OPEN EARTH MONITOR

D2.9 Report "User requirements and data gaps"

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Contents

List of Acronyms

AKIS	Agricultural Knowledge and Innovation Systems
CAP	Common Agricultural Policy
EC	European Commission
EO	Earth Observation
ESA	European Space Agency
EU	European Union
FAIR	Findable, Accessible, Interoperable, Reusable
GEO	Group on Earth Observation
GIS	Geographic Information System
IPCC	International Panel on Climate Change
JRC	The Joint Research Centre
NGO	Non-Governmental Organization
OEMC	Open Earth Monitor Cyberinfrastructure
SME	Small and Medium-sized Enterprises
UNCCD	United Nations Convention to Combat Desertification
WP	Work Package

Executive summary

The project Open Earth Monitor Cyberinfrastructure (OEMC) aims to maximize the impact and uptake of FAIR environmental data by collecting and analyzing EU and national-level stakeholder needs and preferences. To achieve this goal, different activities are implemented in the framework of work package 2. This document gives an overview of current and future activities to push stakeholder engagement throughout the whole project duration.

The first part of the document describes shortly the overall stakeholder engagement strategy and builds on report D2.1. It gives an overview of different stakeholder groups and how their specific needs and feedback are collected for different aspects of the OEMC project.

The second part of the document describes the methods of the stakeholder need and requirement assessment based on an online survey and targeted interviews. The final results of the online survey will be presented and an interview guide for the targeted survey of use-case requirements for OEMC products and services will be presented.

This is the final version of the report on "User requirements and data gaps" showing the ongoing and future activities. The outputs of the described activities are relevant for the tasks in WP3—6 as the stakeholder needs and feedback will have an impact on the design of particular functionalities of the OEMC computing engine (WP3), preparation and dissemination of the in-situ data (WP4), and especially on the EU and world monitors (WP5 and WP6) as well as on the 32 OEMC use cases.

1. Introduction

The emergence of satellite imagery has revolutionized global land cover monitoring. Satellites provide continuous, high-resolution data across vast regions, making them the most efficient choice for environmental monitoring (Herold et al., 2016; Ustin et al., 2021). This, coupled with the increasing accessibility of spaceborne Earth observation (EO) data, ground-based measurements, and other geospatial sources, has led to an era of unprecedented environmental data availability.

This data abundance fuels the development of operational land monitoring systems. These systems hold immense potential to support the implementation of international environmental and sustainable development policies, such as the United Nations Sustainable Development Goals (UN SDGs: https://sdgs.un.org/goals), the Sendai Framework for Disaster Risk Reduction (https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030), and the Paris Agreement on climate change.

In line with these international commitments, the European Union has adopted a series of policies under the European Green Deal (EGD) (Paleari et al., 2022). These policies propose the use of geospatial EO data for implementation, monitoring, and compliance. Examples include the New EU Forest Strategy for 2030, the 2023 EU Regulation on Land, Land Use Change and Forestry (EU LULUCF), the European Climate Law, and the EU Biodiversity Strategy for 2030. Notably, the legislative text for many post-EGD environmental policies explicitly emphasizes the use of advanced technologies available under EU programs, such as the Copernicus program.

To effectively monitor and enforce these policies, transparency and open access to geospatial data sources are essential. Transparency empowers effective mitigation strategies by providing access to data, definitions, assumptions, and methodologies (Herold et al., 2019). This transparency plays a crucial role in tracking policy implementation progress (Heinrich et al., 2023). Overall, enhanced transparency fosters confidence in reported findings and facilitates collaboration among diverse users and stakeholders, enabling the collaborative design of interventions (Herold et al., 2019).

However, realizing these benefits requires understanding the varying needs of diverse stakeholders, including policymakers, geospatial-data-dependent businesses and services, non-profit organizations, and researchers. Szantoi et al. (2020) highlighted that user needs for land cover products differ significantly based on specific fields or applications. For example, requirements for biodiversity indicators diverge from those for water resource management or agricultural monitoring. Xu et al. (2020) proposed a comprehensive mapping framework to address user needs, specifically for aquatic land cover mapping, bridging the gap between user requirements and existing global land cover datasets. By combining user-driven requirements with technological advancements, we can create mapping frameworks that support informed

decision-making and sustainable land management practices. Achieving a holistic view that encompasses all diverse user needs necessitates early dialogue, such as through interviews or surveys (Herold et al., 2019).

To enhance the transfer of scholarly research into policy-making, a consortium of stakeholders established the FAIR principles: Findable, Accessible, Interoperable, and Reusable (Wilkinson et al., 2016). As depicted in Figure 1, these principles outline guidelines for efficient data discovery and utilization, essential for effective scientific data sharing.

Findability:
Machine-readable metadata with unique identifiers, rich content, clear data links, and public accessibility are essential. **F1-F4** criteria.

Main challenge: lack of standardized metadata schemes, due to the use of varying standards across different domains and organizations.

Accessibility: ensures data is readily available to authorized users, with clear usage rights and protocols for access and retrieval. **A1, A1.1, A1.2** & **A2** criteria.

Main Challenge: balancing the need for open data with the protection of sensitive information.

Interoperability: means data can be seamlessly shared, combined, and analyzed with other data sources and systems across different platforms. **I1-I3** criteria.

Main challenge: ensuring data consistency and compatibility across different systems and formats.

Reusability: ensures data can be easily used for new research, with clear conditions for its use and proper citation. **R1, R1.1-R1.3** criteria.

Main challenge: ensuring data is well-described, accessible, and usable for different purposes.
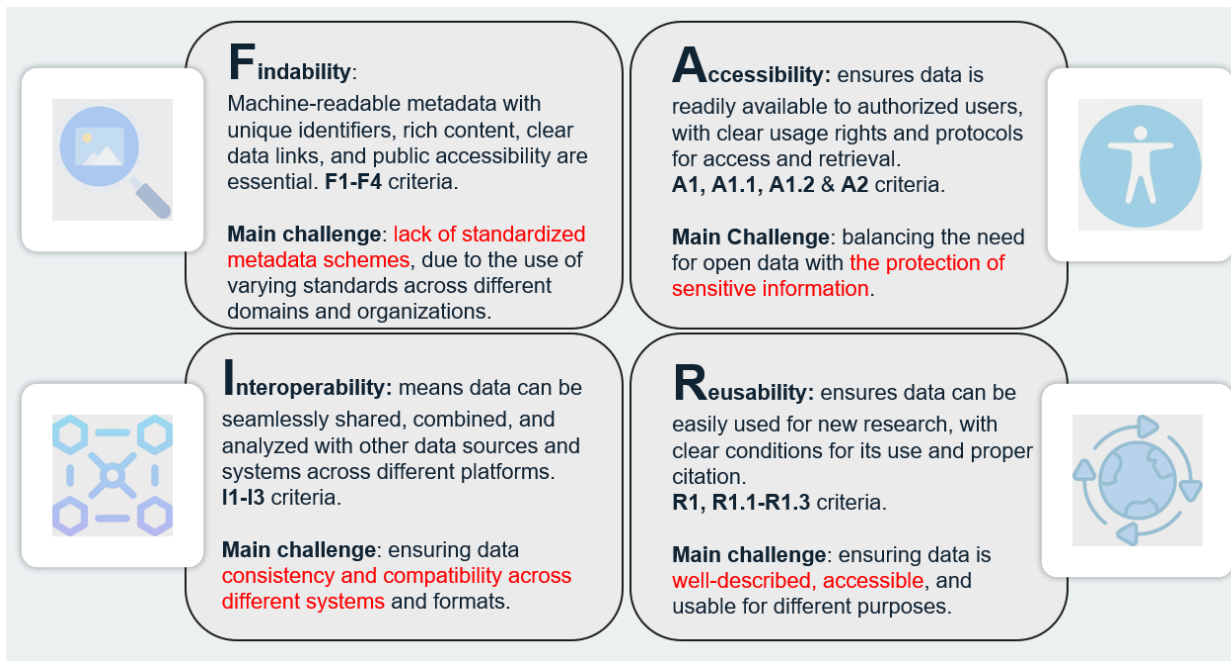
Figure 1: Overview of the four foundational FAIR principles, with criteria mentioned (more details to be found in the indicated references) and main challenge. (Text sources Wilkinson et al., 2016), Figure from manuscript in progress (Berger et al.)

Wilkinson et al. (2016) first introduced the FAIR principles, providing rationale and practical examples from the research community. They emphasized that FAIR principles apply not only to data but also to the underlying algorithms, tools, and workflows used in data production.

The FAIR principles offer a framework for making research data more accessible and usable within the scientific community. While particularly relevant in the geospatial domain for efficient data exchange, current practices often fall short in their application.

2. Stakeholder engagement strategy

The engagement of stakeholders is a key element of the OEMC project, as stakeholder needs and feedback will be systematically considered during the development of the OEMC product and services (WP3-6). The OEMC project aims to offer diverse services to heterogeneous

stakeholders. These stakeholder groups can be roughly categorized thematically into four main groups, as shown in Table 1.

Table 1: A summary of the main stakeholder groups, categorized based on the type of OEMC services.

Stakeholder group	Main focus of services	Description
Government / public administration	CAP; AKIS; National spatial planning/agriculture/forestry agencies; urban and county-level planning; forestry agencies; risk assessment and disaster response agencies; spatial intelligence services	Significantly sized national or international institutions with impact goals at large and regional level with significant budget ability
Company / Industry	Geospatial industry and service providers; traffic/environmental management; Insurance sector such as Risk modeling, Loss assessment and Fraud detection; SME; EO and GIS start-ups	Institutions competing in the "private" sector, developing a diverse array of user-driven solutions.
Research and academia	Research institutes; Universities	Institutions which invest in the development of novel products or solutions, often with project-based or target-based funding.
NGO and citizens	Non-profit organizations; conservation and nature restoration organizations; open-source and open data users; private citizens	Large and diverse groups of users often operate voluntarily and under constrained budgets but can offer novel and smart solutions in often underfunded areas of application.

