST), focusing on lightweight coupling between client and server, and the control of the delivered representation of a resource (such as a feature) through the messages exchanged between client and server. Moreover, the client should be able to discover additional resources through links provided by the server – an architectural principle that is not followed by traditional OGC web services due to the separation of requests for capabilities and the actual data.

As REST is not a protocol, but rather an architectural style for the development and provision of web services, a more concrete intermediate common set of principles is needed for the actual API development. Along these lines, the OpenAPI specification has gained considerable attention as a layer close this gap between the general architecture and a concrete API to be developed. It specifies the form for service descriptions, the general structure of API endpoints, the messages exchanged, and the payload of these messages. Moreover, besides the components required for machine-to-machine communication, the structure of the API's documentation for human users is also specified. In combination, building the OGC API specifications around OpenAPI significantly facilitates adoption by web developers and helps make spatial data a first-class citizen on the Web. This unit will give students familiar with traditional OGC services a solid understanding of the differences and advantages that the OGC API specifications based on Open API bring along.

3.6.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Explain the basic OpenAPI principles.
- LO2: Understand differences and commonalities between traditional OGC services and OGC API services.
- LO3: Explore an OGC API – Features service directly through a Web browser.
- LO4: Access data in an OGC API – Features service from QGIS.

3.6.3 Materials

Literature	– OGC APIs: Building Blocks for Location: https://ogcapi.ogc.org/ – OpenAPI documentation: https://oai.github.io/Documentation/start-here.html – OGC APIs and the evolution of OGC standards: https://www.ogc.org/blog/2996 – OGC Open Geospatial APIs – White Paper: https://docs.ogc.org/wp/16-019r4/16-019r4.html – OpenAPI Specification v3.1.0: https://spec.openapis.org/oas/v3.1.0
Videos	- OGC APIs: Building Blocks for Location: https://www.youtube.com/watch?v=hNmZJ1itqfM - OGC APIs Overview and Implementation: https://www.youtube.com/watch?v=xpw_VvcPjaE
Data	/
Software	/

3.6.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: 1-minute summary of the OpenAPI design principles
- Activity 2: Discussion of the commonalities and differences between traditional OGC web service specifications and the corresponding OGC API services
- Activity 3: Exploration of an OGC API service through a Web browser
- Activity 4: Exploration of an OGC API service through QGIS

3.6.5 Implementation

Activity 1: 1-minute summary of the OpenAPI design principles: Students read the OpenAPI documentation [1]. Each student is assigned one section on a fundamental design principle for a 1-minute summary. The students receive feedback after their presentation from the instructor to make sure that the basic design principles are well understood.

Activity 2: Discussion of the commonalities and differences between traditional OGC web service specifications and the corresponding OGC API services

In groups of 4–5, students try to identify the main differences and commonalities between the OGC Web Feature Service and OGC API - Features in terms of:

- Data access
- Documentation
- Format of the data transferred
- Navigation of the contents offered
- Metadata

Each group then briefly presents their findings to kickstart a final discussion in the whole group so the different findings from the small discussion rounds can be collected and complement each other.

Activity 3 Exploration of an OGC API service through a Web browser: Each student individually tries to find an OGC API - Features instances and interacts with it directly through the web browser. Students should be on exploration of the contents of the service, trying to navigate the different feature types offered and access individual features. One of the key takeaways from this exercise should be that OGC API / OpenAPI is completely HTTP-based and intuitive to navigate even with a tool such as a web browser, which is not made for interaction with SDI web services.

Activity 4: Exploration of an OGC API service through QGIS: After activity 3, students use the same service instance and try to connect it to QGIS. They pay special attention to the differences compared to setting up a connection to a Web Feature Service. The instructor then facilitates a final discussion about the pros and cons of OGC API – Features compared to a traditional Web Feature Service.

3.6.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1	Remember/ understand	Reading and summarising, and presenting	Explain the basic OpenAPI principles.
Activity 2	Understand, Analyse	Develop discussion statements, summarise meeting and present	Understand differences and commonalities between traditional OGC services and OGC API services.
Activity 3	Understand, Analyse	Peer instruction	Explore an OGC API – Features service directly through a Web browser.
Activity 4	Understand, Analyse	Peer instruction	Access data in an OGC API – Features service from QGIS.

3.7 Extract – Transform – Load (HSBO)

3.7.1 Introduction

Data driven processes affect spatial data handling as well as other domains. On the one side sensor networks, the Internet of Things, open-data platforms etc. and on the other side machine-learning tools and data driven business processes characterize data environments. The linkage is done by data integration processes. Developed for the combination and centralization of databases, ETL (Extract – Transform – Load) is a relevant method. Furthermore, ETL describes the data adaption by a reader-component, the forwarding to a transformer and finally the storage by a writer. Beside harmonization of datasets, ETL is used to improve the quality of data. For geodata management spatial ETL is the method, taking the characteristics of spatial data into account.

3.7.2 Learning outcomes

After the teaching practice, the students will be able to:

- Explain what a (spatial) ETL-process is and why it is reasonable
- Know about the possibilities and area of application of ETL in spatial data handling
- Implement and execute an ETL-process in a professional ETL-tool
- Read and develop an ETL-model in FME Desktop

3.7.3 Materials

Data	Administrative boundaries from https://inspire-geoportal.ec.europa.eu/overview.html by OGC WFS
Software	FME Desktop (https://www.safe.com/fme/fme-desktop) (option of free trial)
Literature (additional material)	• Drešček, U., Kosmatin Fras, M., Tekavec, J., & Lisec, A. (2020). Spatial ETL for 3D building modelling based on unmanned aerial vehicle data in semi-urban areas. *Remote Sensing*, *12*(12), 1972. • Klinger, R. (2016, December 12). FME and Talend: ETL tools for your spatial data - Digital Geography. https://digital-geography.com/fme-and-talend-etl-tools-for-your-spatial-data/
Videos (additional material)	• GeoSpatial Integration for Talend: https://www.youtube.com/watch?v=gJOosoj3JUw • Implementing INSPIRE with FME https://www.youtube.com/watch?v=Kx9CYjY77NQ

3.7.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Video preview recorded by teacher for a detailed introduction into (spatial) ETL followed by self-test.
- Intro of teacher and round of questions.

- ETL in Practice: Guest presentation about use in practice, guided example, development of an ETL-model in FME-Desktop

3.7.5 Implementation

Unit 1: Video lecture about spatial ETL

Activity 1.1 – Video presentation of theoretical background and knowledge: Students are invited to follow an online presentation ahead the lecture to get the theoretical background of ETL and spatial ETL, as well as the role in data warehouse and big data environment. Further, the main fields of applications and products on the market are mentioned.

Activity 1.2 – Optional self-test: Based on the previous input students can check they knowledge by a short questionnaire (max. three questions).

Unit 2: Overview through spatial ETL

Activity 2.1 – Overview about spatial ETL: The teaching session itself starts with an intro by the teacher, summing up the central statements of the video presentation, to activate the knowledge from the video presentation.

Activity 2.1 – Round of questions: Students ask comprehension questions as well as questions about special interest. They are also invited to comment and add impressions they got from further readings.

Unit 3: ETL in practice

Activity 3.1 – Guest presentation: An external guest from practice gives an input by an ETL-project in spatial data management. Her/his profession might be in the area of INSPIRE-data-preparation of public sector or in the area of BIM modelling. Realization might be easier by video presentation, prepared in advance.

Activity 3.2 – Guided example: Teacher gives a short and easy example in FME Desktop, e.g. coordinate transformation with one reader, one transformer and one writer.

Activity 3.3 – Development of an ETL-model in FME-Desktop: Students work on their own or in small groups (max. three students) on a small exercise, presenting the manifold interfaces of the FME and the spatial functions. Example: Loading geometries from an OGC WFS, calculating their centre and write these positions as “What3words” (registration needed) into a text file.

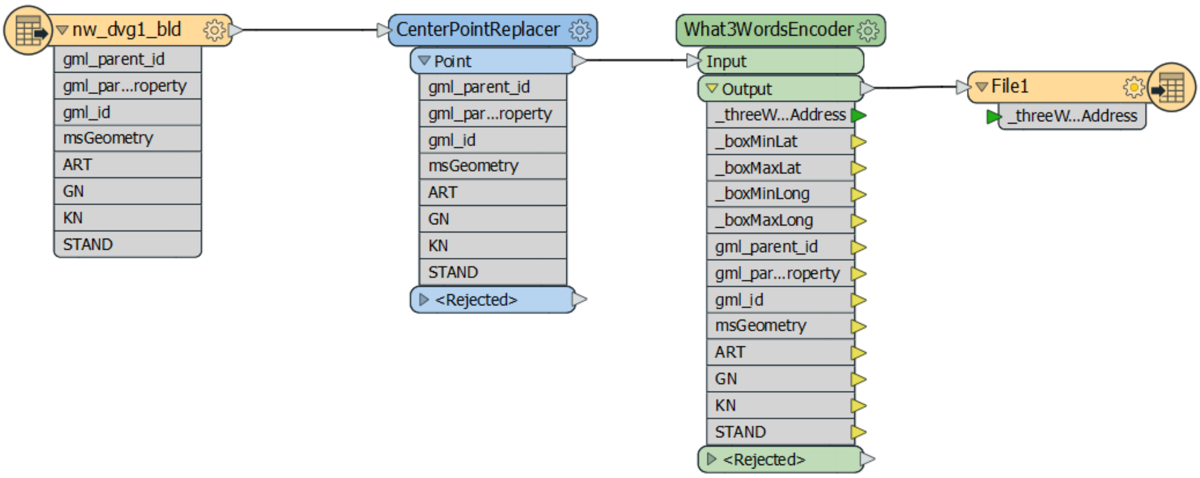

Figure 6: Example of an ETL workflow in FME-Desktop.

3.7.6 Summary

	Level of Bloom	**Type of active teaching**	**Associated learning outcome**
Activity 1.1	Remember Understand	Video presentation	Explain what ETL is and what it is related to
Activity 1.2	Remember	Self-test for students	Self-check of understanding
Activity 2.1	Remember Understand	presentation	Reactivate knowledge of video presentation
Activity 2.2	Understand	Asking questions	Clarify questions and extend common knowledge
Activity 3.1	Remember Understand	guest speakers	Create relation to practice
Activity 3.2	Understand Create	Guided example	Introduce into steps of model creation
Activity 3.3	Remember Create	Exercise	Getting experiences in creating ETL-models

3.8 Blockchain for Open Geodata sharing (Lund)

3.8.1 Introduction

Blockchain and distributed ledger technologies, as new trends in data management, will be introduced. It includes describing blockchain structure and mechanisms as well as its advantages for managing and sharing data in a more transparent and secure way with the possibility of implementing rewarding mechanisms (Farnaghi and Mansourian, 2020). Some examples as below can be taught and discussed in this topic:

A. Recording and keeping track of Spatial Data Supply Chain (SDSC) in an open SDI environment is especially important to deal with trust and copyright issues, while processing and integrating data from different resources to generate new datasets. This becomes more critical while integrating spatial data with different copyrights. However, there are no resilient methods to ensure the identification of source or ownership of the original spatial data and avoid different potential forms of malicious tampering. Different from the centralized platforms, blockchain and digital ledger technologies can provide a trust-free platform via decentralization to realise SDSC while handing over the ownership of spatial data from one peer to another.

