European Commission

Monitoring the FAIRness of geospatial data: Lessons learnt from the European Union

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Joint Research Centre

Introduction

Introduction – Problem statement

- Geospatial data sharing has profoundly changed over the last decades
  - from traditional SDIs to multi-faceted data sharing ecosystems [1,2]
  - (big) data sources: from research, EO, IoT, crowdsourcing, AI/ML
  - technology & infrastructures: cloud, edge & fog; standards; AI/ML models
  - actors: private companies & citizens
  - legislation to open data, improve data sharing, protect privacy
  - business models & governance structures

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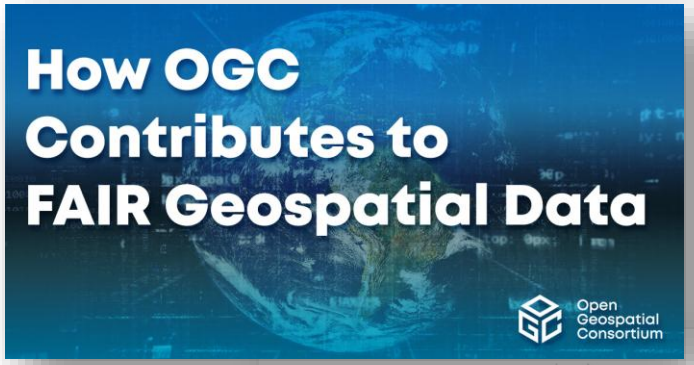
- However, geospatial data is often difficult to access and use – issues are
  - technical: interoperability, use of proprietary technologies, vendor lock-in, etc.
  - legal: copyright, licensing, legislatively-driven constraints, etc.
  - governance: silos, gatekeepers from big commercial actors, etc.

Introduction – Problem statement

- FAIR (Findable, Accessible, Interoperable & Reusable) principles help mitigate this challenge
  - a cornerstone in research, standardisation & data sharing at all scales [3,4,5]



Introduction – Problem statement

- Public sector remains an important provider and user of geospatial data
  - ensuring delivery of high-quality, trustworthy & authoritative data
  - supporting transparency, accountability & informed decision making
- FAIRness of public geospatial data infrastructures is the ultimate objective
- Progress towards FAIRness is measured through various KPIs – e.g.
  - Canadian Geospatial Data Infrastructure (CGDI) framework[6]
  - United States (US) Geospatial Data Act's data quality and accessibility metrics[7]
  - EU INSPIRE Directive[8] and Open Data Directive[9]

Objective

- Focus on the EU context 
- Reflect on 6 years of operational experience in monitoring the FAIRness of the EU public geospatial data infrastructure
  - relevant legislation and monitoring requirements
  - approach and KPIs adopted
- Distill lessons learnt from the outcomes
  - relevant for other legislatively-driven initiatives

EU legal context & FAIRness monitoring

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INSPIRE Directive (2007)

DIRECTIVE 2007/2/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 14 March 2007

establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

- Aimed to unlock public sector geospatial data & facilitate cross-border sharing
- Led to the establishment of a FAIR EU public geospatial data infrastructure
  - data discoverability (metadata), accessibility (network services) & interoperability (data models)
- The largest geospatial data sharing effort ever!
- Evaluation in 2022 triggered a possible revision, currently ongoing