Stakeholder engagement, feedback, and needs are acquired and considered in different ways, including:

- **Key stakeholder of the OEMC stakeholder committee**: This committee consists of (at least) eleven key stakeholders from relevant institutions (e.g., EC, JRC, UNCCD, IPCC, GEO). The initial list of the OEMC Stakeholder committee members has been published in Table 2 in report D2.1. During the project, the OEMC Stakeholder Committee slightly changed; two members were replaced, one member delegated a colleague with more time and work overlap to engage more with the project, and another member was introduced to have a stakeholder relevant to the in-situ data. The final list is publicly available on this OEMC webpage under the GOVENACE - Stakeholder Committee section. The Stakeholder Committee members have been involved in OEMC web

seminars as speakers and invited as keynote speakers on the OEMC Global Workshops and Hackathons to acquire project-level input, feedback, and recommendations for future development.

- **Use-case-related Stakeholders:** These Stakeholders are directly involved in each OEMC use-case and considered at all stages: use case design, co-development, and the receiving end of the OEMC data streams of demonstration services. They have agreed to act as Stakeholder and user with their expertise and interests in OEMC and are engaged through regular interactions such as personalized interviews, involvement in web seminars, and joint workshops with use case leaders at the OEMC Global Workshops. In total, 38 use-case-related Stakeholders from 33 institutions have been involved in developing 32 OEMC use cases and other products. The link among Stakeholders, involved institutions, and use cases is, of course, not one-to-one, as some use cases involve several stakeholders, some use cases with similar scope and requirements share the same Stakeholder, and some Stakeholders come from the same institution, such as WRI, JRC, and EEA but different thematic units. Also, four stakeholders of the stakeholder committee are acting as use-case-related stakeholders. The overview of the use cases and the Stakeholder institutions involved can be found on this OEMC webpage. That page will soon be updated with more details, including also the names of particular Stakeholders.

- **Broad geospatial community and surveys**: This includes all users, producers, and geospatial data providers willing to contribute to the OEMC project (e.g., via online surveys, open workshops, hackathons, science webinars, etc.). To address the challenge of identifying the general needs and requirements of a very diverse community, two broad groups are defined:

  - **Users** are individuals who primarily use geospatial and environmental data and products for their own tasks (e.g., decision-making, research), but do not necessarily produce nor provide derived products.

  - **Producer & provider** are individuals who, on the one hand, use geospatial data and products (e.g., from the OEMC project), but at the same time are actively involved in the production and provision of geospatial and environmental products (e.g., maps, reports, statistics).

The users and producers/providers were reached using our extensive list of the above-mentioned Stakeholders, 23 project partners and their networks, then project externals who participated in the OEMC events such as Global Workshops, Hackathons, and Science Webinars, and finally, a broad audience reached via social network campaigns.

The OEMC Stakeholder and User interaction strategy (Fig.1) has already been presented in the previous deliverables (D2.1, D2.3). Nevertheless, following the review feedback from the first periodic report, we will summarise it here for the reader's convenience. The upper branch flow

of the graph (Figure 2) presents co-development at the project level, whereas the lower branch flow presents co-development at the use case and product level. The project-level co-development is based on acquiring input and feedback from the Stakeholder committee and broad geospatial community (users and producers-providers) for the project-level products such as the development of the OEMC processing backend (WP3), development of the OEMC central app with monitors (WP5-6), the in-situ data catalog (WP4), data management and validation plan (WP1 and WP2). The engagement at the project level is foreseen through different OEMC events such as OEMC Global Workshops, Hackathons, and Science Webinars. It is foreseen that the OEMC board members are the primary contact for the stakeholder committee. To collect additional input at the project-level co-development from the board geospatial community, a FAIR data survey has been introduced, and its input and outcomes will be discussed in the second part of this report.
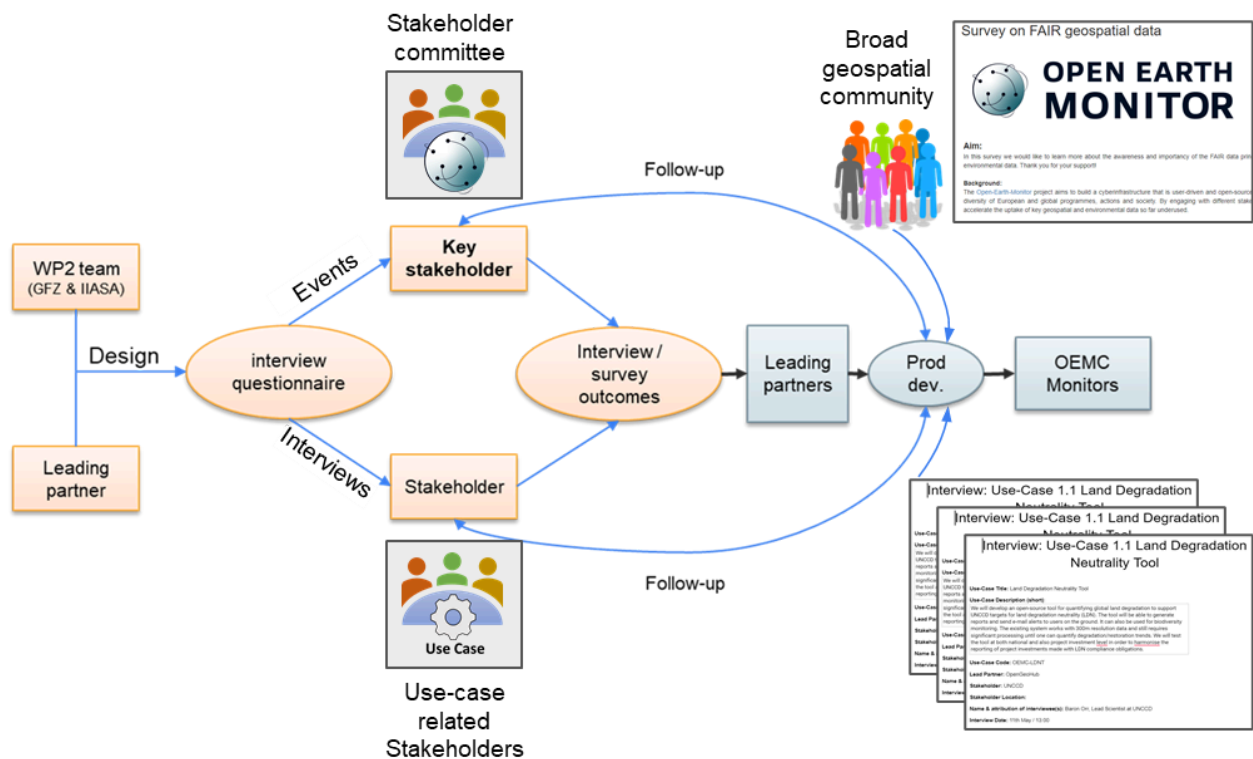
Figure 2: OEMC Stakeholder and User Interaction Strategy Graph with major engagement methods used to acquire the Stakeholder and user requirements and feedback: the FAIR data Survary (top right), and individual interviews (bottom right) with the use-case related Stakeholders

The use-case level co-development (the lower branch on the graph in Figure 2 involves use-case leaders, and use-case related stakeholders who act as both Stakeholders and users. The use-case product requirements and feedback are acquired systematically through direct interviews with Stakeholders at several stages of the project/product development. In the first periodic reporting period, use-case-related stakeholders were interviewed and asked to explicitly define the needs and technical requirements of the specific use case. Furthermore,

they were interviewed to define potential users and the impact of the use case products. The interviews were moderated by WP2 and WP8 members, and besides Stakeholder(s), the use case leader was also present. Almost all interviews were carried out online and the Stakeholder answers were recorded in a document made available only for project partners (not publicly) in the common project repository. Then, the use case leaders were asked to reflect on the requirements and assess their feasibility. The outcome of those processes has been reported in D2.5 deliverable. In the third reporting period, we plan to do the second round of stakeholder interviews that will focus more on the validation of the use case products, system usability, and update of their impact. The engagement at the use-case level is foreseen through the above-personalized interviews and joint tutorials at the OEMC Global workshops and OEMC Science Webinars. To foster use case uptake by a broad geospatial community, WP8 and WP2 are currently preparing short videos with stakeholders and use case leaders based on the interview. Those videos and additional use case details will be published on the OEMC webpage where use cases are presented. WP2 also introduced a comprehensive table to monitor the current state of the use cases (current technology readiness level at the beginning of the project and status, publications, etc.). That input is provided by the OEMC use case leaders and will be used for reporting in the remaining WP2 deliverables.

Finally, we list below several important activities that contributed significantly to the development of the above stakeholder strategy:

- The **OEMC design workshop** was held between 18.07. - 20.07.2022, where a number of key stakeholders participated and provided their project-level feedback. During this workshop, an overall strategy to identify user needs was defined, and OEMC use cases were introduced, which changed the project structure significantly. For more information, please refer to the D2.1 deliverable.

- The **OEMC Global Workshops 2023 and 2024** were held between 04-06 Oct. 2023 in Bolzano, Italy, and 01-03.Oct. 2024 in Laxenburg, Austria, respectively. Over 250 participants and 16 keynote speakers attended both workshops and most of the OEMC use cases and monitors were presented. The videos from all talks are freely available on YouTube as separate playlists for the 2023 and 2024 workshops. The D8.4 deliverable reports on the first workshop, whereas the D8.5 deliverable will report on the second workshop.

- The GEO-OPEN-HACK-2024 hackathon was held between 24-28 June 2024 in Laxenburg, Austria. The hackathon involved 55 persons, representing a broad geospatial community, OEMC Stakeholders, and open big data geospatial exsperts. Particular OEMC products, such as the OEMC central app, OEMC backend, and several use cases, were presented to the audience to receive user feedback and development suggestions. The videos from the hackathon are available on the YouTube playlist.