B. VGI plays a crucial role in open geospatial data and open spatial data infrastructure. The traditional crowdsourcing data collection methods, e.g., OpenStreetMap, are still facing some challenges, such as participation of wider range of the society in data collection and publishing as well as data quality assessment. How blockchain technology can help in:
   - attracting citizens to contribute to collect data.
   - guaranteeing and securing the glory of data collection to the citizens who have actually collected the data, and
   - Providing mechanism for quality assurance of the data

There is little research on using blockchain technology in spatial data-related issues, such as blockchain for land administration, process chain of satellite images, and sustainability (Zheng et al., 2018; Blockchain and earth observation, 2019). Some of these studies showed the suitability of blockchain technology and some other studies displayed the opposite. Unsuitability of blockchain technology has been either related to technical or non-technical aspects, see e.g., Stefanović, et al. (2018). Lessons learned from these projects as well as understanding and discussing them would be very beneficial while thinking about applications of blockchain technologies for open SDI.**References**

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https://www.researchgate.net/publication/342343000_Blockchain_an_enabling_technology_for_transparent_and_accountable_decentralized_public_participatory_GIS

Stefanović, M., Pržulj, D., Ristic, S. and Stefanović, D., 2018. Blockchain and land administration: Possible applications and limitations. In Proc. EBM (pp. 1-8) https://www.researchgate.net/profile/Miroslav-Stefanovic-2/publication/329650717_Blockchain_and_Land_Administration_Possible_applications_and_limitations/links/5c79204e458515831f78b72c/Blockchain-and-Land-Administration-Possible-applications-and-limitations.pdf

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3.8.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Define blockchain and explain its basic concepts
- LO2: Explain how (including advantages and disadvantages) blockchain can be used for open geodata sharing
- LO3: Analyse and discuss some potential applications of blockchain in GIS and VGI projects

3.8.3 Materials

Literature	- Mendi, A.F. and Çabuk, A., 2020. Blockchain applications in geographical information systems. Photogrammetric Engineering & Remote Sensing, 86(1), pp.5-10. (https://www.researchgate.net/profile/Arif-Mendi/publication/338690652_Blockchain_Applications_in_Geographical_Information_Systems/links/5e25868792851cafc393646d/Blockchain-Applications-in-Geographical-Information-Systems.pdf) - EO data provenance with ksi® blockchain, White paer, 2020. (https://eo4society.esa.int/wp-content/uploads/2020/03/EO-data-provenance-with-KSI-blockchain-Feb-2020.pdf) - Qiu, Y., Liu, Y., Li, X. and Chen, J., 2020. A novel location privacy-preserving approach based on blockchain. Sensors, 20(12), p.3519. (https://www.researchgate.net/publication/342406531_A_Novel_Location_Privacy-Preserving_Approach_Based_on_Blockchain) - Leka, E., Lamani, L., Selimi, B. and Deçolli, E., 2019, May. Design and implementation of smart contract: A use case for geo-spatial data sharing. In 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO) (pp. 1565-1570). IEEE. (https://www.researchgate.net/publication/334424688_Design_and_Implementation_of_Smart_Contract_A_use_case_for_geo-spatial_data_sharing)

	- Zheng, Z., Xie, S., Dai, H.N., Chen, X. and Wang, H., 2018. Blockchain challenges and opportunities: A survey. International journal of web and grid services, 14(4), pp.352-375. (https://www.researchgate.net/publication/328338366_Blockchain_challenges_and_opportunities_A_survey) - Blockchain and earth observation, white paper, April 2019. https://eo4society.esa.int/wp-content/uploads/2019/04/Blockchain-and-Earth-Observation_White-Paper-April-2019.pdf - Farnaghi, M. and Mansourian, A., 2020. Blockchain, an enabling technology for transparent and accountable decentralized public participatory GIS. Cities, 105, p.102850. https://www.researchgate.net/publication/342343000_Blockchain_an_enabling_technology_for_transparent_and_accountable_decentralized_public_participatory_GIS
Videos	https://www.youtube.com/watch?v=qOVAbKKSH10 https://www.youtube.com/watch?v=xkbySMNKTOY
Data	/
Software	/

3.8.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: Lecture (LO1/LO2)
- Activity 2: Recording lecture (LO2/LO3)
- Activity 3: Group work and commenting (LO2/LO3)
- Activity 4: Brain storming and commenting (LO2/LO3)

3.8.5 Implementation

Activity 1: A lecture will be given to define blockchain technology and how it manages data and metadata. The lecture then further focuses on applications of blockchain technology for geodata management.

Activity 2: Five selected papers will be given to students to read. Each student should find and read three extra papers. Each student should record two 10-minute video lectures about 1) applications of Blockchain technology in Geospatial information science, and 2) detailed description of an application. Each video lecture will be commented by three other students.

Activity 3: Students will be grouped to work on how blockchain technology can facilitate realisation of open data directives. Each group have to submit a report (max 3 pages). Each student has to comment the reports of two other groups.

3.8.6 Activity 4: In a classroom activity students will be grouped to brain Storming how blockchain can facilitate realisation of VGI. Students are expected to come up with innovative ideas on how blockchain technology can: 1) motivate more volunteer participation in VGI initiatives and 2) increase quality of and the degree of trust to VGI. Groups will present their ideas to be discussed and commented by other groups.Summary

	Level of Bloom	**Type of active teaching**	**Associated learning outcome**
Activity 1	Remember Understand	Lecture presentation	Explain what Blockchain is and what it is related to open geodata sharing
Activity 2	Understand	Self-study for students	Students read the recommended papers
Activity 3	Remember Understand	Group work	Summarize what they learned in report
Activity 4	Understand Analyse	Group discussion	Reactivate knowledge of lecture presentation

3.9 Geoportals for Open SDI (Lund)

3.9.1 Introduction

Effective management and sharing of geospatial data are of crucial importance in the development of a city or nation, as it reduces duplication of geospatial data collection efforts and increases the efficiency of decision making. In order to solve the geospatial data sharing and management problem, collaboration across both private and public geospatial organizations are required since different geospatial dataset are produced and collected by them. In this context, an open SDI is required to support the collaboration between organizations. Different agencies or organizations are allowed to share and access geospatial data through such a platform.

The basis for the formation of SDI is a network of integrated Web-GIS or geoportals. Geoportal is a web service platform for viewing, editing, analysing, and advanced application development of geospatial information in a service-oriented architecture. For instance, the INSPIRE spatial data infrastructure has been created in the European Union, which integrates the sites of countries that contain geospatial data of heterogeneous objects. In short, geoportals provide access to geospatial datasets and functions for processing and analysing them. Note that it is important to make sure the interface comfortable and user-friendly and provide the necessary range of functionality while developing a geoportal.

In recent years, different geoportals have been developed and implemented for different SDI initiatives at local, national and regional levels. Each of these geoportals has various levels of user-friendliness and are based on different structures and technologies. Which OGC standards and specifications have been implemented and for which services, also differs in various geoportals. The geoportals, developed today, are suitable for traditional SDIs, where a large part of spatial data is shared by governmental organisations and major private players. How geoportals can be expanded to include other types of data, e.g. VGI, in an open SDI environment yet to be discussed.

3.9.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Define geoportals in (open) SDI
- LO2: Explain structures/generations of spatial data clearinghouse
- LO3: Analyse geoportals
- LO4: explain characteristics of a clearing house network in an open SDI

3.9.3 Materials

Literature	– Coordinating geographic data acquisition and access: the National Spatial Data Infrastructure, Federal Register, 1994 (https://www.archives.gov/files/federal-register/executive-orders/pdf/12906.pdf) – Crompvoets, J., Bregt, A., Rajabifard, A. and Williamson, I., 2004. Assessing the worldwide developments of national spatial data clearinghouses. International Journal of Geographical Information Science, 18(7), pp.665-689.

	https://www.researchgate.net/publication/233785500_Assessing_the_worldwide_developments_of_national_spatial_data_clearinghouses) – Kostesha, V.A., Shapovalov, D.A., Barbasov, V.K., Chetverikova, A.A. and Kolesnikova, I.K., 2021, October. Geoportal for highways as a basic element of spatial data infrastructure. In IOP Conference Series: Earth and Environmental Science (Vol. 867, No. 1, p. 012162). IOP Publishing. (https://iopscience.iop.org/article/10.1088/1755-1315/867/1/012162/pdf) – Fatih, S.A.R.I., 2018. Design and implementation of an open access geoportal. Selçuk Üniversitesi Mühendislik, Bilim Ve Teknoloji Dergisi, 6(1), pp.88-99. (https://www.researchgate.net/publication/323658756_DESIGN_AND_IMPLEMENTATION_OF_AN_OPEN_ACCESS_GEOPORTAL)
Videos	/
Data	/
Software	/

3.9.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: Lecture (LO1/LO2)
- Activity 2: Reading documentations (LO1/LO2)
- Activity 3: Study three different geoportals (LO3)
- Activity 4: Brain storming (LO4)

3.9.5 Implementation

Activity 1: A lecture about clearinghouse networks and geoportals, and how OGC standards are used for implementing different parts of the network.

Activity 2: Reading documents and pass a quiz.

Activity 3: Students study three geoportals (clearinghouse networks) in details and prepare a report describing the studies systems. The report should answer to pre-designed questions about, e.g., functionalities of the geoportal, user-friendliness, OGC standards used, structure/generation of the system, and services available.

Activity 4: Students are grouped for brainstorming on characteristics of clearinghouse networks for open SDIs. They should discuss technical and non-technical solutions to be considered and further developed to make geoportals and clearinghouse networks suitable for open SDI.

3.9.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1	Remember Understand	Lecture presentation	Explain what clearinghouse network and geoportal are

Activity 2	Understand	Self-study and self-test for students	Students read the recommended documents and complete a quiz
Activity 3	Remember Understand	Answer questions	Answer questions in report
Activity 4	Understand Analyse	Group discussion	Reactivate knowledge of lecture presentation

3.10 Crowdsourcing GI & Citizens Science (UNIZG)

3.10.1 Introduction

Noise pollution or unwanted and disturbing sound is a pervasive feature of modern life, and mostly comes from anthropogenic sources, including road traffic, airplanes, landscaping services, and construction. It can cause increased stress, cognitive impairment, illness in humans and decreased fitness. Comprehensive information on the spatial and temporal distribution of noise is crucial to address the issue by relevant authorities and experts.

Nowadays everyone can contribute to society using smartphone apps and their hardware which is very powerful and can be used in many ways to gather data. For example, using smartphone GPS and microphone through the sound meter app it is possible to gather valuable information to make an overview of noise impact in everyday life. Using available tech solutions and with the concept of crowdsourcing, it is now easier than ever for individuals to collectively contribute - whether with ideas, time, expertise, or funds - to a project or cause.

Using data gathered this way, it is possible to analyze noise levels in various locations getting information about the main source of the noise presenting the whole aspect through different thematic maps. Crowdsourcing GI & Citizen Science involves the following tasks:

- collecting noise data in the selected area,
- interpolate measurement data,
- attribute data classification,
- map design and print layout creating,
- analysis and results comparison.

The results of the tasks are:

- designed map for the presentation of statistical data set and printed in PDF format.
- thematic map published via the web.

3.10.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Perform noise pollution survey
- LO2: Check topological correctness and identify and eliminate irregularities
- LO3: Manipulate with attribute tables and fields in GIS,
- LO4: Link CSV data sets with geometry and field from other nonspatial tables,
- LO5: Demonstrate how the selection of data classification and/or symbolization techniques affects the message of the thematic map,
- LO6: Critique the design of a given map in light of its intended audience and purpose,
- LO7: understand principles of map design, including symbolization, colour use, and typography.