https://eur-lex.europa.eu/eli/dir/2007/2

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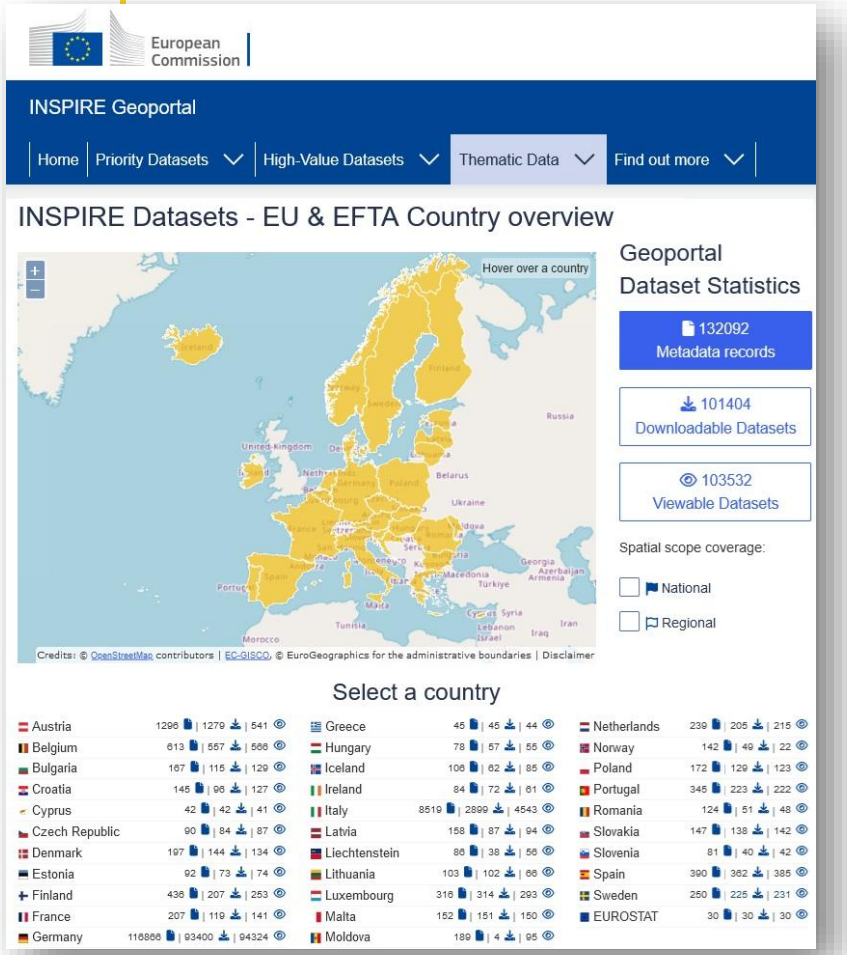
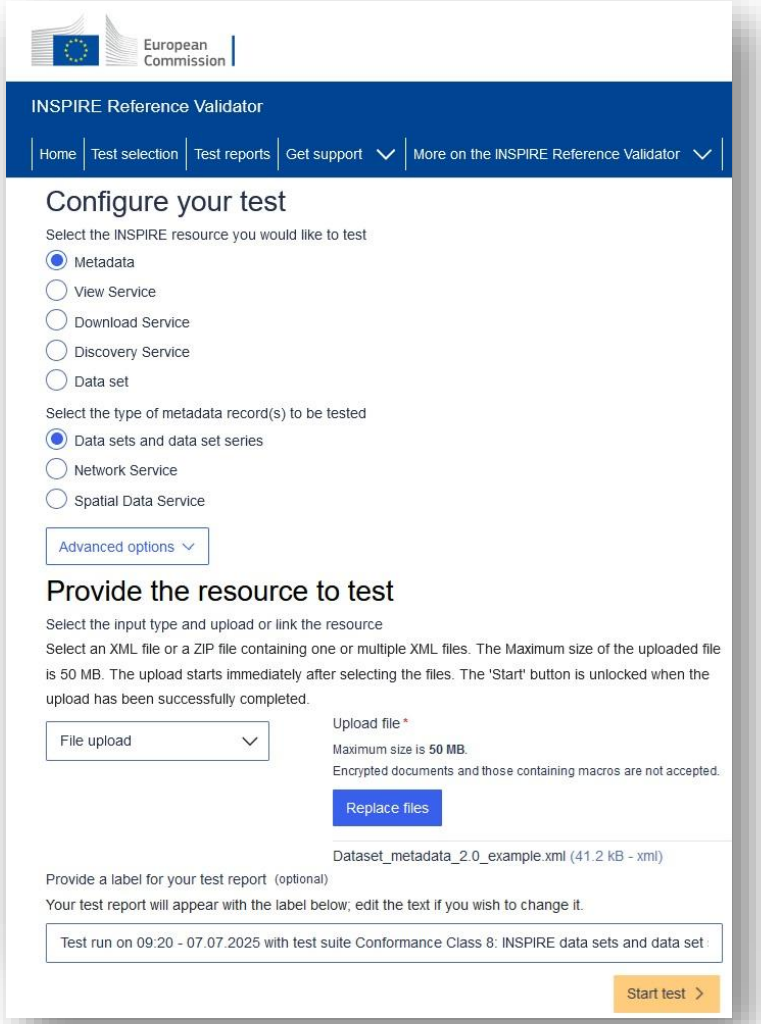
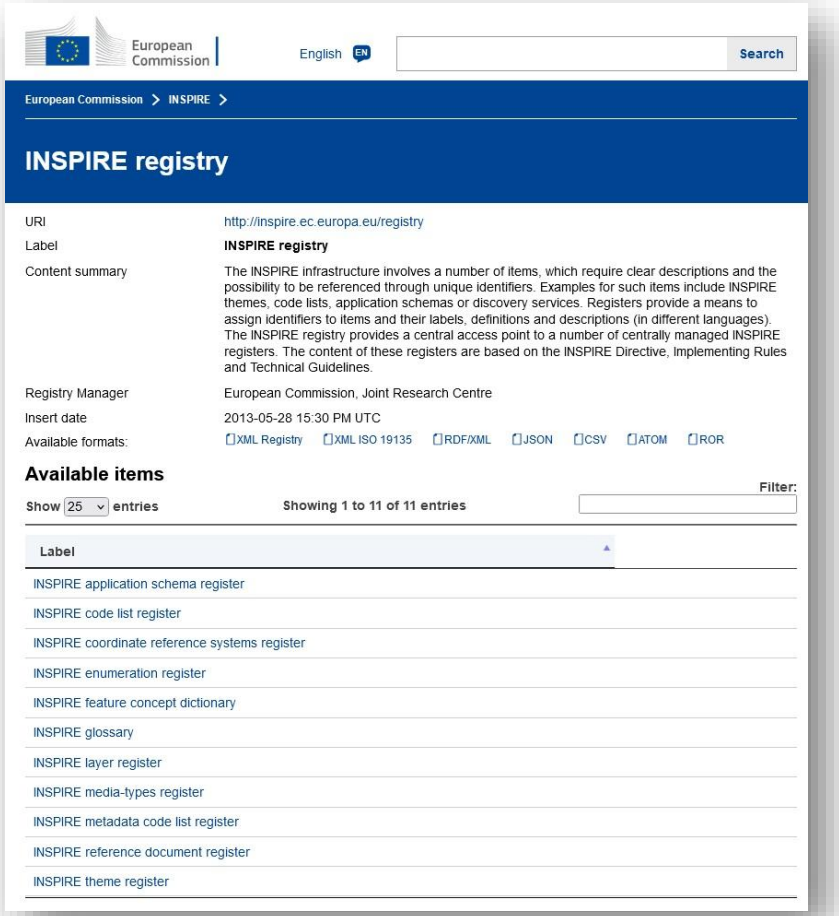
INSPIRE infrastructure