- Implementation of an **online survey to collect feedback on FAIR data** from the broad EU and international geospatial community. The aim of this online survey is to get a comprehensive picture of whether users, producers and providers of geospatial and

environmental data are aware of the FAIR data principles. In addition, it is investigated whether users and producers/providers have a similar or divergent understanding of the relevance of FAIR principles. This survey was started on 25.10.2022 and will remain open until December 2024. The results were statistically evaluated and are presented in chapter 3.

● Implementation of **targeted online interviews with key stakeholders** with a focus on the 32 OEMC use cases introduced by the 24 monitors (e.g., EU-coastal monitor, World-flood risk monitor). The interviews were collected between February and May 2023 and the description and structure of the first stakeholder interview is given in [Section 3.2](#) of this report.

The stakeholder engagement will continue through the OEMC Global Workshops, Hackathons planned for 2025 and 2026 as well as the second round of the personalized interviews with the use-case-related stakeholders as described above. It is also expected that use case leaders will present OEMC products at conferences and other public events where they will collect additional user feedback for their products.

3. Methods for stakeholder need & requirement assessment

In addition to stakeholder events (e.g., workshops, hackathons, and science webinars), different research and survey activities are implemented to collect and analyze stakeholder needs and requirements in the framework of WP2. The following activities will be described in the current chapter:

● A broad survey on FAIR data
● A targeted stakeholder survey on the needs and requirements of the OEMC use cases

3.1 Broad survey on FAIR data

The OEMC project aims to maximize the impact and uptake of FAIR environmental data. This online survey is a key activity to get a comprehensive picture of whether the broad geospatial community is aware of the FAIR data principles and what importance is attached to each principle. Furthermore, it is investigated whether users and producers & providers have a similar or divergent understanding of the relevance of FAIR principles[1]. To identify potential gaps, users and producers & providers are asked separate questions, the results of which can be compared. The survey consists of three question blocks:

- **The first block** includes seven general questions with respect to location of work, type of organization, role at work, main field of application, gender identity and range of age. In the last question, the participant must indicate whether she or he is primarily a user or

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[1] GOFAIR data principles: https://www.go-fair.org/fair-principles/

producer/provider of geospatial data. According to the answer, the participant receives specific questions in the course of the survey.

- **The second block** examines more information about the type of geospatial and environmental data that is primarily used or provided/produced.

    - Users are asked what type of geospatial data they primarily use, what properties of that data are particularly important to them and whether certain properties are problematic. The questions indirectly refer to the relevance of the FAIR principles (without the participants necessarily being aware of it).

    - Providers & producers are asked which type of data they offer, what they believe are the properties of geospatial data that are important and what properties are problematic for users.

- **The third block** focuses on the FAIR data principles. Users and producers & providers are asked whether they are familiar with the FAIR principles and which ones are particularly important to them. Users are also asked what they see as the biggest barriers to using FAIR and open data. While producers & providers are asked what primarily prevents them from offering fair and open data.

The survey[2] includes 17 mandatory questions (and some optional response options) and was intentionally kept short so that many people from the geospatial community would respond to get a comprehensive picture. The survey was promoted at relevant OEMC events, such as OEMC Global Workshop 2023 and 2024, the GEO-OPEN-HACK-2024 hackathon, the geospatial conferences such as the EGU 2024 in Vienna and social media, such as LinkedIn posts. The survey was also communicated to the OEMC stakeholders, who were asked to further distribute it to their networks. This survey was created and published using EU Survey[3] which is a tool developed by the EU Commission for survey purposes and has been used in prior scientific studies on this field of earth observation[4]. The full sheet of questions for this survey is made available in Appendix 1.

3.2 Use-case-related stakeholder interviews

As part of the project, different OEMC monitoring tasks (WP 5 - 6) are to be developed and undertaken. These provide the technical underpinnings for the development of specific OEMC use cases. These use cases are characterized and driven by specific stakeholders (acting also as a user) that have been actively involved in its definition, implementation and assessment, i.e.

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[2] Broad survey on FAIR data - https://ec.europa.eu/eusurvey/runner/OpenEM-Survey-FAIR-geospatial-data

[3] EUSurvey - https://ec.europa.eu/eusurvey/home/welcome

[4] Wagemann, J., Siemen, S., Seeger, B., & Bendix, J. (2021). Users of open Big Earth data – An analysis of the current state. Computers & Geosciences, 157, 104916. https://doi.org/10.1016/j.cageo.2021.104916

each use case has been co-developed with the stakeholder who acts also as the main user of the use case product. WP2 efforts have an important role in terms of preparing and managing these stakeholder interactions, systematically acquiring user requirements, stimulating exchange among data producers and users, and soliciting user/stakeholder feedback once the data and information have been delivered, as described in Section 2 and Fig.2.

Initial discussions with use-case-related stakeholders have already occurred in the first half of 2023. The OEMC use-case leaders and WP2 representatives were also present during the interviews. This interaction aimed to identify not just the needs of stakeholders but also to actively integrate them in the co-development of final products to be delivered by particular OEMC use cases. The use-case-related stakeholder survey is provided in the Supplementary materials. Due to the high diversity of stakeholders and use case products, this template survey has been slightly changed and adapted according to each stakeholder and in coordination with the leading partners which are assigned. The WP2 representatives at the interview had a role in ensuring that the questions were well interpreted by the use case leader and Stakeholder, and that Stakeholder provided answers to all the questions raised in the interview.

The targeted interview consists mainly of three question blocks:

- The first block contained the **questions from the online survey on FAIR data** (see Appendix 1). In addition to the broad survey of the geospatial community, it is very important to understand to what extent use-case-related stakeholders are familiar with the FAIR data principles and what the individual principles mean to them. Their assessments can be of significant importance for the development of OEMC monitors.

- The second block relates to **user-centred questions about the required products and information**. To identify the needs and requirements of the use-case-related stakeholders and their environment it is necessary to understand

    - Broad motivation and needs for specific use cases, incl. the field of application and related tasks in detail
    - existing routines and current work environment to fulfil these needs today; incl. Limitations and FAIR and open data status
    - currently used products/information and their characteristics to identify potential gaps in existing solutions
    - Expected information coming from OEMC use case and how and for what it should be used
    - type of users or services that will work with/use the product

    After this block of questions, the required product type and its main technical properties must be known to define the specific product requirements in the next step.

- Based on the identified product type (data, tools, app, etc.), a block of **detailed questions on the product requirements** follows. Due to the different use cases product types, and diverse stakeholder groups, it is not possible to create a completely

standardized questionnaire, so some technical requirements were slightly adopted or omitted. For example, if the product type is a tool and not a dataset, we omitted dataset-related questions such as the requirements for its temporal and spatial resolution. Instead, we focused on where the tool will be implemented and to what software data shall be compatible. The main aim of this block was to find suitable requirements for the following categories:

- Content & units (e.g. definitions, parameters, indices, feature classes, objects)
- Spatial level of detail (e.g. spatial resolution, minimum mapping units)
- Spatial coverage (e.g. spatial extent, areas of interest)
- Temporal detail (e.g. temporal resolution, temporal coverage, update frequency)
- Accuracy (e.g. horizontal resolution, thematic accuracy, probability)
- Access & delivery (e.g. via FTP server, data portals, web services, WMS & WFS)
- Data formats (e.g. GeoTIFF, geojson, shapefile)
- Metadata
- Place of implementation
- Compatible data and software
- Other requirements identified in the interview

The interviews were 60 minutes long and led by the use case leader. To be able to focus on question blocks 2 and 3, the stakeholders were asked to fill in the questions of the online survey and the FAIR block before the interview. If some stakeholders were unavailable for an interview, they would be asked to answer the questions in writing, which happened only in a few cases. The filled-in questionnaires from all the interviews are not publicly available, but stored in the common project folder and available to the whole consortium for further use. In a follow-up internal co-development session on May 15. 2023 at Münster University, we performed a feasibility study where each use case leader reflected on the stakeholders' requirements, identified obstacles, and offered alternative solutions. This analysis has been reporting the D2.5 deliverable.

4. Final results of the broad survey on FAIR data

In this chapter, the final results of the online survey are presented with a focus on the results which we found to be most significant. While not all plots and tables are shown here for simplicity, they are all made available in two purposely created GitHub repository, one with intermediate results and some updated for final results[5]. Note that some clearning is still in progress in the final repository (14/Nov 2024). Alongside, all the data used in the analysis, higher-resolution images and the R scripts used are also available in that repository.

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[5] Data, R scripts and higher quality plots are all available in the following repositories:
https://github.com/nunocesarsa/OpenEM_interimFAIRSurveyResults
https://git.gfz-potsdam.de/global-land-monitoring/fair-survey

The results presented cover the period Oct. 25, 2022 to Oct.1, 2024. The survey was distributed primarily through OEMC project partners' email distribution lists and social networks (such as LinkedIn, see above). Thus, **a total of 170 complete responses** were acquired and are the basis for this final analysis.

The **first block of questions** consists of general questions to characterize the respondents (e.g. location of work, type of organization, role at work, main field of application, gender identity and range of age). In total, 170 people from 33 different countries participated and around 80% were from the European Union. As Figure 3 shows, most participants work in Germany (42%, n=70), followed by Italy (10%, n=20), the Netherlands (7%, n=12) and Romania (7%, n=12). For a better overview, all countries with two or fewer participants have been combined.
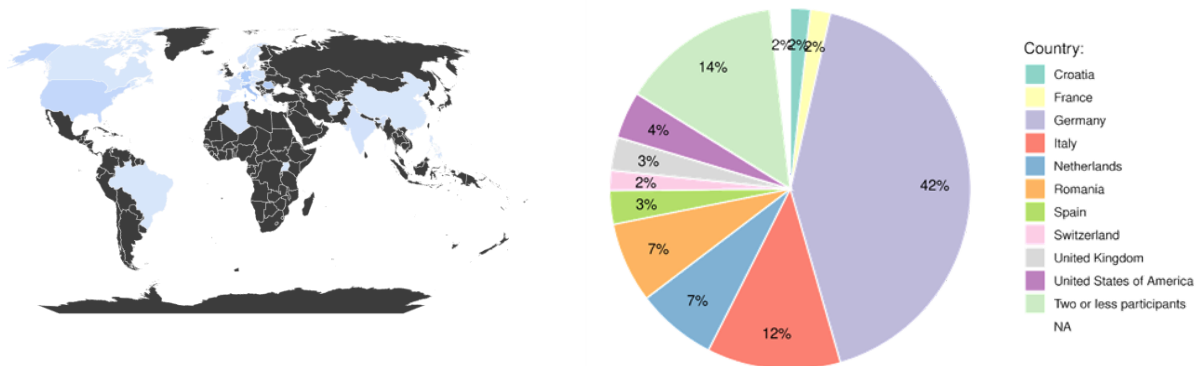
Figure 3: Summary of the survey answers regarding the workplace of the participants. Left: global distribution of responses and right in % per country.