3.10.3 Materials

Literature	– Pozlončec-Petrić, V.; Cibilić, I.; Frangeš, S.: Crowdsourcing Application in the Development of a Dynamic Noise Map, Proceedings of the International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies (IAT) 2021, Ademović, Naida; Mujčić, Edin; Akšamija, Zlatan; Kevrić, Jasmin; Avdaković, Samir; Volić, Ismar (ur.). Mostar, Bosna i Hercegovina: Springer Nature Switzerland AG 2022, 2021. str. 676-683 doi:10.1007/978-3-030-90055-7_54 (https://www.researchgate.net/publication/356287629_Crowdsourcing_Application_in_the_Development_of_a_Dynamic_Noise_Map) – Poslončec-Petrić, V.; Šlabek, L.; Frangeš, S.: With the Crowdsourced Spatial Data Collection to Dynamic Noise Map of the City of Zagreb // *International Symposium on Engineering Geodesy SIG 2016* / Paar, Rinaldo ; Marendić, Ante ; Zrinjski, Mladen (ur.). Zagreb: Croatian Geodetic Society, 2016. str. 411-426. https://www.bib.irb.hr/822774 – Poslončec-Petrić, V., Vuković, V., Frangeš, S., Bačić, Ž. (2016): Voluntary Noise Mapping for Smart City, First International Conference on Smart Data and Smart Cities, September 7-9, 2016, Split, Croatia. https://www.bib.irb.hr/830980 – Poslončec-Petrić, V; Šlabek, L.; Frangeš, S.: With the Crowdsourced Spatial Data Collection to Dynamic Noise Map of the City of Zagreb, International Symposium on Engineering Geodesy SIG 2016 / Paar, Rinaldo; Marendić, Ante; Zrinjski, Mladen (ur.). Zagreb: Croatian Geodetic Society, 2016. str. 411-426. https://www.bib.irb.hr/822774 – Howe, J. (2006): Crowdsourcing: Why the power of the crowd is driving the future of business, https://www.researchgate.net/publication/280205170_Crowdsourcing_Why_the_Power_of_the_Crowd_is_Driving_the_Future_of_Business_Book_Review_2009_Jeff_Howe_New_York_NY_Crown_Business (20.12.2022.) See, L.; Mooney, P.; Foody, G.; Bastin, L.; Comber, A.; Estima, J.; Fritz, S.; Kerle, N.; Jiang, B.; Laakso, M.; Liu, H.-Y.; Milčinski, G.; Nikšič, M.; Painho, M.; Pődör, A.; Olteanu-Raimond, A.-M.; Rutzinger, M. Crowdsourcing, Citizen Science or Volunteered Geographic Information? The Current State of Crowdsourced Geographic Information. ISPRS Int. J. Geo-Inf. 2016, 5, 55. https://doi.org/10.3390/ijgi5050055. – Poslončec-Petrić, V. (2020): Instructions for making a dynamic noise map, teaching materials, Faculty of Geodesy, University of Zagreb, Zagreb. https://www.bib.irb.hr/1237707
Videos	/
Data	Noise Map (demo data) https://www.bib.irb.hr/1237709.
Software	QGIS, Noise Tube

3.10.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: Crowdsourcing, Citizen Science or Volunteered Geographic Information - opportunities and perspectives
- Activity 2: Theoretical bases of making a noise map
- Activity 3: Introduction to Information, Strategic Noise Map Systems and Action Plans

3.10.5 Implementation

Activity 1 Lab 1: Noise data acquisition and import in GIS software: This exercise introduces students to noise data collecting by a mobile application (e.g., NoiseTube) and its processing. They should collect the minimum data required for visualisation and be able to import it into the software using different formats. This lab exercise should last up to four hours.

Activity 2 Lab 2: Data classification: Input datasets are in the form of CSV files. Geometry is described by polygonal features of the vector grid. In this exercise, students will practice the tasks of linking attribute tables with geometry using operations and expressions to manipulate tabular data. Previously they should select and structure the statistical data. As a result, they should get statistical attribute data linked to the spatial units. This lab exercise should last up to four hours. This duration can be increased by introducing independent practice (in the classroom or as homework).

Activity 3 Lab 3: Map design and printing layout: For a cartographic presentation of geospatial data, it is necessary to understand the techniques of its visualization, thematic presentation, symbology, and graphic layout in GIS. For these maps, it is necessary to create layouts using cartographic elements such as legend, title, scale indicator, coordinate grid, and various annotations. Here, students should practice creating symbology, adding graphic map elements, and preparing a printing template for a PDF document. The result should be a map ready for web publication and printing. This lab exercise should last up to four hours.

3.10.6 Summary

	Level of Bloom	**Type of active teaching**	**Associated learning outcome**
Activity 1	Remember/ understand	Peer instructions	Introduce students to noise data collecting by a mobile application and its processing.
Activity 2	Understand, Analyse	Exercise - data classification	Input datasets are in the form of CSV files. Select and structure the statistical data.
Activity 3	Apply	Student Presentations-breakout discussions	Presenting results - cartographic presentation of geospatial data.

3.11 Open Research Data (UNIZG)

3.11.1 Introduction

Starting from definition: "Open research data is data that can be freely accessed, reused, remixed and redistributed, for academic research and teaching purposes and beyond. Ideally, open data have no restrictions on reuse or redistribution, and are appropriately licensed as such. In exceptional cases, e.g., to protect the identity of human subjects, special or limited restrictions of access are set." a rationale can be set in a way that research data are often the most valuable output of many research projects, they are used as primary sources that underpin scientific research and enable derivation of theoretical or applied findings. In order to make findings/studies replicable, or at least reproducible or reusable in any other way, the best practice recommendation for research data is to be as open and FAIR as possible, while accounting for ethical, commercial and privacy constraints with sensitive data or proprietary data. (Open-science-training-handbook)

3.11.2 Learning outcomes

After the teaching practice, the students will be able to:

- LO1: Gain an understanding of the basic characteristics and principles of open and FAIR (Findable, Accessible, Interoperable, Re-usable) research data and sensitivity of using them.
- LO2: Be able to convert a 'closed' dataset into one which is 'open' by implementing management, data stewardship and metadata.
- LO3: Understand the pros and cons of openly sharing different types of data (e.g., privacy, sensitivity, de-identification, mediated access).

3.11.3 Materials

Literature	– Musa, A., Bevandić, D., Herak, D., Jadrijević, L., Kovačić, M., Luša, Z., Vrček, N.: Otvoreni podaci za sve: priručnik za ponovnu uporabu informacija za tijela javne vlasti. Povjerenik za informiranje Republike Hrvatske, 2018, Otvoreni podaci za sve E-book final small-1.pdf (pristupinfo.hr) – Vlada Republike Hrvatske: Politika otvorenih podataka, 2018. POLITIKA OTVORENIH PODATAKA.pdf (gov.hr) – Open Data Handbook: Open Data Guide The Open Data Handbook – Markovinović, D.: Geoprostorni podaci DGU - partneri ekonomiji i gospodarstvu – Državna geodetska uprava 2016. CROPOS – podrška gospodarstvu i ekonomskom razvoju u Republici Hrvatskoj (irb.hr) – Nevistić, Z., Bačić, Ž.: Improving the Availability of Space research Spatial Data. Interdisciplinary Description of Complex Systems: INDECS Vol. 20 No. 2, 2022. (str. 64-77)
Videos	What is Open Data? - Bing video
Data	– The World Bhttps://opendatahandbook.org/ank: World Bank Open Data World Bank Open Data | Data

	– European Union Publications Office: The official portal for European data The official portal for European data | data.europa.eu – Središnji državni ured za razvoj digitalnog društva: Središnji državni ured za razvoj digitalnog društva - Popis skupova podataka s metapodacima (Asset lista) (gov.hr)
Software	/

3.11.4 Learning activities

The teaching practice consists of the following teaching/learning activities:

- Activity 1: Lecture (LO1/LO2)
- Activity 2: Practical exercise in mining for specific topic open data sets and evaluation of identified sets in accordance with FAIR criteria and sensitivity.
- Activity 3: Presenting the results of individual student's exercises
- Activity 4: Lecture (LO3/LO4)
- Activity 5 Discussion and brainstorming

3.11.5 Implementation

Activity 1: A lecture about open research data concept and rationale. Explaining FAIR criteria and sensitivity of open data as well as importance of metadata.

Activity 2: Student is conducting project with goal to detect open data sets related to given/chosen data type and evaluate collected sets in accordance with FAIR criteria and sensitivity.

Activity 3: Presenting result of individual student projects, brainstorming on recognized issues in open data sets identification and categorization

Activity 4: A lecture about understanding conversion of a 'closed' dataset into one which is 'open' convert a 'closed' dataset into one which is 'open' and necessary measures in a data management plan, data stewardship and metadata

Activity 5: Student is conducting project with goal to convert one or more closed data sets to open one and use it for executing specified task.

Activity 6: Presenting result of individual student projects, brainstorming on recognized issues in data sets conversion achieved results

3.11.6 Summary

	Level of Bloom	Type of active teaching	Associated learning outcome
Activity 1	Remember/ understand	Peer instructions	Explain the basic of global and national data discovery and accessibility.

Activity 2	Understand, Analyse	Exercise data mining and develop discussion statements	Understand differences in data discovery and accessibility on global and national level. Recognize obstacles.
Activity 3	Apply	Student Presentations-breakout discussions	Explain how open data can be accessed and what are the obstacles in accessing them
Activity 4	Remember/ understand	Peer instruction	View on global and national obstacles for better access to open data.
Activity 5	Apply	Student breakout discussions	Discuss the open data discovery and access in different student's countries and present challenges.

4 Problem-Based Learning on Open SDI

4.1 Introduction

This chapter presents a Problem-Based Learning approach on Open SDI, in which concrete, real-world problems related to the development and implementation of Open SDIs are put central in the student's learning process. Students work together in small groups and apply relevant theories and research-based knowledge to an authentic problem. Students jointly phrase, analyse and solve a problem towards a tangible result, which in some way and to a certain extent should be related to an Open SDI.

The approach presented in this report was prepared, implemented and tested in the context of the SPIDER Summer School. Throughout several daily sessions, students collaborated on so-called Open SDI projects. Each day, students worked on a specific aspect of this project. In this chapter, we describe the approach as it was implemented during the SPIDER Summer School, and present some of the main results.

4.2 Session 1 – Project ideas

The first session of the Problem-Based Learning practice on Open SDI focused on the design and preparation of the Open SDI projects. This session consisted of three main activities.

4.2.1 Activity 1.1 – Introduction into PBL

The **first activity** consisted of an introductory lecture on Problem-Based Learning (PBL). This lecture briefly explained what PBL is, and what key principles of PBL are. In addition, the advantages of this learning approach were discussed, and guidance was provided on how the groups of students should function and how the problem that will be addressed should be phrased.