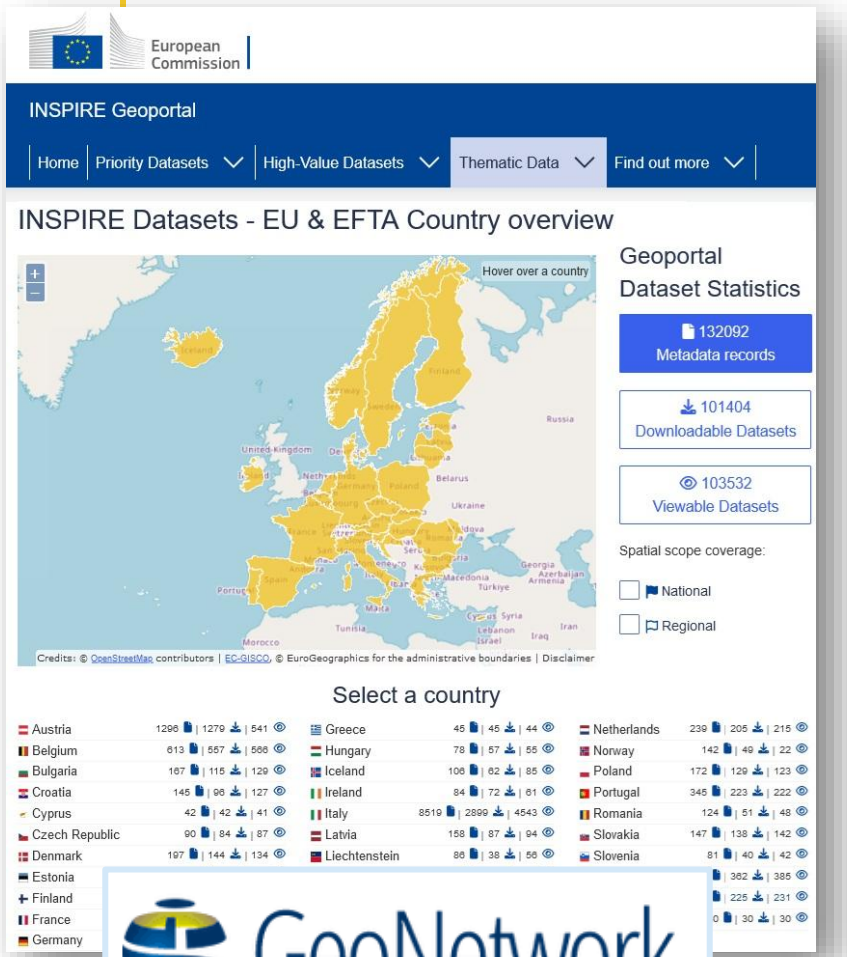


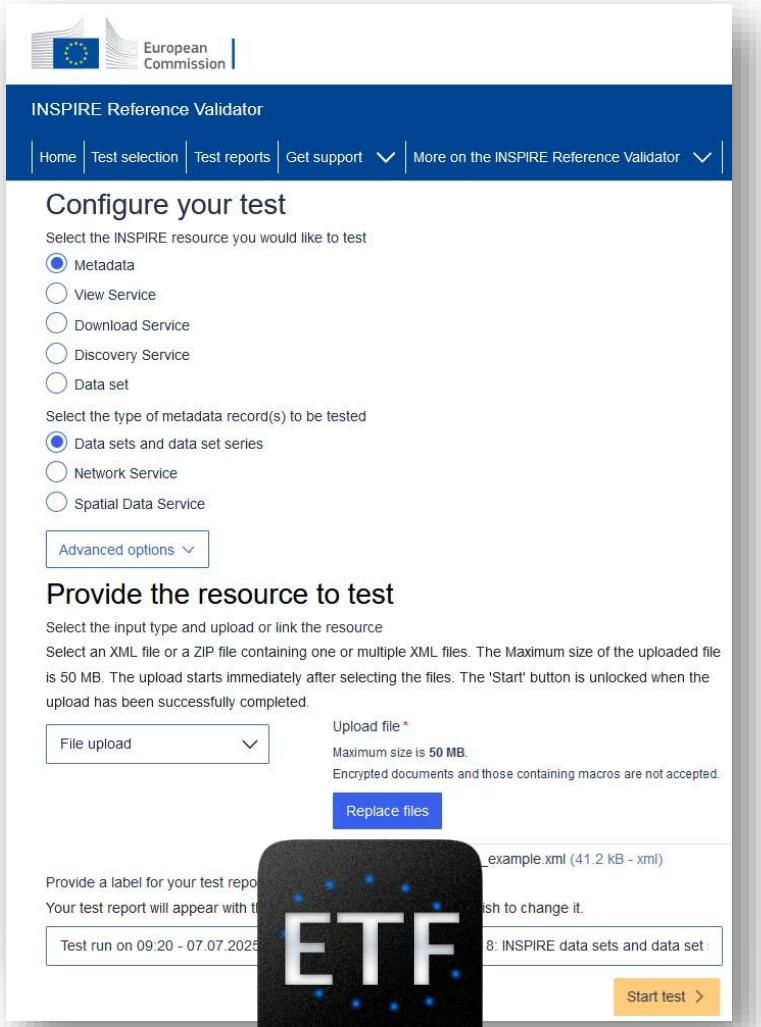


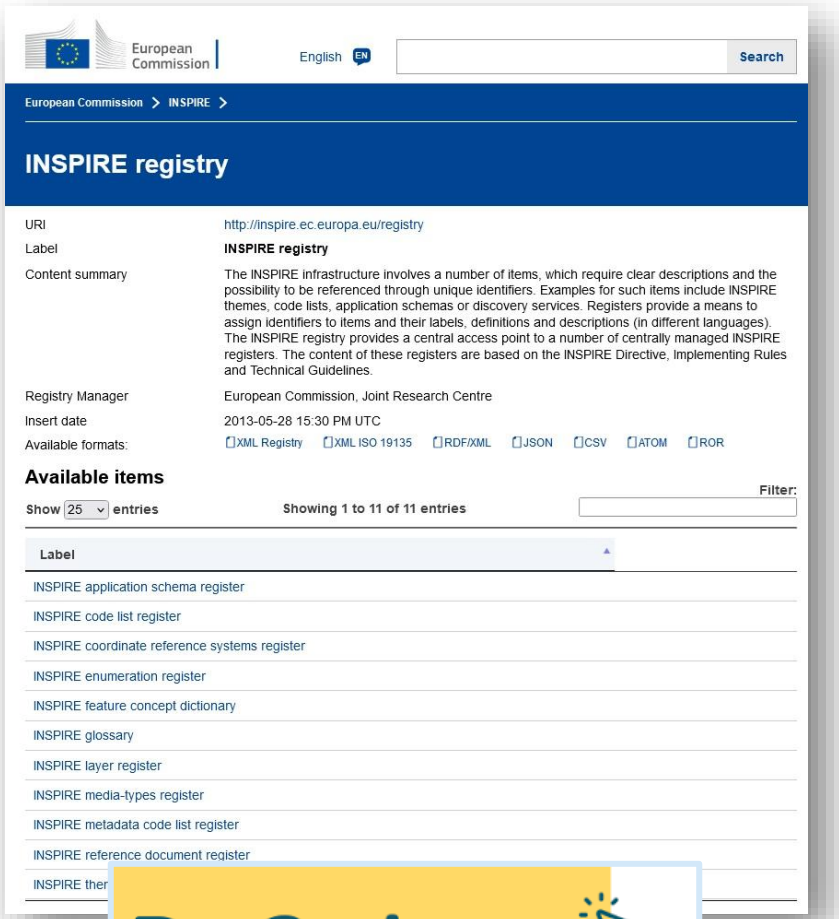


https://inspire-geoportal.ec.europa.eu https://inspire.ec.europa.eu/validator https://inspire.ec.europa.eu/registry