Most of the participants work in academia (Figure 4) with 42% responding they work in a research institute plus 17 % in a university. In addition, many people from the governmental and public sectors (17%) and the private sector (17%) participated. It is therefore not surprising that most of the participants are scientists (68%), followed by technicians (14%). Furthermore, a significant number of participants (11%) identified "other" as their job role, showcasing a strong diversity ranging from company founders and owners, GIS technicians, and system administrators, to sales and department heads.
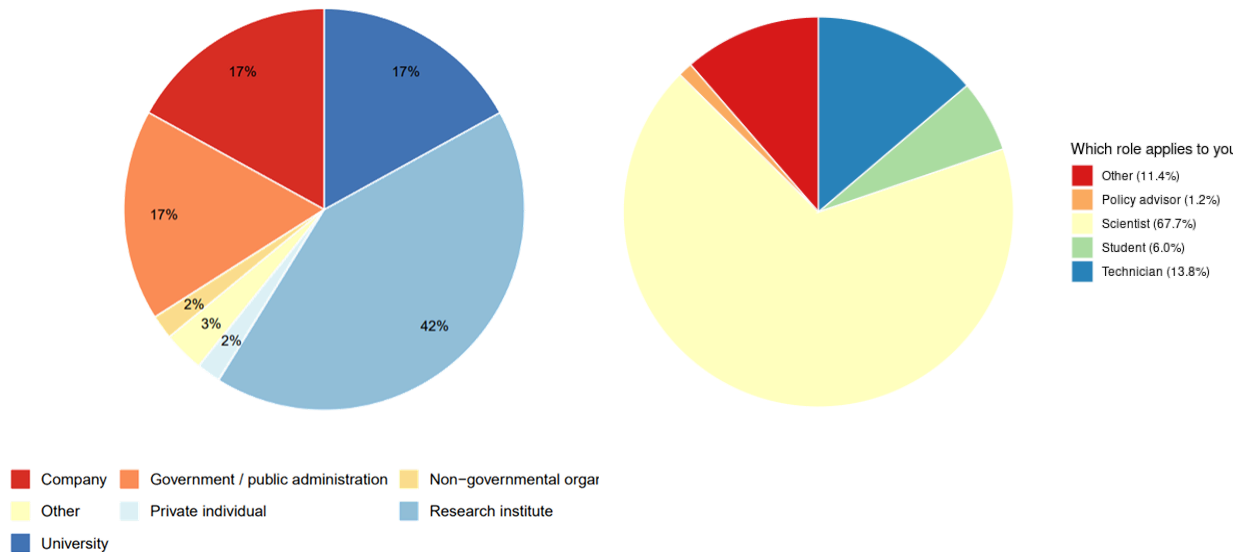
Figure 4: Type of organisation where survey participants were employed (left) and roles that applied to them (right).

In terms of field application (Figure 5), the results show a high diversity and given that respondents could answer multiple options, it is likely that many of them work in multiple fields. *Agriculture/land degradation* alongside *Nature conservation/biodiversity* were selected by 20% and 18%, respectively, of the respondents and are the most common field of applications (see Figure 5). Other fields like *Risk/hazards* (16%), *Coastal marine areas* (16%) and *Water resources* (14%) were also selected a significant number of times.
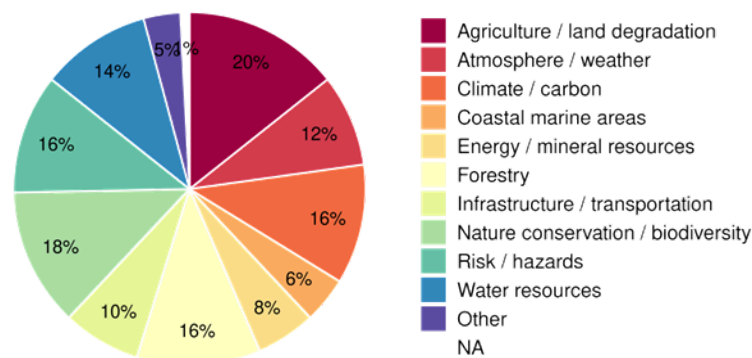
Figure 5: In this question, the participants could choose multiple options. The ratios represented on the pie chart show how many of the total participants (n=170) selected each of the options.
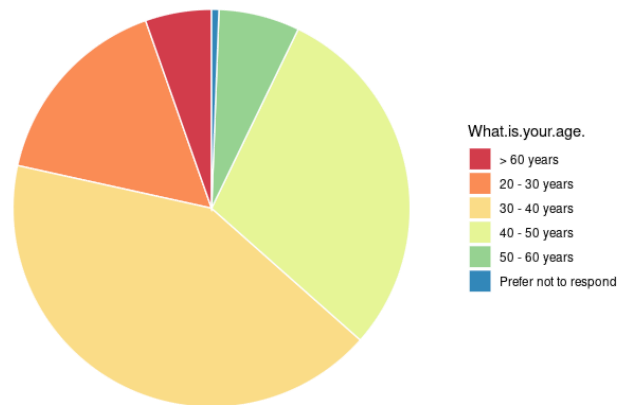
Figure 6: Age distribution of the survey participants.

In terms of gender diversity, 68% of participants were male, 26% of participants were female, 2% of participants were non-binary/non-conforming and the final 4% preferred to not respond. Furthermore, the majority of participants were aged between 30 - 40 years (46%) with also a significant contribution of participants aged between 40 - 50 (27%) and 20 - 30 (17%), see also Figure 6.

In the last question of the first block, participants must decide whether they are primarily users or providers of data. The result shows that most participants describe themselves as *users* (74%), while 26% are data *producers/providers* (Figure 7). Based on the answer, the participants were further given slightly different questions in the next two question blocks.

You are primarily a ...
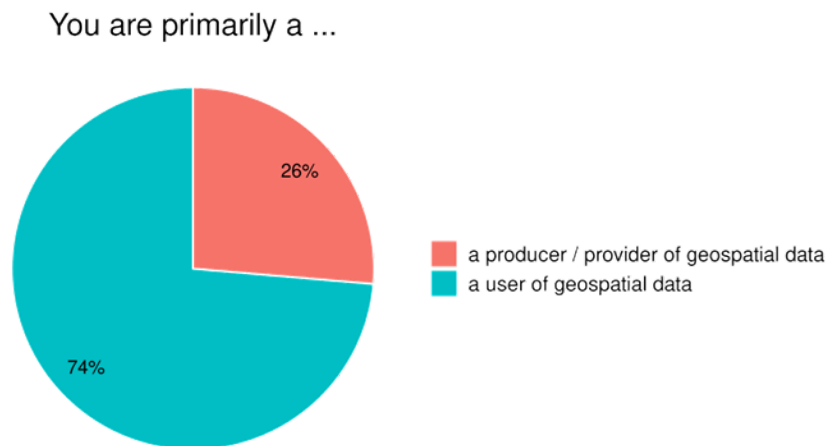
Figure 7: Overview of how respondents identified as part of the user group or the producer/provider group

As mentioned, the second block of questions refers to the characteristics of geospatial data as seen by its users on one side and by producers/providers on the other. The results of both groups are shown and compared in the further course. Figure 8 shows which data users work with most often and which data is provided by producers/providers. The results show that *Open Satellite-based remote sensing data & derived products* are primarily used by many users (89%) and provided by most producers/providers (66%). The result indicates a high demand for open satellite-based earth observation data in the geospatial community.
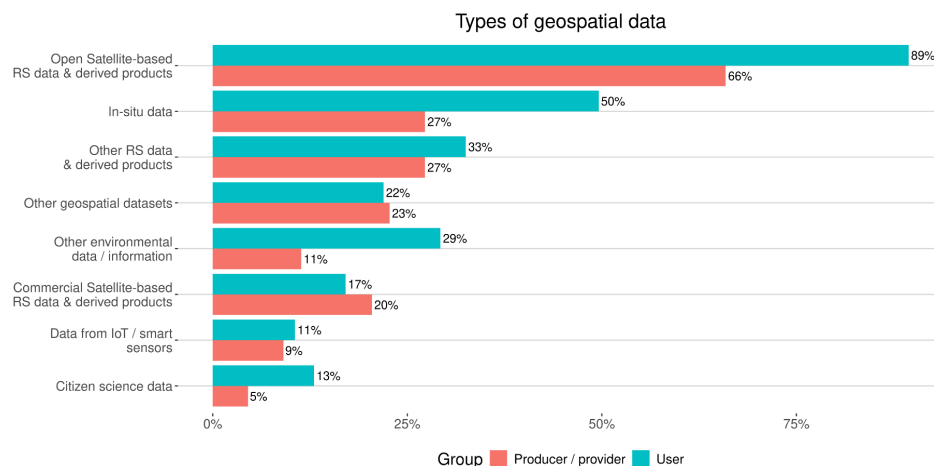
Figure 8: Comparison of responses between the group of users and producers/providers regarding the question on the type of geospatial data that is used or produced/provided