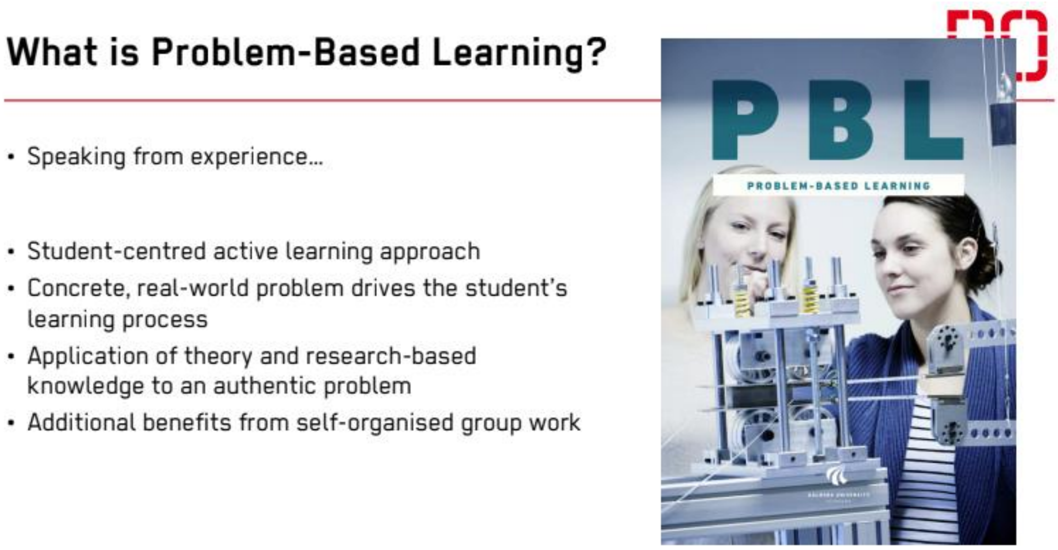


Figure 7:: slide explaining Problem-Based Learning presented during the Summer School

4.2.2 Activity 1.2 – PBL Examples

The **second activity** was the demonstration of some PBL project examples. Several existing PBL projects were presented, with relevant information on the problem they addressed, the way the projects were managed and implemented but also some key results. Below we show some of the PBL examples that were presented in the session.

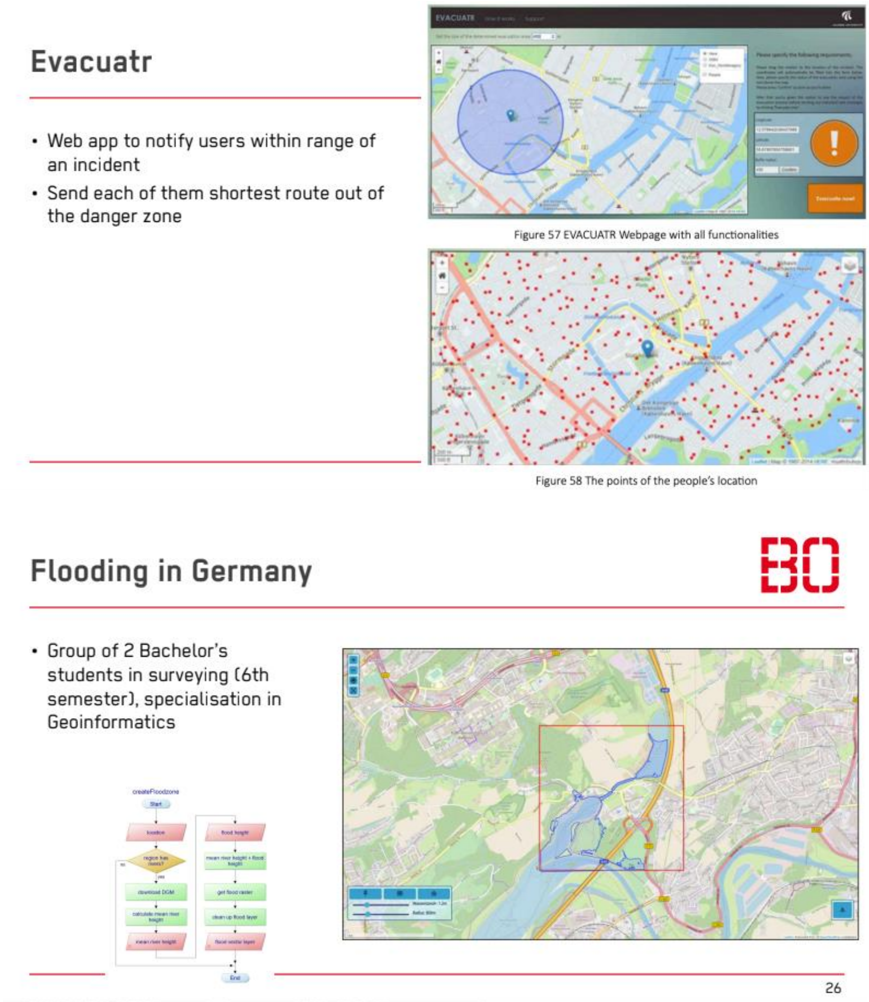


Figure 8: PBL Examples presented during the Summer School

4.2.3 Activity 1.3 – Project idea proposals

The third activity of this session was the preparation and selection of project ideas for the Problem-Based group work during the SPIDER Summer School. The students were divided into small groups of 4-5 students, and each group was assigned a supervisor from the group of SPIDER teachers. Each group had to develop and present two project ideas, i.e., a concrete application area for the development or use of an Open SDI (e.g. Open SDI for Emergency Management in Croatia). During a plenary discussion, each group first presented their two main ideas, after which one idea per group was selected (in consultation with the supervisor and avoiding any duplications between the groups).

The selected project Ideas were as follows:

- Group 1: Household waste management in Amsterdam
- Group 2: Climate change effects on forestry in North Rhine-Westphalia
- Group 3: Managing risk of forest fire in Spain
- Group 4: Hiking routes in Croatia
- Group 5: Drought risk information for farmers in Agadir

4.2.4 Activity 1.4 – Project idea development

Finally, all groups were asked to prepare and give a short presentation on their project, in which they briefly had to explain the following points:

1. How is the current status of SDI in your topic area (available data, services and portals, main stakeholders)?
2. What is the role for each of the five sections (administration, citizens, SMEs, big tech, academia) in your SDI?
3. How could a more Open SDI be developed in your topic area, and what are the pros and cons?

Below we show you some extracts of the presentations prepared by the Summer School participants.

2. What is the role for each of the five sections (administration, citizens, SMEs, big tech, academia) in your SDI?

- **Ministry of Agriculture** is a data provider and a data user; a lot of bureaucratic hurdles for accessing this data (government)
- **Meteorological Agency** provides data on a platform/ website (government)
- **GDO** (Joint research Center Drought Observatory) - drought index;
- **Academia**: engineering schools as well doing research on the topic of drought (Master and PhD levels)
- **Farmers** (drone data and local sensing) + farmers organizations: data collection and data use
- **Insurance** and other **private companies** (eg. consulting, solutions, software);
- **Big tech** - hosting services

3. How could a more Open SDI be developed in your topic area, and what are the pros and cons?

- Improve legal and governance aspects to make (existing government) data more open and accessible
- Increase transparency and participation to governance;
- Foster trust between stakeholders
- Increase awareness and capacity building among farmers
- Increase access to data and new technology;
- Create an open data platform where all stakeholders have access;

Advantages: food security, save water, money, electricity, times etc; Better monitoring of production and taxation and decrease a knowledge gap

Disadvantages: might cause discontent among farmers; sensitive information might be shared; might contribute to financial insecurity for farmers (taxation)

Figure 9: Extracts of the presentations presented by Summer School participants

4.3 Session 2 – Data licensing and VGI

The second session focused on two – related – topics: data licensing and voluntary geographic information. The central activity of this session was about students reflecting on both existing and potential licenses to be applied to their Open SDI solution and on the integration of citizen data to their Open SDI. In preparation to this central activity, students were first introduced into the two topics.

4.3.1 Activity 2.1 Introduction to data licenses

The session started with a short introduction to the Creative Commons licensing framework. Students were shown the different Creative Commons licenses, and the key differences between the various CC licenses were explained. As a background story, also the case of the OpenStreetMap Licence Change was discussed.

Students were also given a set of references providing more information on licensing of – geospatial – data. These included:

- https://creativecommons.org/about/program-areas/opendata/
- https://wiki.creativecommons.org/wiki/Data
- http://opendatatoolkit.worldbank.org/en/essentials.html
- https://choosealicense.com

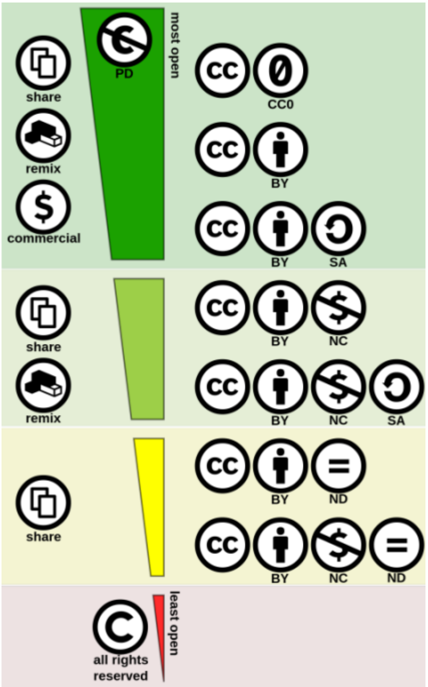


Figure 10: example of Creative Commons licencing suite

4.3.2 Activity 2.2 Introduction to VGI

The second activity consisted of a demonstration of several Voluntary Geographic Information (VGI) initiatives, including examples such as OpenStreetMap and Sensebox. These initiatives were briefly shown and discussed.