INSPIRE infrastructure (open source)







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Monitoring – INSPIRE Directive

- Process rooted in the very nature of EU legislation
  - certification of compliance from Member States & evidence for possible infringements
  - opportunity for Member States to strengthen cooperation at the national level and enhance accountability
- Monitoring rules currently in place were defined in 2019 [10]
- Automated calculation of 19 KPIs divided in 5 categories [11]
  - availability of spatial data and services
  - conformity of metadata
  - conformity of spatial data sets
  - accessibility of spatial data sets
  - conformity of network services

COMMISSION IMPLEMENTING DECISION (EU) 2019/1372

of 19 August 2019

implementing Directive 2007/2/EC of the European Parliament and of the Council as regards monitoring and reporting

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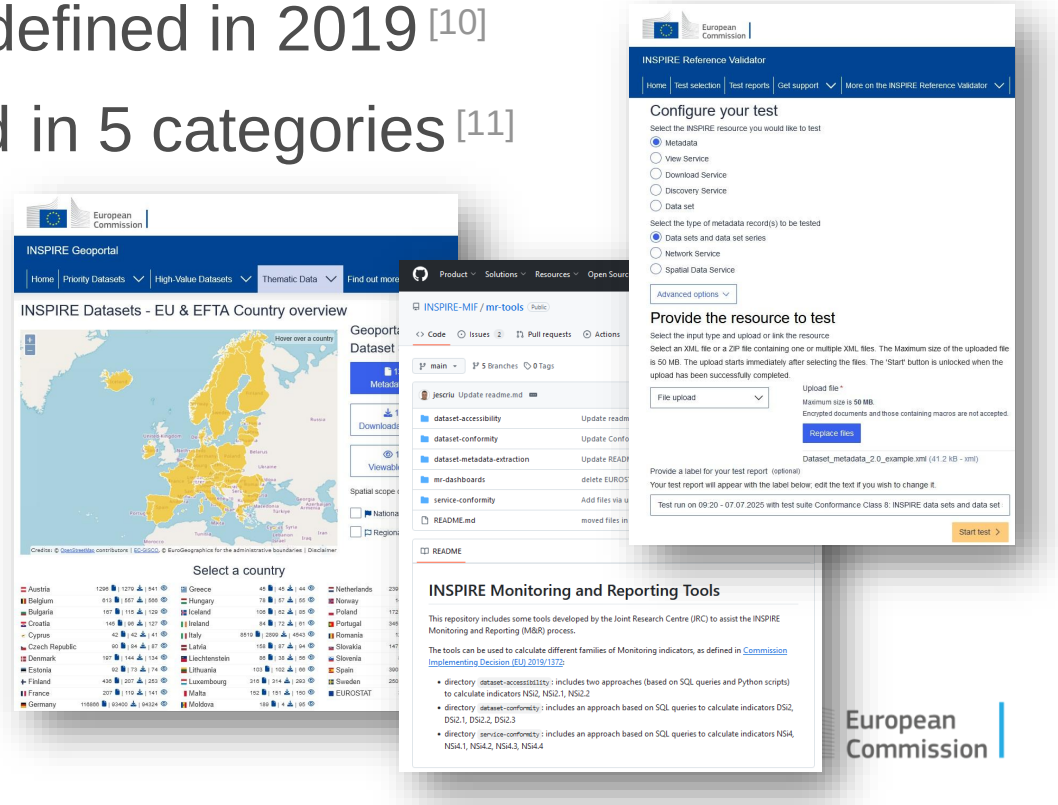
- Fully automated process based on the INSPIRE infrastructure



Open Data Directive (2019) & Implementing Act on high-value datasets (2023)

- The Open Data Directive [9] defined high-value datasets (HVD)
  - datasets the re-use of which is associated with important socio-economic benefits
- To be made available
  - for free, under open access licenses
  - in machine-readable formats, via APIs and (when relevant) as a bulk download
- Thematic categories of HVD

Geospatial	***Earth observation and environment***	***Meteorological***	***Statistics***	***Companies and company ownership***	***Mobility***

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geospatial datasets

- The Implementing Act [12] defines
  - the list of high-value datasets for each thematic category
  - the requirements for their provision:
    - license (CC BY 4.0, CC0 or any equivalent or less restrictive license)
    - key attributes, formats, metadata, granularity, etc.