Furthermore, the scale level at which users and producers/providers operate was compared (see Figure 9). While 59% of producers/providers offer data products on a global scale, only 35% of users use global data. On average, 41% of the users work at local and federal/regional

scales, but only 25% of producers/providers make data available at that level. This can indicate a gap between user needs and data availability.
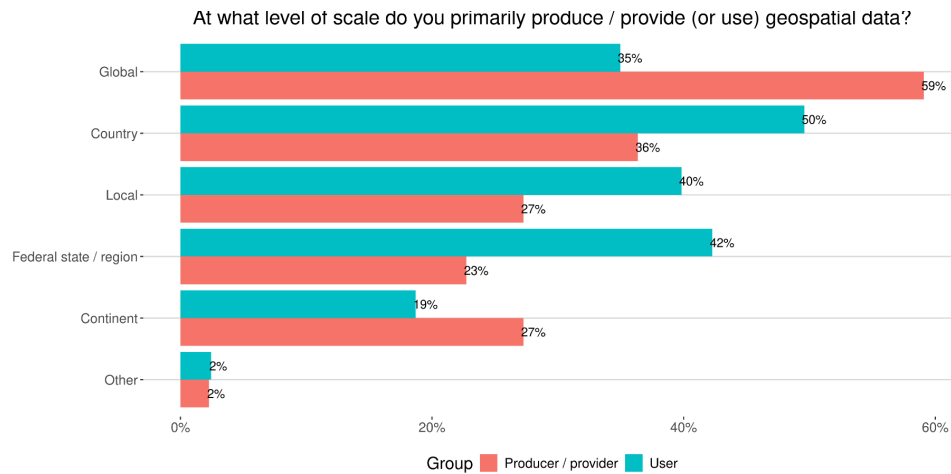
Figure 9: Comparison of responses between the group of users and producers/providers regarding the geographical scale at which they work on

Regarding important features of geospatial data, there is a general agreement between users and producers/providers (Figure 10). In particular, both groups find it extremely important that *Data is easy to find online* (57% of users and 73% of producers/providers) and that *Data is open* (54% of users and 64% of providers/producers). Less important features for both groups are 1) *Data can be retrieved via domain-relevant community standards,* 2) *Data can be reproduced* and 3) *Data is interoperable with other data sets*. In the context of the FAIR principles, it shows that both groups prioritize easy findability and quick access to data instead of interoperability, reproducibility or clear community standards (Figure 10).
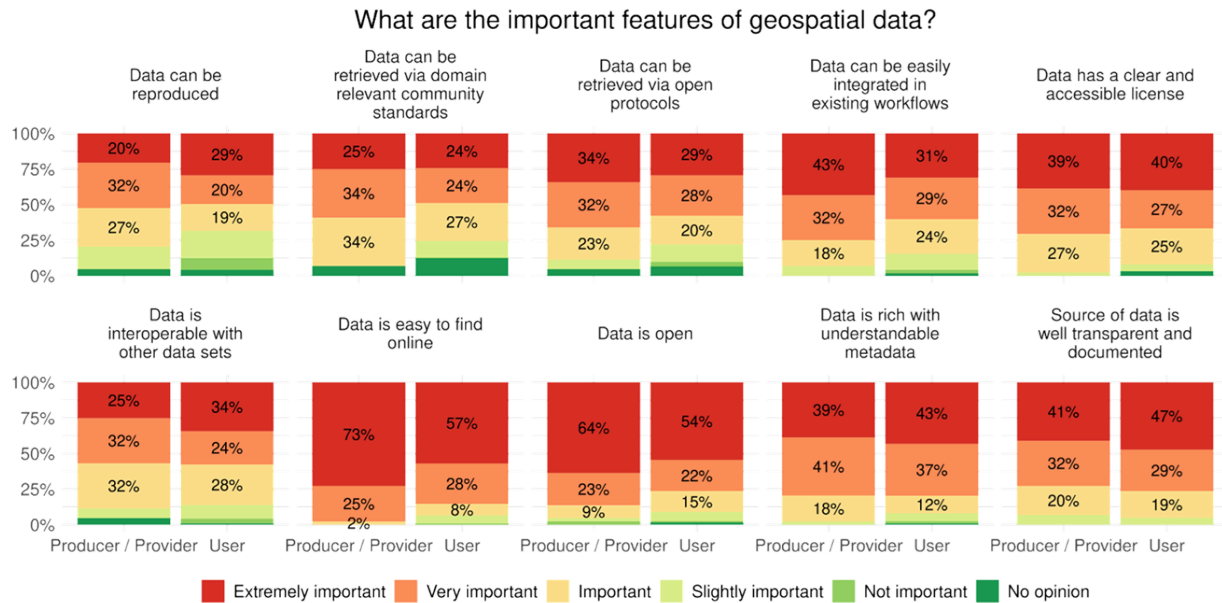
Figure 10: Overview of the most important features of geospatial data from the point of view of users and producers/ providers of geospatial data.

In addition, users and producers/providers see similar problems regarding geospatial data (Figure 11). Data not being open is extremely problematic for many users and producers/providers also see this as a major problem for users (33%). Another big problem for the users is incomplete metadata (for 21% of both groups this is extremely problematic). Identification or registration to get access to data is not critical for most users. Nor do the producers/providers believe that this is a major problem for users.
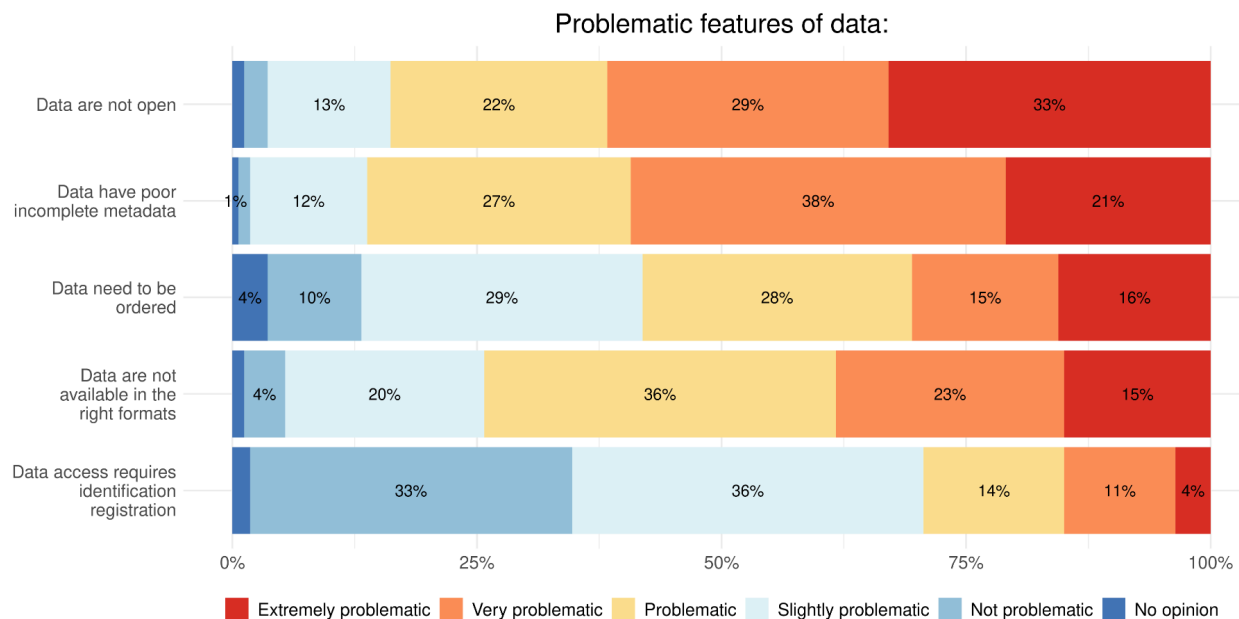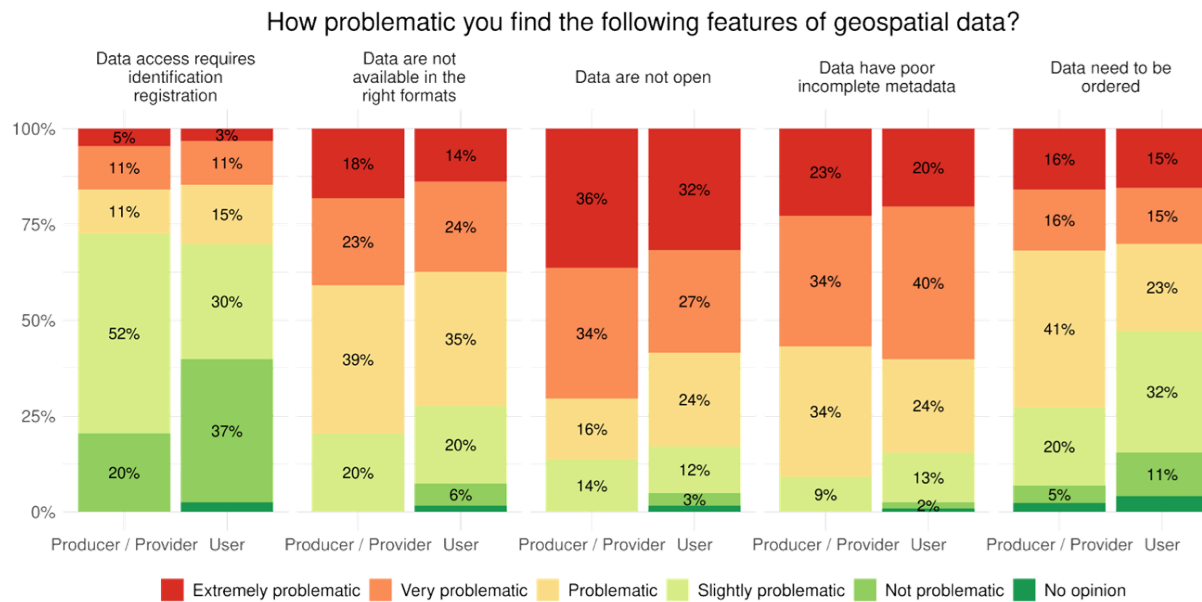
Figure 11: Overview of the most problematic features of geospatial data from the point of view of users and producers/ providers of geospatial data, separated (above) and aggregated (below).