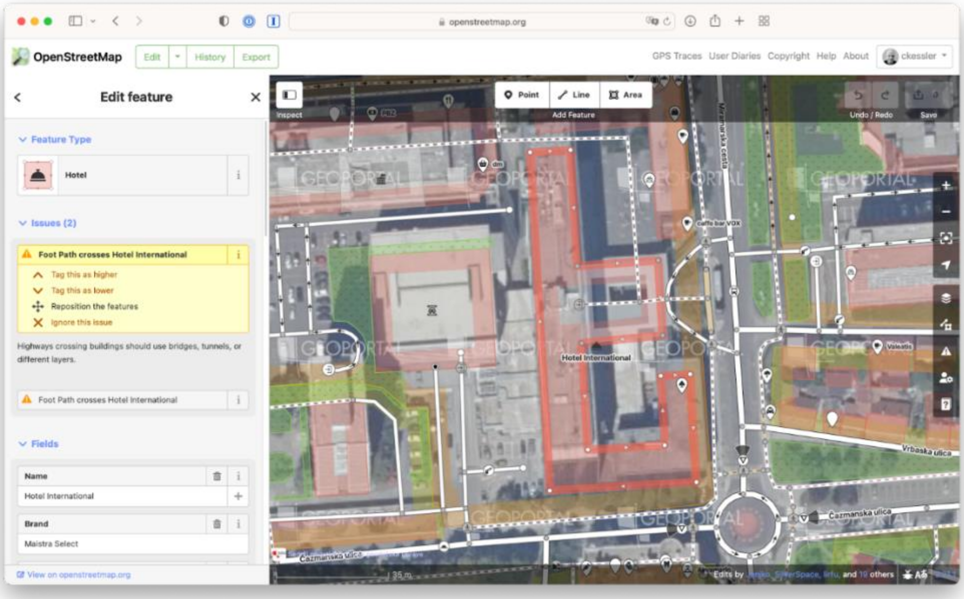


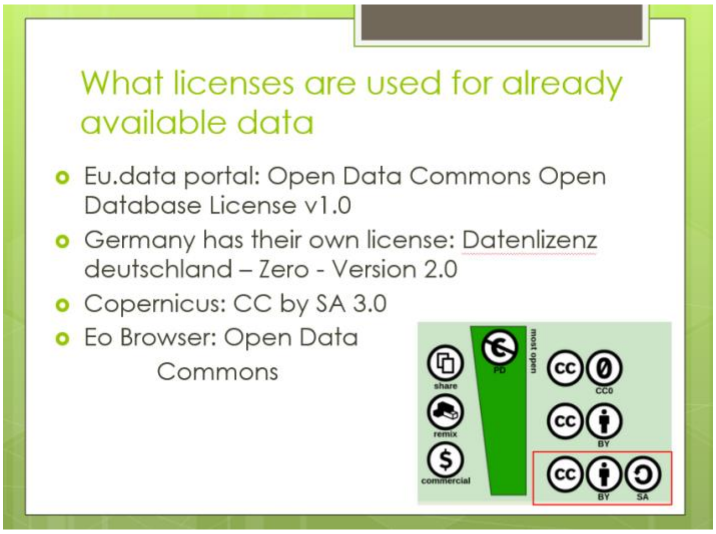
Figure 11: example of VGI contribution

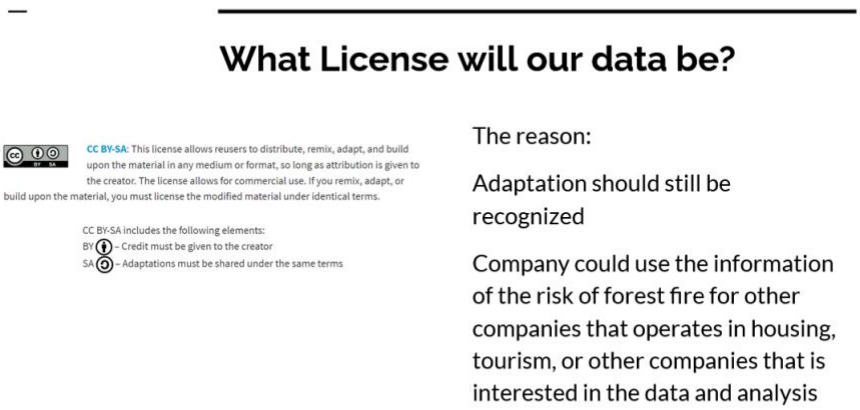
4.3.3 Activity 2.3 Data licensing and VGI applied to the Open SDI solutions.

Students had to reflect and prepare a presentation on the data licensing and VGI aspects related to their Open SDI solution. In the presentations, they had to address three points:

1. What licenses are used for the data that is already available for your project? Are these licenses a good choice?
2. Which license would you use for the new data that you provide through your SDI? Why?
3. Design a workflow to collect relevant citizen data for your SDI. This can be done as an activity diagram, user interface mockup, or just as a description of the process. Think about what data will be collected, how, and whether it needs to be checked and processed in any way

Students had around 1,5h to prepare these presentations. Afterwards, each group was given 10 minutes to present their answers/ideas on these three points. Below we present some of the results of the work done by the students on these topics.





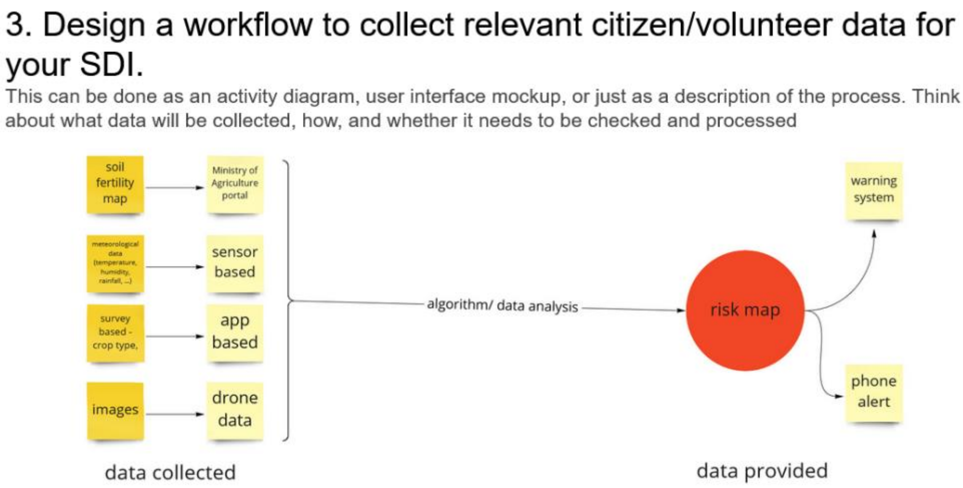


Figure 12: examples of licencing presented by the Summer School participants

4.4 Session 3 – Ethical challenges

The third session of the problem-based group work focused on the ethical challenges related to the establishment of Open SDIs. During this session, students were first introduced into what ethics and ethical challenges are, and afterwards had to prepare an assessment of the ethical aspects of their Open SDI solution.

4.4.1 Activity 3.1: The trolley problem

Performative experience enacting various specifications of the trolley problem: a trolley is moving on the tracks. The brakes of the trolley are broken. If the students do nothing the train will continue on the current tracks. If the students pull the lever, however, the train will be directed to a different track. The typical scenario is that not pulling the lever will kill 5 people, while pulling the lever will only kill one.

- 1st scenario involved a group of engineers as control group, deciding about unknown people as "victims": five unknown victims in the instance of not pulling the lever, one unknown victim if the lever is pulled.
- 2nd scenario involved a group of engineers as control group, deciding about known people as "victims": five Summer school students and two open SDI teachers.

In both cases the control group decided to take action (pull the lever). The experience can be replicated changing either the control group and/or the "victims", based on various socio-demographics variables.

As a concretization of the trolley problem and the idea of "ecosystems as complex scenarios", driverless cars examples were discussed, as well as related issues concerning the allocation of ethics responsibility. This also allowed to show that not necessarily more data/technology leads to better solutions; the context of "better" is extremely contextual (the example of the policing algorithm gone wrong could also have been an option to discuss).

The discussion was vibrant and challenging and students felt compelled to reflect upon entangled socio-technical issues that remain mostly out of the picture (especially for students with a technical background). In the pictures, heated debates on who should be spared and who should be sacrificed.

Figure 13: The students were confronted with the 'trolley' problem

4.4.2 Activity 3.2: Applying the Ethics Assessment Framework to open SDI

Students were given the Ethics Assessment List for Geoinformation Initiatives (EALGI) to be applied (and tested) to their Open SDI solutions. EALGI was not specifically designed to be applied to open SDI, but retrospectively it proved flexible enough to fit the task.

Students were given half an hour was for delivering a comprehensive application of EALGI to their case study, specifying that not necessarily all questions and 5 principles had to be covered depending on the state of the art of their case study (However, more time was likely needed to make the analysis more robust). The goal was to assess the ethical maturity of their chosen case study based on the principles, maturity levels and questions mutated from ALTAI (Assessment List for Trustworthy Artificial Intelligence) and JUDMA (Joined-Up Data Maturity Assessment). Secondly, students had to provide feedback on the robustness of EALGI discussing possible limitations aspects not covered or unclear, etc. Thirdly, students briefly presented their results.

The task showed the framework demands to be explained clearly in its principles and maturity levels, because students might not be familiar with concepts such as "robustness" or "accountability". Students found EALGI pertinent for the assessment of the ethical robustness of their chosen open SDI, however not all questions were deemed equally relevant. This can also be clarified before starting the task; similarly, it could be specified beforehand what is the minimum threshold of maturity an initiative should reach (this needs to be contextualized depending on capabilities, funding allocation, the ecosystem at stake, etc.). In the picture, two students, representative for their group, presenting the main results concerning the application of EALGI to their case study and the assessment of EALGI.

Figure 14: Summer School participants presenting the EALGI assessment of their case studies

Overall, all the five case studies showed low levels of ethical maturity across the five principles, going mostly from undefined to learning, with only two case studies (climate change effects on German forests and mapping of fire risk in Spain) showing building levels concerning robustness and transparency. This is likely because these cases are mostly based on non-sensitive data. The group focusing on waste management in Amsterdam found the "environmental and societal well-being" principle of EALGI particularly relevant because it forced them to reflect upon the possible environmental trade-offs of an open SDI meant to "do good for the environment". This issue remains largely untapped by open data initiatives at large. As a principle, "accountability" remains the most "immature" one in all case studies as it requires a complex organisation involving also third party performing fair and transparent audits

Students found questions understandable, which means that EALGI can be used relatively easily by a varied cohort of subjects in terms of background and levels of expertise. It was however suggested that some questions are quite long and dense and might be broken down and/or simplified for the sake of clarity and a more effective implementation.

4.5 Session 4 – Ecosystem mapping

The central topic of the third session was the mapping of geospatial data ecosystems. During this session, students created a data ecosystem map of their Open SDI project as a visualization of the broader setting/context of the project. The session consisted of three main activities.

4.5.1 Activity 4.1: Introduction into data ecosystem mapping

The session started with an introductory lecture on what data ecosystems and ecosystem are.

- **A data ecosystem** is the people, communities, and organisations that are creating, managing, processing, and/or sharing data, creating things from it, deciding what to do based on it, influencing any of those activities, or are affected by any of those activities (adapted from ODI, 2019)
- **A data ecosystem map** illustrates the different actors in a data ecosystem, and how value is exchanged across it. You can use this map as a practical tool to plan and visualise a data ecosystem, or show opportunities for increasing value to particular parts of a data ecosystem.

In this presentation, reference was made to some relevant guidance documents on how to design such maps, including:

- Open Data Institute - four-step process to map create a data ecosystem map: https://open-data-institute.gitbook.io/data-landscape-playbook/play-two-map-the-data-ecosystem/create-an-ecosystem-map
- Transparent Data - Data ecosystem mapping in 5 steps: https://medium.com/transparent-data-eng/data-ecosystem-mapping-in-5-steps-ca55a8987690
- RD4C Data Ecosystem Mapping Tool: https://files.rd4c.org/RD4C_Data_Ecosystem_Mapping.pdf
- Guide to Civic Tech & Data Ecosystem Mapping: https://www.urban.org/sites/default/files/publication/98649/guide_to_civic_tech_and_data_ecosystem_mapping.pdf

4.5.2 Activity 4.2: Examples of data ecosystem maps

The second activity was the demonstration of some existing data ecosystem maps, in which also the key components of these maps were discussed. These components are:

- Actors/nodes
- Relationships/connections
- End products/goals
- Context/drivers/determinants

Below some examples of existing data ecosystem maps are presented.