Reporting – Open Data Directive

Reporting

1. By 2 years after entry into force of this Implementing Regulation Member States shall provide the Commission with a report on the measures they have carried out to implement this Implementing Regulation. Where appropriate, the information under paragraph 3 can be provided through references to relevant metadata.

2. Each Member State shall provide an updated version of the report upon the request of the Commission which should be made every 2 years.

3. The report shall contain the following information:

(a) a list of specific datasets at Member State level (and, where relevant, subnational level) corresponding to the description of each high-value dataset in the Annex to this Regulation and with online reference to metadata that follow existing standards, such as a single register or open data catalogue;

(b) persistent link to the licensing conditions applicable to the re-use of high-value datasets listed in the Annex to this Regulation, per dataset referred to in point a);

(c) persistent link to the APIs ensuring access to the high-value datasets listed in the Annex to this Regulation, per dataset referred to in point a);

(d) where available, guidance documents issued by the Member State on publishing and reusing their high-value datasets;

(e) where available, the existence of data protection impact assessments carried out in accordance with Article 35 of Regulation (EU) 2016/679;

(f) the number of public sector bodies exempted in accordance with Article 14(5) of Directive (EU) 2019/1024.

- No monitoring KPIs defined in the legislation, only a reporting obligation
  - every two years, first one was in February 2025
  - still focused on the FAIRness of implementation

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Results & Lessons learnt

General considerations

- Monitoring results – INSPIRE Directive (2019-2024)
  - slow but continuous improvement of KPI values
  - currently a well-established process
- Reporting results (still under processing) – Open Data Directive (2025)
  - not all Member States submitted a report
  - heterogeneous picture – geospatial high-value datasets not in all cases coinciding with those reported under INSPIRE
  - legal, organisational & technical issues
  - partial availability of established approaches and guidelines

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Policy implementation, especially for public sector-driven initiatives, takes time!

Monitoring strategy

- The way chosen to monitor a policy initiative will influence its development
- Implementers tuned their infrastructures to maximise the KPI values
  - example: to maximise the fraction of conformant metadata, in some cases they simply decreased the total number of metadata!

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High-values of KPIs (i.e. of FAIRness) do not necessarily mean quality!

- KPIs do not measure whether all resources have been shared
- KPIs do not measure the *content* of data, e.g. no topology/quality checks

Monitoring strategy

- KPIs should also measure the value/fitness for use for user needs
  - just counting data does not make sense
  - depending on the cases, different/partial levels of FAIRness may be enough
  - incorporation of CARE (Collective Benefit, Authority to Control, Responsibility and Ethics) principles [13] can be incorporated

Move from provider-centric to user-centric KPIs!

Monitoring strategy

- The values of some conformity KPIs are based on self-declarations by implementers
  - self-declarations were demonstrated to be largely unreliable [14]

KPIs based on self-declarations should be avoided!

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- Legislation requires monitoring to happen at predefined moments, e.g. for INSPIRE on 15 December every year
  - improvement actions at the national level were concentrated in the period immediately preceding the deadline

Move from discrete to continuous monitoring!