The final question of this second block asked users what was their preferred method to find geospatial data and producers/providers and how they delivered their data. Again, this question allowed respondents to provide multiple answers and therefore the ratios represent the total of times each answer was given by the total number of participants of that group, implying that they can sum to over 100%. Regarding producers/providers, 81% provide their data through a website and 60% through a geospatial catalogue/geoportal. The preferred method for users to

find geospatial data was through web searches (79%) data hubs (e.g., Sentinel hub) (55%) or geospatial catalogues (50%). Overall, it appears a bit of a mismatch exists between both groups with providers focusing on providing data through a "website" instead of data hubs which users seem to prefer.

The third block of questions relates especially to the FAIR data principles. In this case, we found that a significant proportion of both users (32%) and producers/providers were not familiar with FAIR data principles (23%), as shown in Figure 12. Nevertheless, while 61% of producers/providers are (at least) familiar with the FAIR principles (green colours), only 40% of the users are familiar with the FAIR principles. These results seem to indicate that in the case of our participants, there is a relatively poor familiarity with FAIR data principles for both groups, even if a bit higher familiarity in the case of producers/providers.

How familiar are you with the FAIR data principles?

Legend: Extremely familiar | Very familiar | Familiar | Slightly familiar | Not familiar
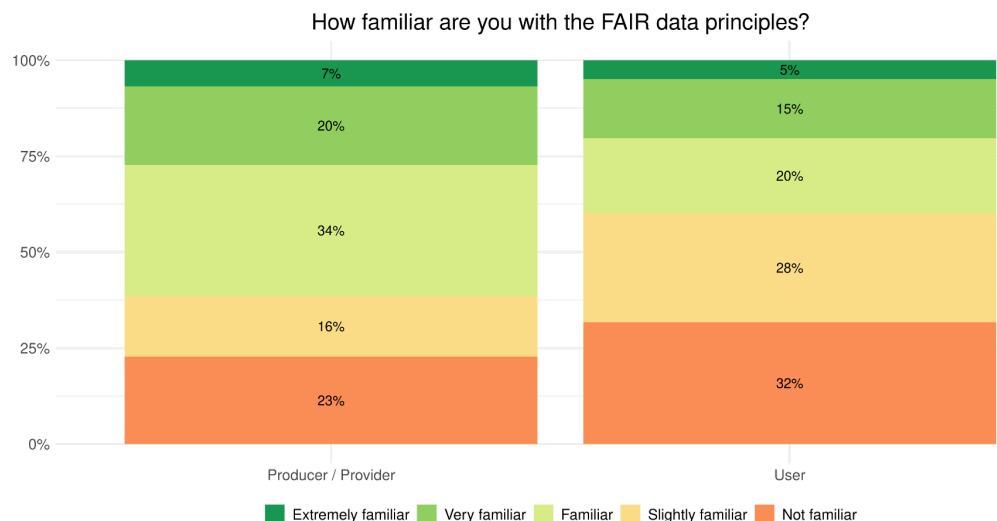
Figure 12: Overview of familiarity of both producers/providers and users regarding the FAIR data principles

When asked which FAIR principles are particularly important to users and producers/providers, it is again apparent that the priority of both groups is on *Data must be easily accessible* and *Data must be easy and quick to find* (Figure 13). Again, similarly to a previous result (Figure 10 and Figure 11), less importance is given to the reproducibility of data or interoperability with other data.
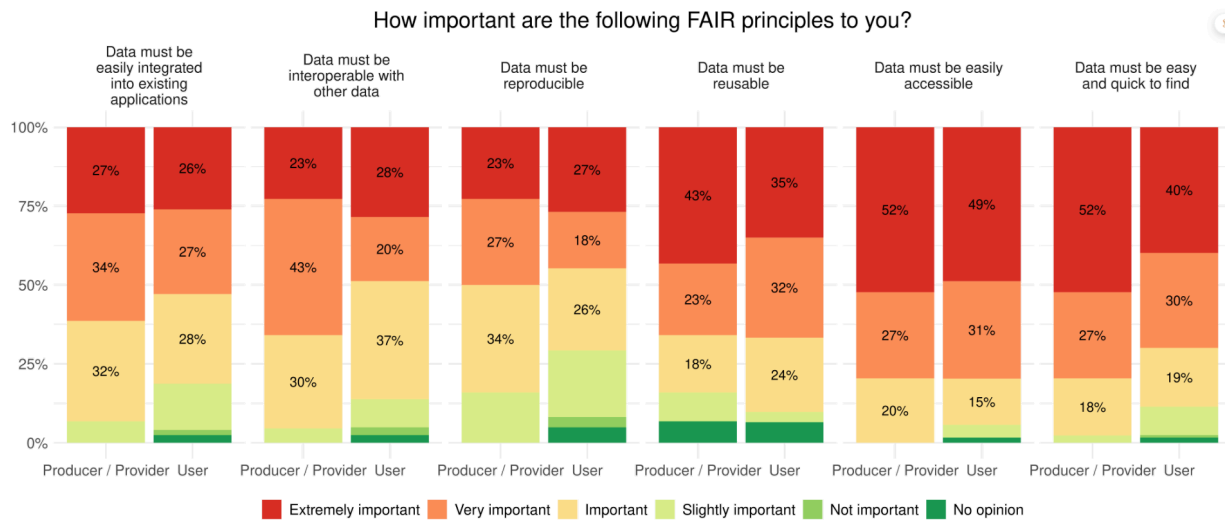
Figure 13: Overview of importance that both producers/providers and users give to the core FAIR data principles

A very significant proportion of producers/providers responded that they are already providing their data at least partially according to the FAIR principles with 43% responding that they provide FAIR data and 32% saying that they provide partially FAIR data ([Figure 14](#), left). On the other side, only 20% of the users claimed to have used FAIR data while 24% claimed to have not used FAIR data ([Figure 14](#), right). Around half of the users do not know if they are using FAIR data or not (51%). These results represent a large lack of awareness from the users regarding the source of their data which can be problematic for providers/producers and their concerns regarding data sharing.
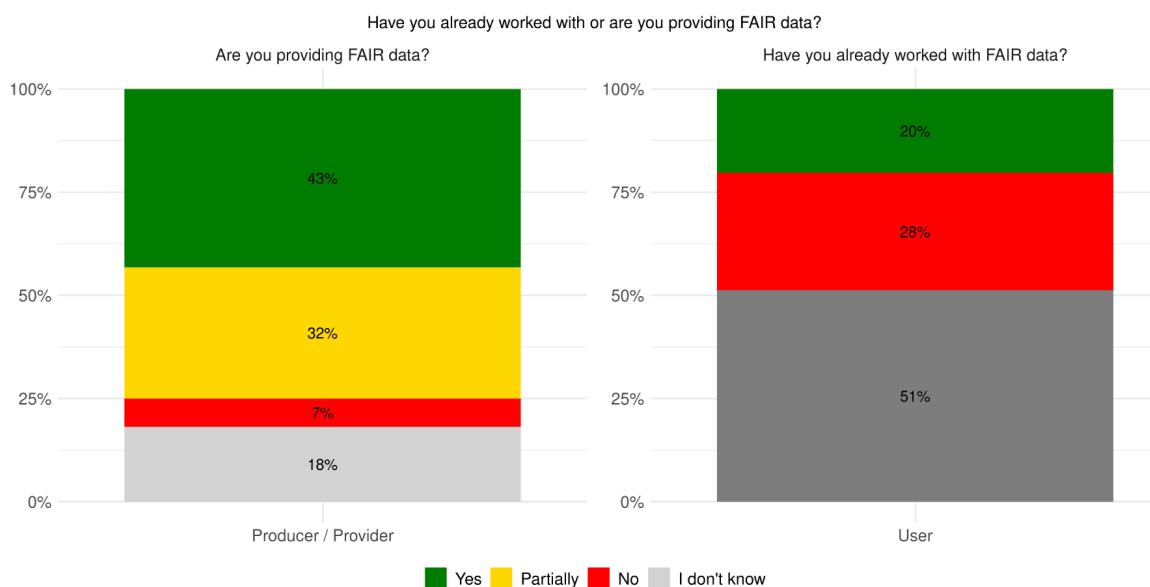
Figure 14: Overview of the responses to the question if producers/providers already provide data according to FAIR standards (left) and if users have worked with FAIR data (right).