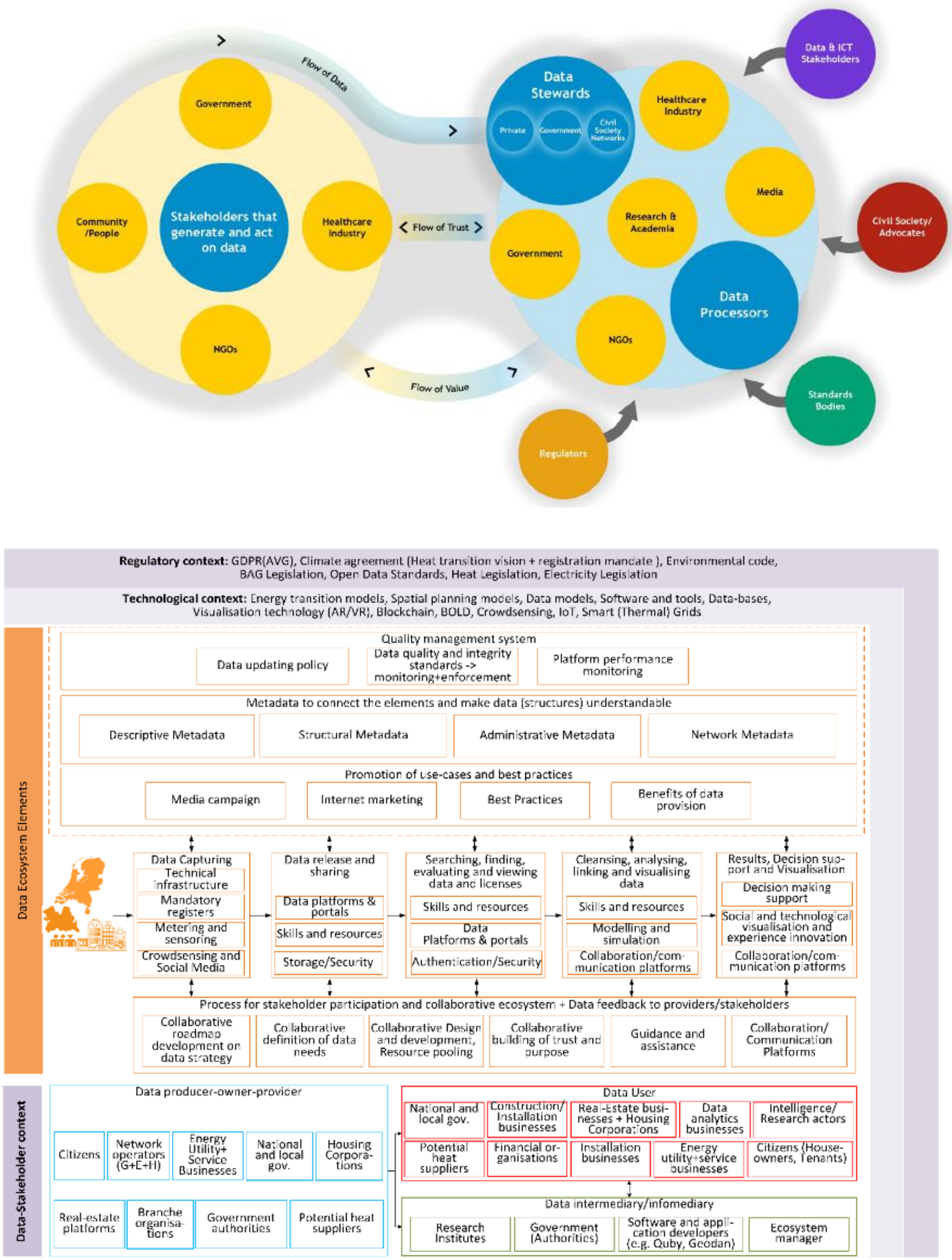


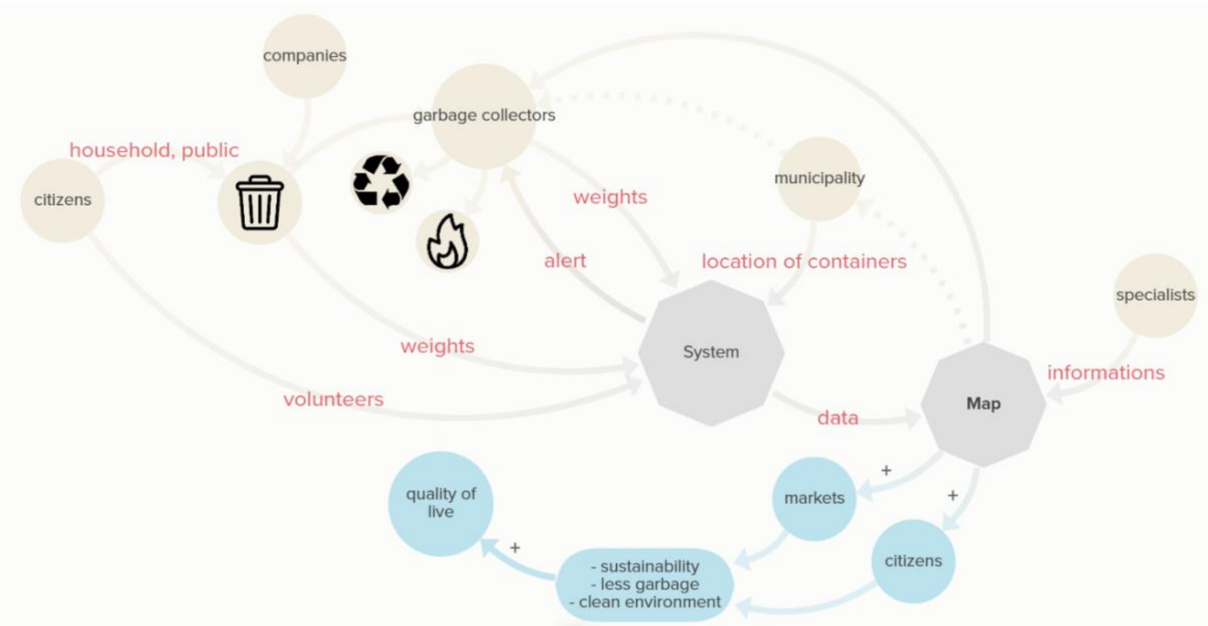
Figure 15: examples of existing data ecosystem maps

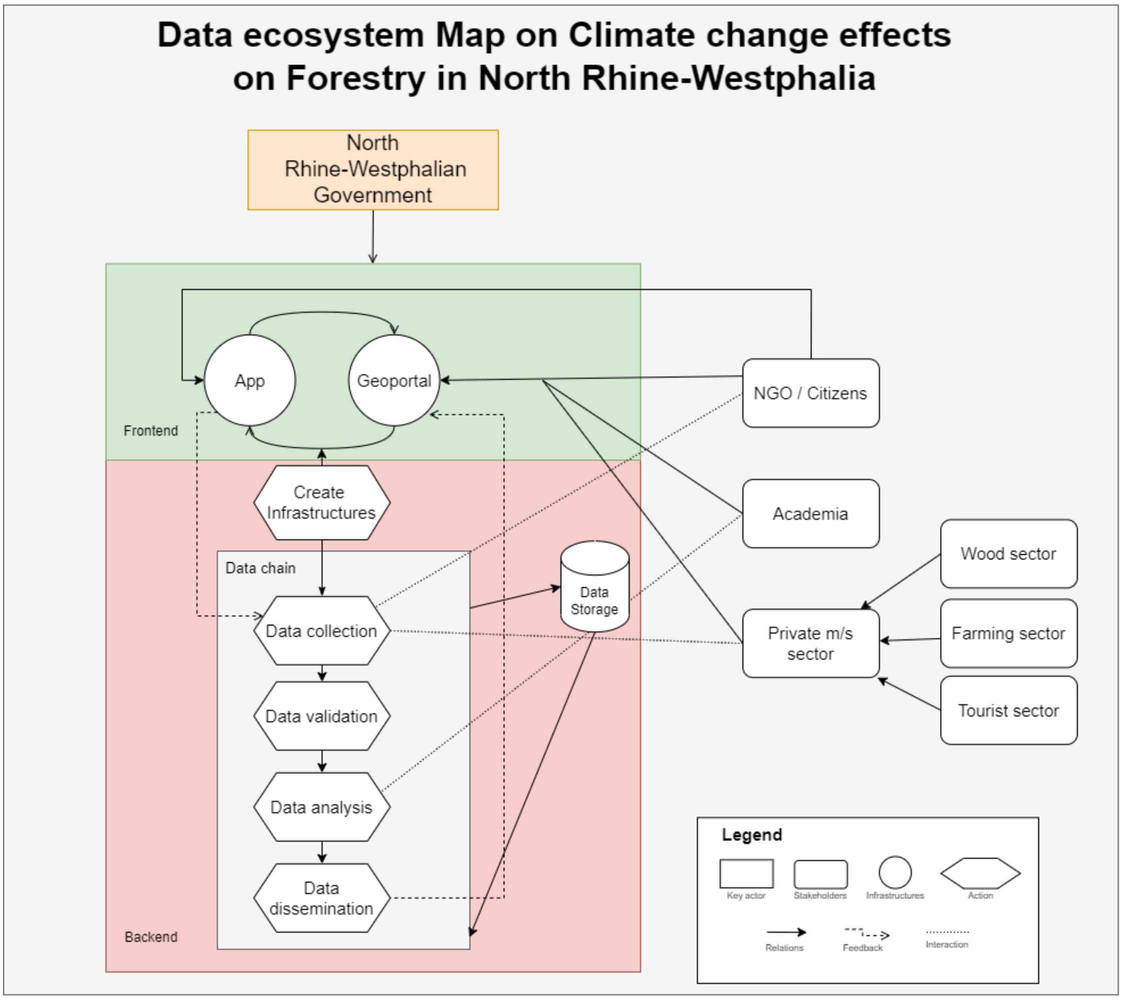
4.5.3 Activity 4.3: Preparation of data ecosystem maps

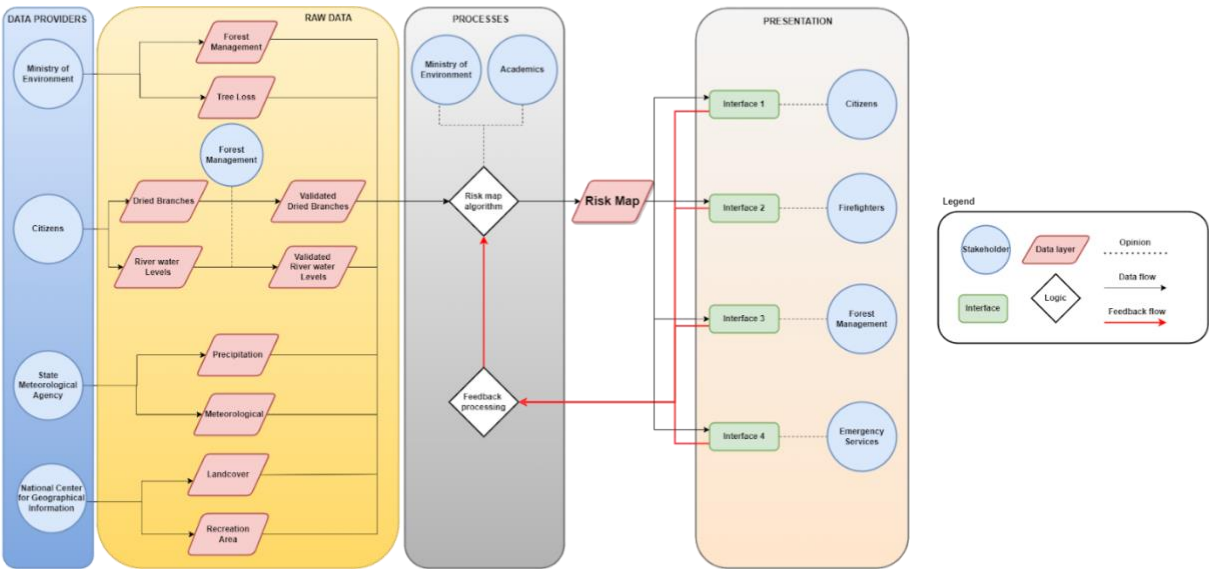
After presenting and discussing these examples, students were asked to prepare a data ecosystem map for their own Open SDI project. They were provided with a set of evaluation criteria to take into consideration in preparing their ecosystem maps:

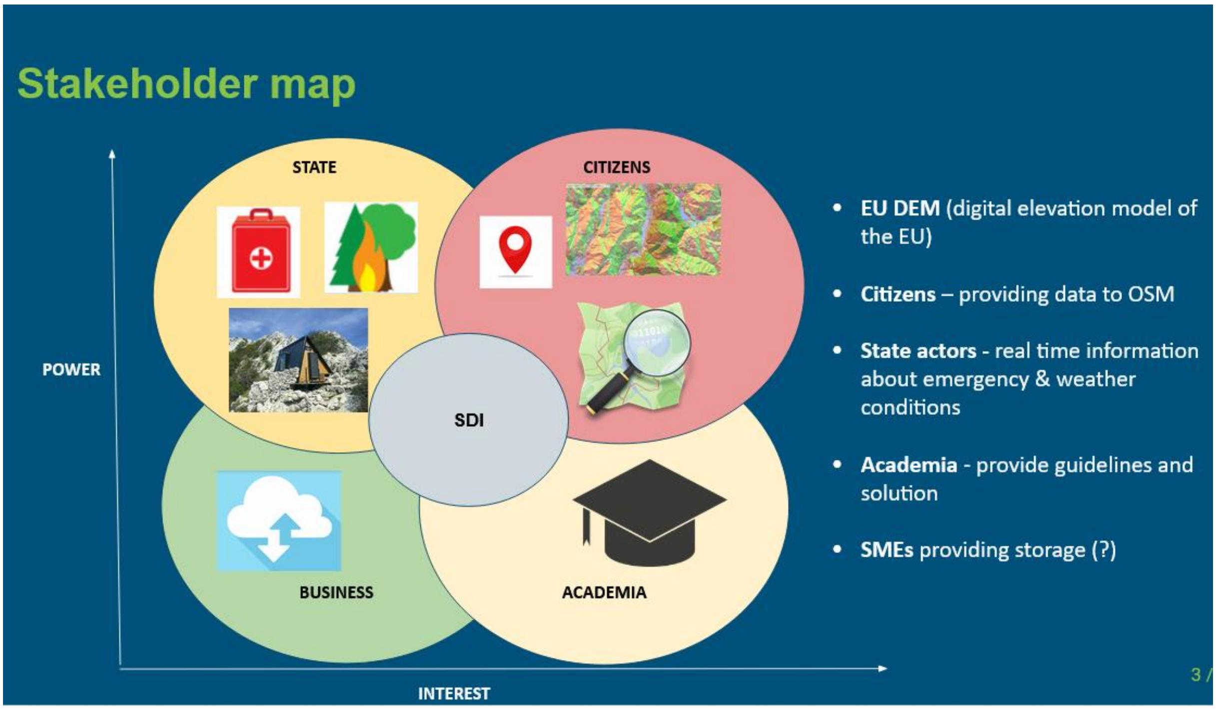
- Comprehensive/complete: include as much relevant information as possible
- Easy to understand: do not make it too complex
- Attractive: make it look nice
- Creativity: include new/innovative elements or approaches

The students had to work as a team but were free to decide on both the approach/content of their ecosystem map and way of allocating tasks to team members. Some examples of the data ecosystem maps prepared during the SPIDER Summer School are presented below:




Data ecosystem Map on Climate change effects on Forestry in North Rhine-Westphalia
North Rhine-Westphalian Government
App
Geoportal
Frontend
NGO / Citizens
Create Infrastructures
Academia
Data chain
Data Storage
Wood sector
Data collection
Private m/s sector
Farming sector
Data validation
Tourist sector
Data analysis
Data dissemination
Backend
Legend
Key actor
Stakeholders
Infrastructures
Action
Relations
Feedback
Interaction


DATA PROVIDERS
RAW DATA
PROCESSES
PRESENTATION
Ministry of Environment
Forest Management
Tree Loss
Citizens
Dried Branches
River water Levels
Validated Dried Branches
Validated River water Levels
State Meteorological Agency
Precipitation
Meteorological
National Center for Geographical Information
Landcover
Recreation Area
Academics
Risk map algorithm
Risk Map
Feedback processing
Interface 1
Interface 2
Interface 3
Interface 4
Firefighters
Emergency Services
Legend
Stakeholder
Data layer
Opinion
Data flow
Interface
Logic
Feedback flow



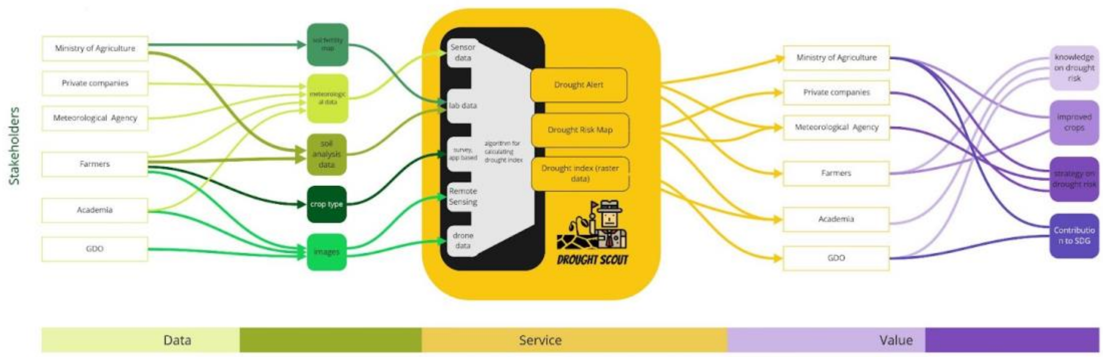


Figure 16: examples of the data ecosystem maps prepared during the SPIDER Summer School

4.6 Session 5 – Final presentations

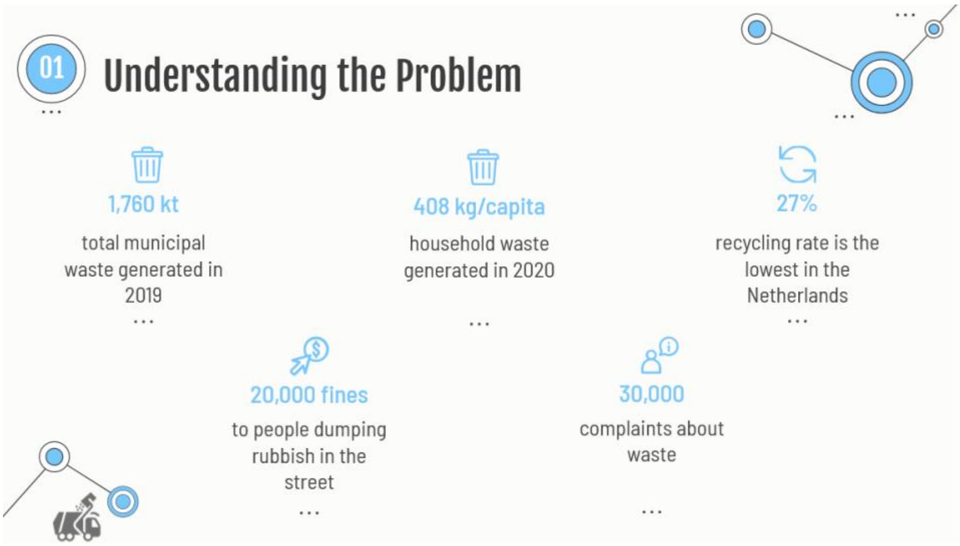
The fifth and final session of the problem-based group work consisted of the final presentations, in which each group presented their work, i.e. a Open SDI-driven solution to the problem they identified in the earlier stage of the group work. Prior to the session itself, all groups jointly prepared their presentation. The final session itself consisted of three main activities.

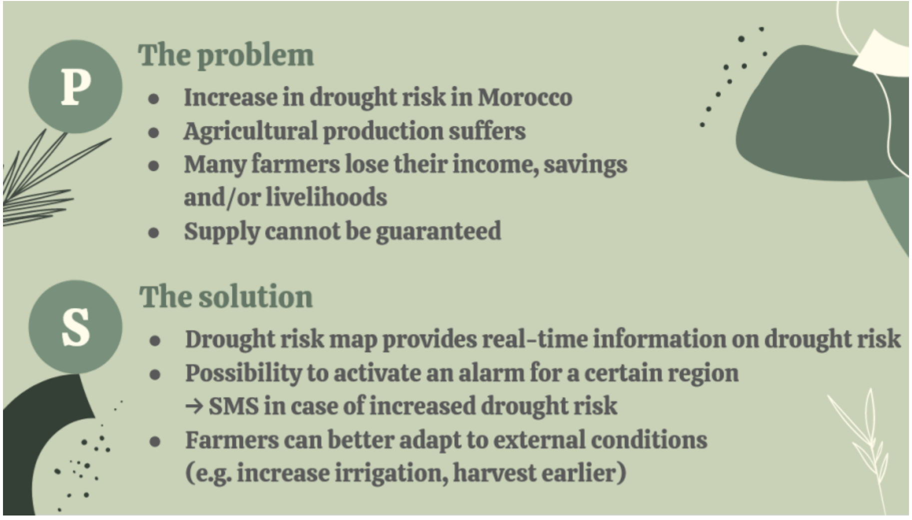
4.6.1 Activity 5.1 – Presentation of Open SDI solution

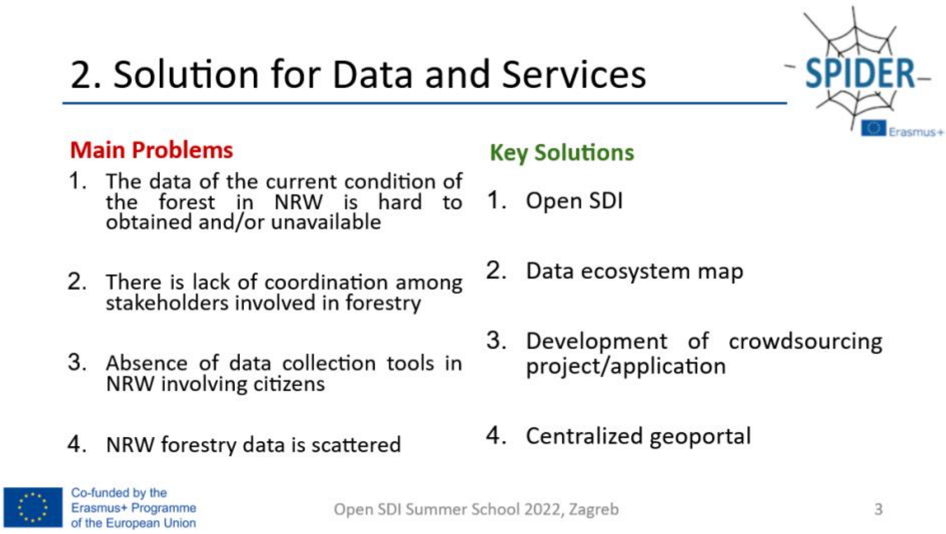
The **main activity** consisted of the different group presentations, in which each group briefly presented the work done on describing and investigating the problem and preparing and developing the solution. The students were asked to structure their presentations around five key topics/questions:

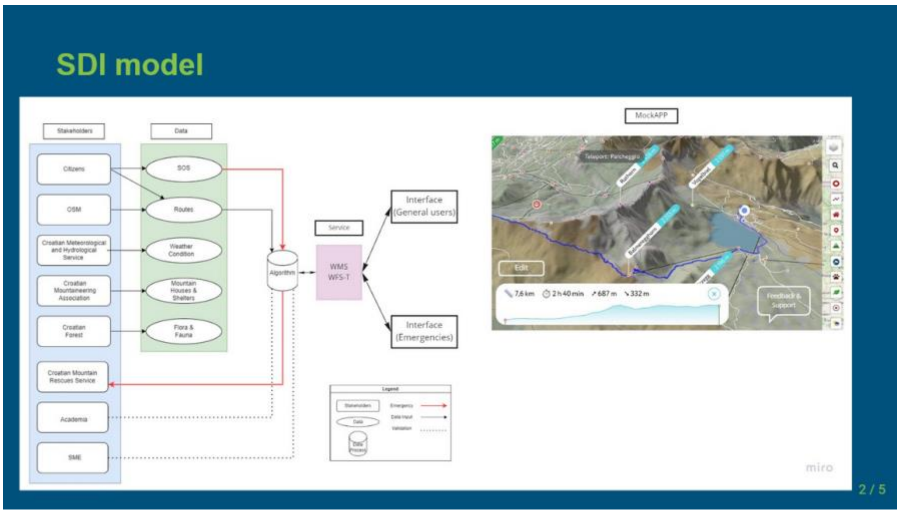
1. What societal problem does your Open SDI solution address? How does it change the life of XXX?
2. What does your solution offer in terms of data and services?
3. Who is contributing to your Open SDI solution? ⇢ Ecosystem Map
4. Why is this an Open SDI solution? What sets it apart from a "traditional" SDI?
5. Which challenges do you foresee in implementing your solution?