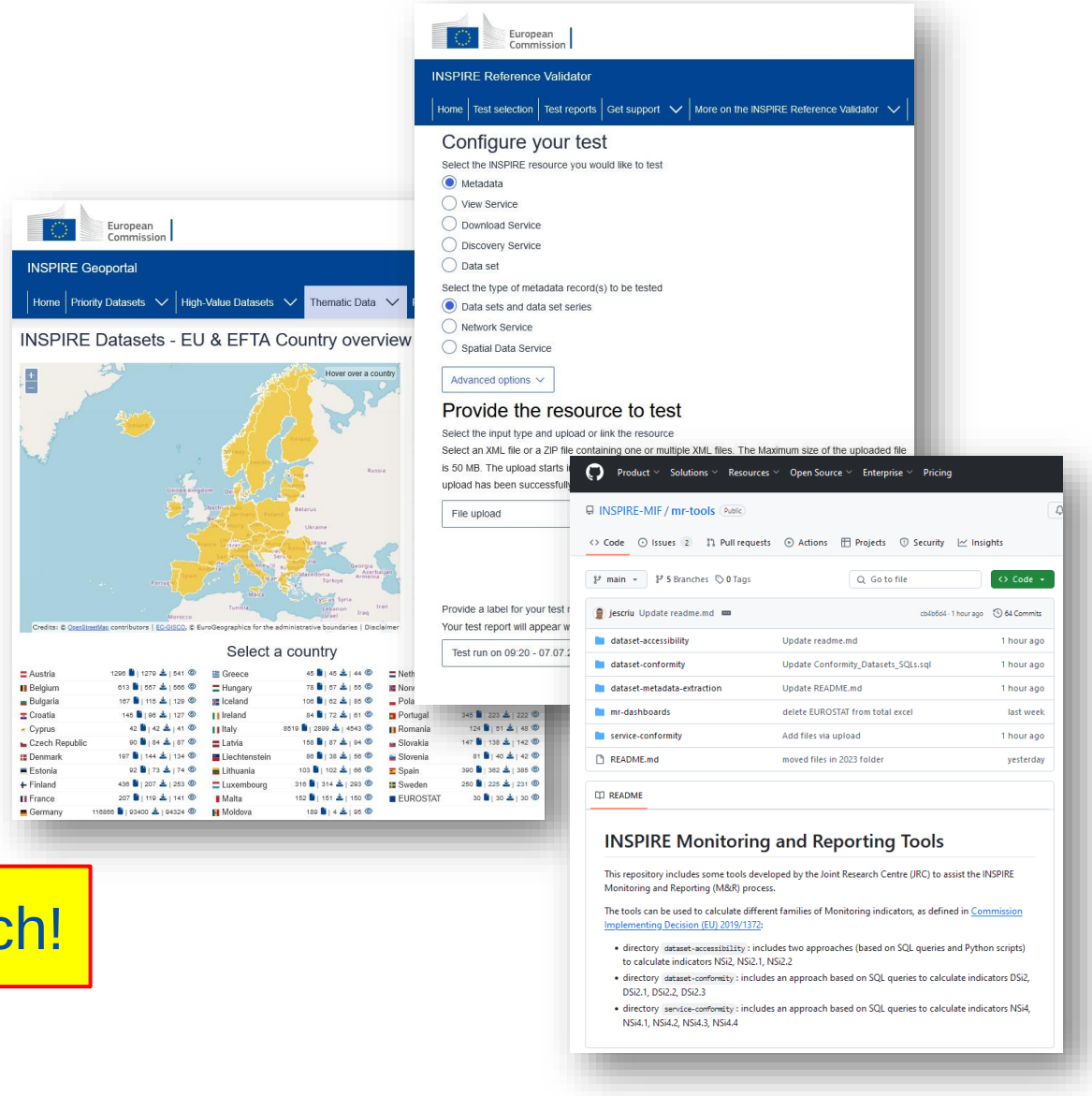
Technical & technological aspects

- Calculation of KPIs has changed over the years to take into account new developments, e.g.
  - GeoPackage & GeoJSON as valid data encodings
  - OGC API - Features as a valid data sharing API

Design a flexible monitoring approach that can accommodate novelties

Technical & technological aspects

- Monitoring is based on a fully automated and transparent process
- Software stack entirely based on open source components
  - clear documentation and release plans to enable early testing/preparation
  - objectivity, transparency & reproducibility of results
  - the validation tool brought legal certainty to the process



Adopt an open-by-design technical approach!

Community and governance

- The ultimate success of monitoring relies on establishing a continuous dialogue and a trust relationship with the relevant community
  - setup of clear governance structures
  - provide scientifically sound guidance on KPIs calculation, interpretation of results & feedback on improvement areas
  - if engaged, the community contributes back by improving the infrastructure

A technical infrastructure is only as good as the social infrastructure underpinning it!