Overall, most producers/providers (56%) correctly identified that FAIR data is not necessarily open. In comparison, 38% of the users expected FAIR data to be open (Figure 15). This again shows that the producers/providers are more familiar with the FAIR principles. Also, of significant note is that the majority of users do not know the difference between FAIR and Open data (48%). This might indicate a need for addressing this in future communications with the broader geospatial community.
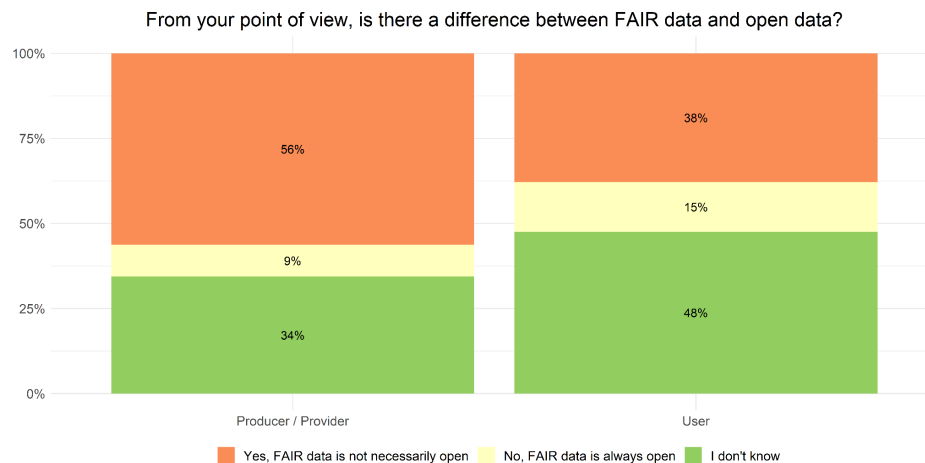
Figure 15: Comparison of the expectation between users and producers/providers regarding FAIR data being also Open data

Furthermore, producers/providers were asked what they perceive as barriers to producing or providing FAIR data (Figure 16, left). The main reasons cited by producers/providers are *lack of resources* (25%) and *missing incentives* (21%). A significant proportion also pointed out a lack of *guidelines* and *potential misuse* (11/12%). From the user perspective (Figure 16, right), *lack of awareness* (24%) and lack of *knowledge about the benefits of FAIR data* (20%) were selected by the majority. Interestingly, the *concerns about licensing* in the case of the users and the *lack of technical solutions* in the case of producers were not considered significant barriers. This may indicate that producers/providers are potentially ready to offer FAIR data but do lack the incentive to do so.
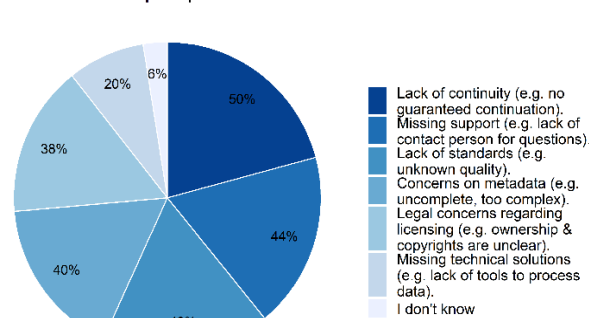
Barriers to FAIR data:
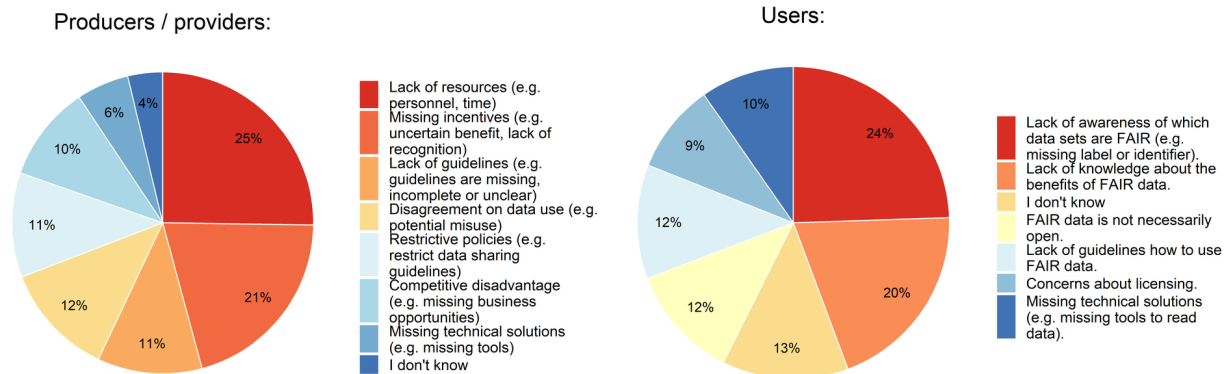
Figure 16: Overview of the most significant barriers for users to use FAIR data and for producers/providers to offer FAIR data. The respondents could choose up to three options and therefore the % represents the total number an answer was given by the total number of participants in that group.

Regarding Open data (Figure 17, left), *competitive disadvantage*, *economic disadvantage* and *concerns regarding sensible data* were the most selected options with 53%, 50% and 47% of the producers/providers group. This clearly shows that this group is mainly concerned with competition, economic benefit and data protection as indeed these aspects play a significant role in the valuation of products. On the other side, concern about privacy, ethical use of data or restrictive policies are not considered to be significant barriers which is not surprising considering that the geospatial data field often works with broad and aggregated data which inherently protects many of these aspects.

From the user perspective (Figure 17, right), responses are more well spread throughout all the options with the main barriers of Open data being the *lack of continuity* (50%), *missing support* (44%) and *lack of* standards (43%) . Still, *metadata concerns* (40%) and *licensing* (38%) were highly voted options with the least voted being technical difficulties (20%). Overall, users are concerned that Open data might not be consistently available in time and there will be a lack of support and standards which are barriers that can be potentially addressed with Open and FAIR data.

Barriers to the use of Open data from:
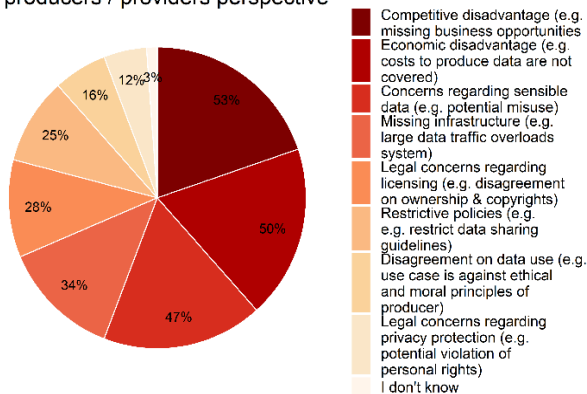
Figure 17: Overview of the most significant barriers for users to use Open data and for producers/providers to offer FAIR data. The respondents could choose up to three options and therefore the % represents the total number an answer was given by the total number of participants in that group

5. Conclusions

OEMC Stakeholder Engagement and FAIR Data Survey

Within the OEMC project, a comprehensive stakeholder engagement framework was implemented to systematically identify stakeholder needs and existing data gaps. Various activities, such as the establishment of a stakeholder committee, workshops, hackathons, an online survey, and use-case-related interviews, were conducted to achieve this goal.

This report presents the final results of the online survey on FAIR data. With a satisfying participation rate (170 respondents), the survey results are representative of diverse fields of applications. However, there was some bias due to a disproportionate representation of German participants (42%) and academic stakeholders (>60%). Additionally, there was an overrepresentation of male respondents compared to women.

The survey revealed a wide range of application areas, indicating that the survey reached various fields within the geospatial community. The survey also highlighted the importance of complete metadata for FAIR data. The key findings of the FAIR survey have been communicated to the OEMC consortium and wide audience at the OEMC Global Workshop

2024, within a special workshop session, and a publication in a scientific journal is under preparation.

Key findings from the survey include:

- The level of familiarity with FAIR data principles varies: users are much less aware than data producers (60 versus 40%).
- The most important FAIR principles for respondents are data findability, accessibility, and openness.
- Lack of awareness of FAIR data sets and their benefits, as well as concerns about data openness, are major barriers to FAIR data adoption.
- While many respondents do not necessarily expect FAIR data to be open, open data remains a high priority for many users.

The survey results underscore the need to promote FAIR principles within the OEMC project through direct interaction with stakeholders and sustained dialogue between data producers/providers and users.

** Implications for further Technical Developments: **

To demonstrate FAIR data within the OEMC project, the focus of WP3-WP6 is on creating essential FAIR technical infrastructures. These infrastructures should ensure that data is easily findable and accessible online, open-source, well-documented with metadata, and capable of handling a variety of data sources. Additionally, OEMC can help overcome "producer" obstacles by providing investments, incentives, improved guidelines, and lessons learned. The OEMC data management plan builds upon the FAIR technical infrastructure, defining and recommending a series of technologies and tools, such as STAC catalogues and cloud-optimized formats, for the OEMC products to comply with FAIR principles. Furthermore, some particular open tools have been developed with the OEMC project, such as the zen Python library that simplifies the upload and management of geospatial datasets on the Zenodo platform, thus making them more findable and accessible.

** Implications for Stakeholder Engagements: **

Engaging in a user-producer dialogue, particularly through use cases, is crucial. It is essential to emphasize the importance of FAIR and open data and demonstrate their practical value. Moreover, it is important to recognize that many data producers create large-scale datasets while users often operate at national or local levels.

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Related tasks and outputs

[Report D2.1](#): Stakeholder Committee and "Open-Earth-Monitor design" workshop.

Report D2.2 (1st version): Status and prospect for European environmental data

Report D2.4 (1st version): Economic Assessment Framework Guidelines

Appendix 1:

Questions of the survey

General questions

* In which country do you work?

[dropdown]

* What type of organization do you work for?
- ○ University
- ○ Research institute
- ○ Private individual
- ○ Government / public administration
- ○ Company
- ○ Non-governmental organization
- ○ Other

Name of your organization: (optional)

[text field]

* Which role applies primarily to you?
- ○ Technician
- ○ Scientist
- ○ Policy maker
- ○ Policy advisor
- ○ Student
- ○ Other

* What is your gender identity?
- ☐ Woman
- ☐ Man
- ☐ Transgender
- ☐ Non-binary / non-conforming
- ☐ Prefer not to respond

* What are your main fields of application?
- ☐ Atmosphere / weather
- ☐ Climate / carbon
- ☐ Risk / hazards
- ☐ Coastal marine areas
- ☐ Agriculture / land degradation
- ☐ Forestry
- ☐ Nature conservation / biodiversity
- ☐ Infrastructure / transportation
- ☐ Public health surveillance
- ☐ Water resources
- ☐ Energy / mineral resources
- ☐ Other

* What is your age?
- ○ < 20 years
- ○ 20 - 30 years
- ○ 30 - 40 years
- ○ 40 - 50 years
- ○ 50 - 60 years
- ○ > 60 years
- ○ Prefer not to respond

* You are primarily...
- ○ a **user** of geospatial data
- ○ a **producer / provider** of geospatial data

If you are a user of geospatial data:

* What type of geospatial data do you primarily use?
- ☐ Open Satellite-based remote sensing data & derived products
- ☐ Commercial Satellite-based remote sensing data & derived products
- ☐ Other remote sensing data & derived products (e.g. from airborne, UAVs, terrestrial laser scanner)
- ☐ In-situ data
- ☐ Citizen science data
- ☐ Data from IoT / smart sensors
- ☐ Other environmental data / information
- ☐ Other geospatial data sets

* At what level of scale do you primarily work with geospatial data?
- ☐ Global
- ☐ Continent
- ☐ Country
- ☐ Federal state / region
- ☐ Local
- ☐ Other

How important are the following features of geospatial data to you?