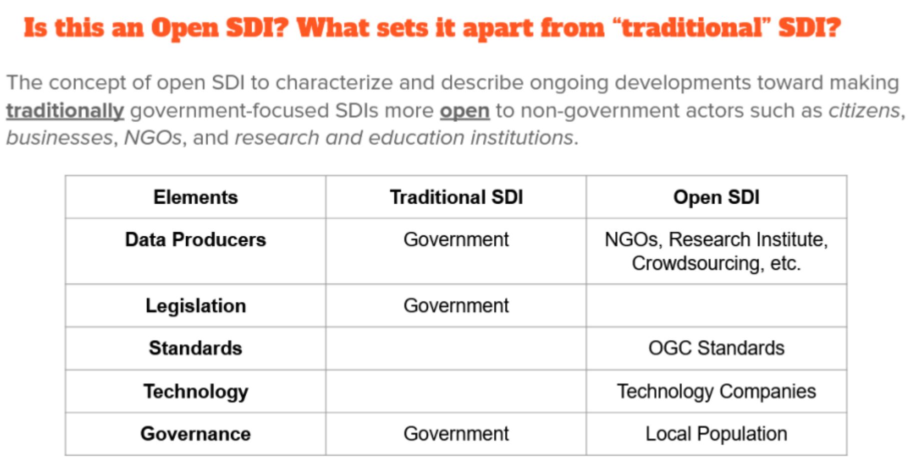
Preferably, the presentation had to consist of just five slides, i.e., one slide for each of the abovementioned questions. Each slide had to be presented by another group member, and in total groups had 10 minutes to present their work. Below we show some of the slides presented by the different Summer School groups.




P
The problem
Increase in drought risk in Morocco
Agricultural production suffers
Many farmers lose their income, savings and/or livelihoods
Supply cannot be guaranteed
S
The solution
Drought risk map provides real-time information on drought risk
Possibility to activate an alarm for a certain region
→ SMS in case of increased drought risk
Farmers can better adapt to external conditions
(e.g. increase irrigation, harvest earlier)


2. Solution for Data and Services
Main Problems
1. The data of the current condition of the forest in NRW is hard to obtained and/or unavailable
2. There is lack of coordination among stakeholders involved in forestry
3. Absence of data collection tools in NRW involving citizens
4. NRW forestry data is scattered
Key Solutions
1. Open SDI
2. Data ecosystem map
3. Development of crowdsourcing project/application
4. Centralized geoportal
Co-funded by the Erasmus+ Programme of the European Union
Open SDI Summer School 2022, Zagreb
3


SDI model
Stakeholders
Data
Citizens
OSM
SOS
Routes
Service
Interface (General users)
Interface (Emergencies)
MockAPP
Legend
Academia
SME
miro
2 / 5



Elements	Traditional SDI	Open SDI
Data Producers	Government	NGOs, Research Institute, Crowdsourcing, etc.
Legislation	Government	
Standards		OGC Standards
Technology		Technology Companies
Governance	Government	Local Population

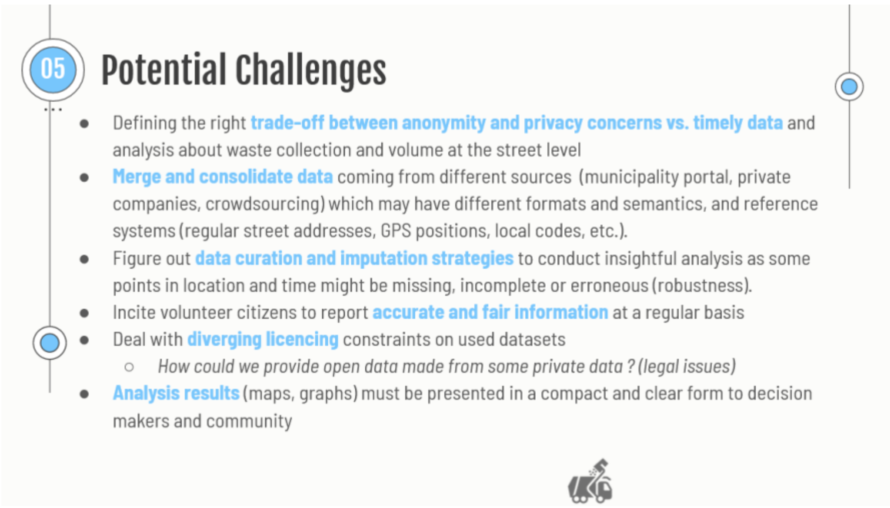


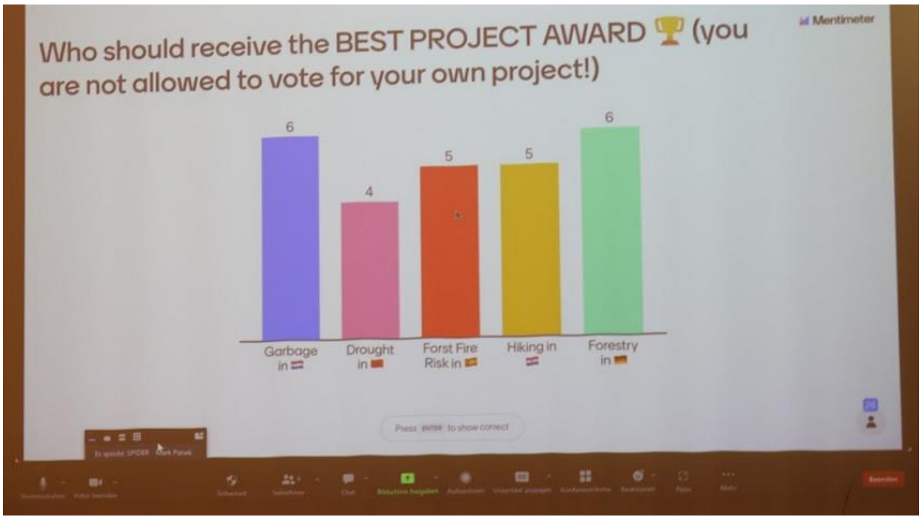
Figure 17: examples of the slides presented by the different Summer School groups

4.6.2 Activity 5.2 – Plenary Q&A on each presentation

After each presentation, the coaches assigned to each group were invited to briefly comment on the solution presented by his/her team. Afterwards, a **short plenary Q&A session** was organized, in which the Summer School participants, including both teachers and students, could comment and ask questions on the presentation. In addition, some external SDI experts participated in the final presentation session (remotely), and were given to opportunity to ask questions to the presenters.

4.6.3 Activity 5.3 – Feedback session on the PBL approach

At the end of the session, a short **evaluation activity** was organized, in which both the presentations and the PBL practice were evaluated. All Summer School participants were asked to – anonymously - select the best presentation. Interesting to notice is that all presentations of the SPIDER Summer School received several nominations, which reflect the very high quality of the proposed solutions and presentations. Afterwards, students were asked to give feedback on the entire Summer School, and in particular the PBL approach. This feedback was used to further improve the various teaching activities.



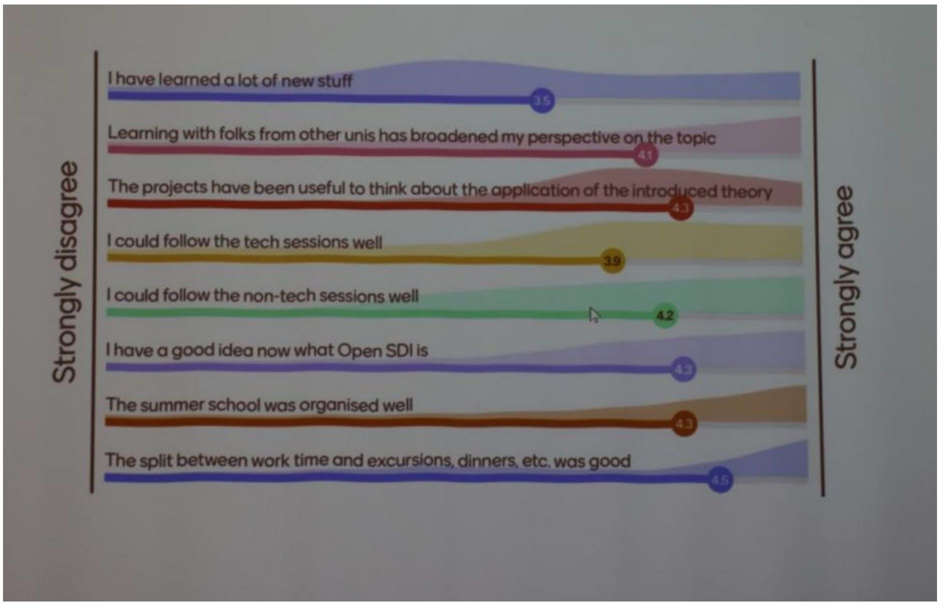


Figure 18: feedback provided by the Summer School participants

5 Conclusion

This report presented and discussed a series of active teaching practices on new topics related to Open Spatial Data Infrastructures. For identifying these topics, the SPIDER consortium investigated a set of key documents dealing with recent and future trends in the development and implementation of SDIs. The identified topics were further discussed with key experts in the SDI domain, after which the different partners of the SPIDER consortium selected a set of topics to be further developed into active teaching practices. The development of these practices was in line with the SPIDER Methodology on Active Teaching and Learning on Open SDI developed.

Testing of these practices took place during the SPIDER Summer School on Open SDI. In the context of this Summer School, the SPIDER consortium also implemented a problem-based learning approach on Open SDI, which also is documented in this report. This interdisciplinary approach, covering various – technological and non-technological – aspects of Open SDIs, allowed students to apply their knowledge on Open SDIs to real life problems, which are central and drive the learning process. The implementation and testing of the teaching practices in the context of a Summer School can be considered as a key element in the process of developing these practices, since active teaching practices only become active when implementing them.

With this report, we aim to promote active teaching on Open SDI by documenting and sharing these practices in a clear and easy-to-understand manner. We are aware that effective sharing of these practices also demands for additional approaches, such as real demonstrations and more 'active' approaches. During the SPIDER Summer School we also experimented with this exchange of knowledge on active teaching, by inviting several SDI teachers to participate in the Summer School. The Summer School allowed these teachers to increase their knowledge on and understanding of key developments and trends in the establishment of Open SDIs, but also to learn about more active teaching practices and approaches. This combination helped them in revising and improving their own SDI education.