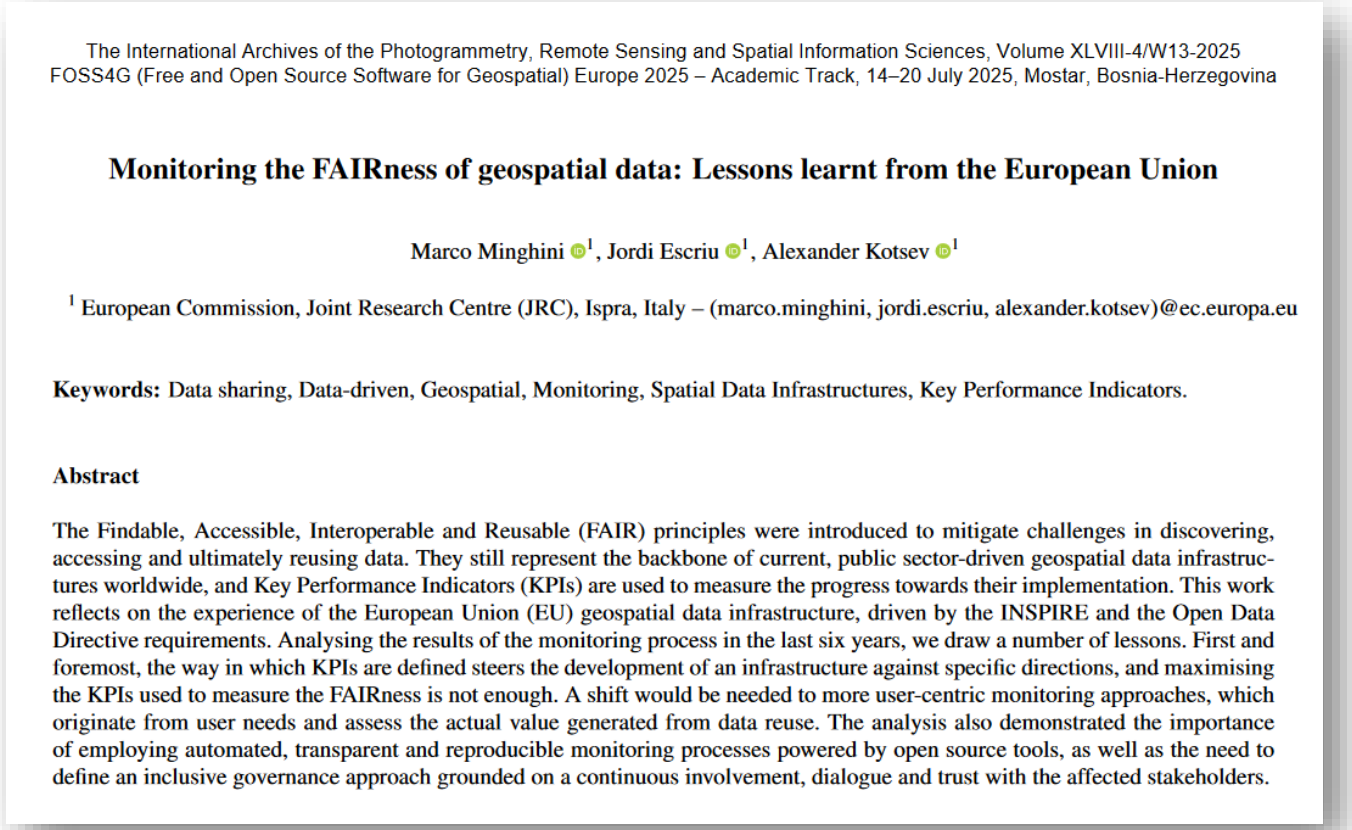
Conclusions

Conclusions

- Analysis of processes for monitoring FAIRness of public geospatial data infrastructures, with examples from the EU
  - analysis of positive & negatives, deriving lessons
  - formulation of actionable improvement proposals, do's & don'ts
  - relevance to a broad range of data sharing initiatives
- Making infrastructures FAIR should not be the goal but a means to an end
  - address user demands, support decision-making and generate societal value
- A wish-list that research can help achieve:
  - choose *good* KPIs beyond FAIRness, capturing data usage/value derived from use
  - use available technology (AI, APIs, etc.) to shift monitoring from time-bounded activities to real-time processes

Want to know more?

- Check the paper



The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-4/W13-2025
FOSS4G (Free and Open Source Software for Geospatial) Europe 2025 – Academic Track, 14–20 July 2025, Mostar, Bosnia-Herzegovina

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Keywords: Data sharing, Data-driven, Geospatial, Monitoring, Spatial Data Infrastructures, Key Performance Indicators.

Abstract

The Findable, Accessible, Interoperable and Reusable (FAIR) principles were introduced to mitigate challenges in discovering, accessing and ultimately reusing data. They still represent the backbone of current, public sector-driven geospatial data infrastructures worldwide, and Key Performance Indicators (KPIs) are used to measure the progress towards their implementation. This work reflects on the experience of the European Union (EU) geospatial data infrastructure, driven by the INSPIRE and the Open Data Directive requirements. Analysing the results of the monitoring process in the last six years, we draw a number of lessons. First and foremost, the way in which KPIs are defined steers the development of an infrastructure against specific directions, and maximising the KPIs used to measure the FAIRness is not enough. A shift would be needed to more user-centric monitoring approaches, which originate from user needs and assess the actual value generated from data reuse. The analysis also demonstrated the importance of employing automated, transparent and reproducible monitoring processes powered by open source tools, as well as the need to define an inclusive governance approach grounded on a continuous involvement, dialogue and trust with the affected stakeholders.

https://isprs-archives.copernicus.org/articles/XLVIII-4-W13-2025/179/2025/isprs-archives-XLVIII-4-W13-2025-179-2025.pdf

- Don’t miss my (related) talk tomorrow!

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Thank you!

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