	Not important	Slightly important	Important	Very important	Extremely important	No opinion
Data is easy to find online.	○	○	○	○	○	○
Data has a clear and accessible license.	○	○	○	○	○	○
Data can be retrieved via domain-relevant community standards.	○	○	○	○	○	○
Data can be retrieved via open protocols.	○	○	○	○	○	○
Data is rich with understandable metadata.	○	○	○	○	○	○
Data is interoperable with other data sets.	○	○	○	○	○	○
Data can be easily integrated in existing workflows.	○	○	○	○	○	○
Source of data is well transparent and documented.	○	○	○	○	○	○
Data can be reproduced.	○	○	○	○	○	○
Data is open.	○	○	○	○	○	○

Other features that are very or extremely important to you? *(optional)*

How problematic do you find the following features of geospatial data?

	Not problematic	Slightly problematic	Problematic	Very problematic	Extremely problematic	No opinion
Data are not open.	○	○	○	○	○	○
Data have poor / incomplete metadata.	○	○	○	○	○	○
Data are not available in the right formats.	○	○	○	○	○	○
Data need to be ordered.	○	○	○	○	○	○
Data access requires identification / registration	○	○	○	○	○	○

Other features that are very or extremely problematic to you? *(optional)*

* What is your favorite approach to finding geospatial data?
☐ Through web search (e.g. via Google, Bing, Ecosia)
☐ Through geospatial catalogs (e.g. geoportal)
☐ Through open repositories (e.g. zenodo)
☐ Through data hubs (e.g. Copernicus Open Access Hub, Sentinel Hub)
☐ Through a commercial data provider
☐ I do not search for data myself
☐ Other

FAIR data (users)

The FAIR principles intend to improve the **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets.

Please find more information here: www.go-fair.org/fair-principles/

* How familiar are you with the FAIR data principles?
○ Not familiar
○ Slightly familiar
○ Familiar
○ Very familiar
○ Extremly familar

How important are the following FAIR principles for you?

	Not important	Slightly important	Important	Very important	Extremly important	No opinion
▪ Data must be easy and quick to find.	○	○	○	○	○	○
▪ Data must be easily accessible.	○	○	○	○	○	○
▪ Data must be easily integrated into existing applications.	○	○	○	○	○	○
▪ Data must be interoperable with other data sets.	○	○	○	○	○	○
▪ Data must be reproducible.	○	○	○	○	○	○
▪ Data must be reusable.	○	○	○	○	○	○

* Have you already worked with FAIR data?
- ○ Yes
- ○ No
- ○ I don't know

* From your point of view, is there a difference between FAIR data and open data?
- ○ Yes, FAIR data is not necessarily open
- ○ No, FAIR data is always open
- ○ I don't know

* What do you think are the biggest barriers to use **FAIR data**? Select your top 3
Between 1 and 3 selections
- ☐ Lack of knowledge about the benefits of FAIR data.
- ☐ Lack of awareness of which data sets are FAIR (e.g. missing label or identifier).
- ☐ Lack of guidelines how to use FAIR data.
- ☐ Missing technical solutions (e.g. missing tools to read data).
- ☐ Concerns about licensing.
- ☐ FAIR data is not necessarily open.
- ☐ I don't know

Any other barriers to use FAIR data? *(optional)*

[   ]

* What do you think are the biggest barriers to use **open data**? Select your top 3
Between 1 and 3 selections
- ☐ Legal concerns regarding licensing (e.g. ownership & copyrights are unclear).
- ☐ Concerns on metadata (e.g. uncomplete, too complex).
- ☐ Missing support (e.g. lack of contact person for questions).
- ☐ Missing technical solutions (e.g. lack of tools to process data).
- ☐ Lack of continuity (e.g. no guaranteed continuation).
- ☐ Lack of standards (e.g. unknown quality).
- ☐ I don't know

Any other barriers to use open data? *(optional)*

[   ]

Thank you very much for taking the time to complete this survey!

Become part of our network and we will inform you regularly about the Open-Earth-Monitor project. Subscribe here or scan the QR code below to signup for our quarterly newsletter.

Would you like to actively contribute to a European fair and open infrastructure? May we contact you again and interview you about your specific requirements?

If you are a producer / provider of geospatial data:

* What type of geospatial data do you produce / provide?
- ☐ Open Satellite-based remote sensing data & derived products
- ☐ Commercial Satellite-based remote sensing data & derived products
- ☐ Other remote sensing data & derived products (e.g. from airborne, UAVs, terrestrial laser scanner)
- ☐ In-situ data
- ☐ Citizen science data
- ☐ Data from IoT / smart sensors
- ☐ Other environmental data / information
- ☐ Other geospatial data sets

* At what level of scale do you primarily produce / provide geospatial data?
- ☐ Global
- ☐ Continent
- ☐ Country
- ☐ Federal state / region
- ☐ Local
- ☐ Other

From your point of view: what are important features of geospatial data for the users?

	Not important	Slightly important	Important	Very important	Extremely important	No opinion
• Data is easy to find online.	○	○	○	○	○	○
• Data has a clear and accessible license.	○	○	○	○	○	○
• Data can be retrieved via domain-relevant community standards.	○	○	○	○	○	○
• Data can be retrieved via open protocols.	○	○	○	○	○	○
• Data is rich with understandable metadata.	○	○	○	○	○	○
• Data is interoperable with other data sets.	○	○	○	○	○	○
• Data can be easily integrated in existing workflows.	○	○	○	○	○	○
• Source of data is well transparent and documented.	○	○	○	○	○	○
• Data can be reproduced.	○	○	○	○	○	○
• Data is open.	○	○	○	○	○	○

Other features are extremely important to the users? (optional)

From your point of view: how problematic do users find the following features of geospatial data?

	Not problematic	Slightly problematic	Problematic	Very problematic	Extremely problematic	No opinion
• Data are not open.	○	○	○	○	○	○
• Data have poor / incomplete metadata.	○	○	○	○	○	○
• Data are not available in the right formats.	○	○	○	○	○	○
• Data need to be ordered.	○	○	○	○	○	○
• Data access requires identification / registration	○	○	○	○	○	○

Other features that are very or extremely problematic to users? (optional)

* How can users find the geospatial data you produce / provide?

- ☐ On a website
- ☐ Through geospatial catalogs (e.g. geoportal)
- ☐ Through open repositories (e.g. zenodo)
- ☐ Through data hubs (e.g. Copernicus Open Access Hub, Sentinel Hub)
- ☐ Through commercial data provider
- ☐ Other

FAIR data (producers / providers)

The FAIR principles intend to improve the **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets.

Please find more information here: www.go-fair.org/fair-principles/

* How familiar are you with the FAIR data principles?

- ○ Not familiar
- ○ Slightly familiar
- ○ Familiar
- ○ Very
- ○ Extremely familiar

How important are the following FAIR principles to you?

	Not important	Slightly important	Important	Very important	Extremely important	No opinion
• Data must be easy and quick to find	○	○	○	○	○	○
• Data must be easily accessible	○	○	○	○	○	○
• Data must be easily integrated into existing applications	○	○	○	○	○	○
• Data must be interoperable with other data	○	○	○	○	○	○
• Data must be reproducible	○	○	○	○	○	○
• Dat must be reusable	○	○	○	○	○	○

* Are you providing FAIR data?

- ○ Yes
- ○ No
- ○ Partially
- ○ I don't know

* From your point of view, is there a difference between FAIR data and open data?

- ○ Yes, FAIR data is not necessarily open
- ○ No, FAIR data is always open
- ○ I don't know

* What do you think are the biggest barriers to produce more FAIR data? Select your top 3!
Between 1 and 3 selections

- ☐ Competitive disadvantage (e.g. missing business opportunities)
- ☐ Lack of resources (e.g. personnel, time)
- ☐ Missing incentives (e.g. uncertain benefit, lack of recognition)
- ☐ Missing technical solutions (e.g. missing tools)
- ☐ Restrictive policies (e.g. restrict data sharing guidelines)
- ☐ Lack of guidelines (e.g. guidelines are missing, incomplete or unclear)
- ☐ Disagreement on data use (e.g. potential misuse)
- ☐ I don't know

Any other barrier(s) to produce more FAIR data? (optional)

[ ]

* What do you think are the biggest barriers to produce more open data? Select your top 3!
Between 1 and 3 selections

- ☐ Economic disadvantage (e.g. costs to produce data are not covered)
- ☐ Competitive disadvantage (e.g. missing business opportunities)
- ☐ Disagreement on data use (e.g. use case is against ethical and moral principles of producer)
- ☐ Legal concerns regarding licensing (e.g. disagreement on ownership & copyrights)
- ☐ Legal concerns regarding privacy protection (e.g. potential violation of personal rights)
- ☐ Concerns regarding sensible data (e.g. potential misuse)
- ☐ Restrictive policies (e.g. e.g. restrict data sharing guidelines)
- ☐ Missing infrastructure (e.g. large data traffic overloads system)
- ☐ I don't know

Any other barrier(s) to produce more open data? (optional)

[ ]

Thank you very much for taking the time to complete this survey!

Become part of our network and we will inform you regularly about the Open-Earth-Monitor project. Subscribe here or scan the QR code below to signup for our quarterly newsletter.

Would you like to actively contribute to a European fair and open infrastructure? May we contact you again and interview you about your specific requirements?

Then don't hesitate to contacts us by email: open-earth-monitor@gfz-potsdam.de