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Scoping Study for a

Pan-European Geological Data Infrastructure

D 1.3

Implementation Plan for the European Geological Data Infrastructure (EGDI)

Geological information for Europe:
Towards a pan-European Geological Data Infrastructure

SEVENTH FRAMEWORK PROGRAMME

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Contents

I. Introduction

This implementation plan is the final report of EGDI-Scope, a scoping Study for a pan-European Geological Data Infrastructure (EGDI) that has been executed as coordination and support action under the EU FP7 Research Program. It summarizes and integrates the main results, conclusions and recommendations of the individual work package project and research reports, thus providing the main background and guidelines towards the implementation of the EGDI. The content will be used as a work plan for the next stages of the development of the EGDI.

1 Executive Summary

1.1 The subsurface and geological survey organisations

The subsurface is important. It provides us with *energy, water* and *minerals*; resources of which are indispensable assets that need to be managed carefully. And we usually forget that we live on top of it – the subsurface is part of our *living environment.* Its properties and processes determine ground *stability, arability*, the extent to which mining activities may have side *effects* such as subsidence and induced earthquakes, and how and in what way soils and groundwater are vulnerable to *human impact*. And we use the subsurface for *storage* or disposal: of thermal energy, natural gas, CO_2 and a variety of wastes. It goes without saying that our subsurface needs to be *terra cognita*.

At national and regional levels in EU-member states the geological survey organisations (GSO's) are crucial for the long-term (public) management and development of substantial geological data and knowledge repositories, and to provide this information for societal use, for public as well as private purposes. Every survey operates a repository of geological data and information, tailored to the societal challenges and peculiarities of their home country.

1.2 European societal challenges and geological information

Like individual countries and regions, also Europe as a whole is facing major challenges towards the further development of European society. For the European Horizon 2020 Research Programme the major concerns and policy priorities are reflected by the following societal challenges:

- Health, demographic change and wellbeing;
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy;
- Secure, clean and efficient energy;
- Smart, green and integrated transport;
- Climate action, environment, resource efficiency and raw materials;
- Europe in a changing world - inclusive, innovative and reflective societies;
- Secure societies - protecting freedom and security of Europe and its citizens.

In many of these domains the use of **geological knowledge and information** is crucial to enable stakeholders from policy, research and industry to contribute to sustainable solutions. At European level this concerns for example the Raw Materials Initiative, the Strategic Energy Technology Plan (SET Plan), the Soil thematic strategy, the Water Framework Directive and INSPIRE. In the marine domain it concerns coastal and off-shore topics covered by the Horizon 2020 focus area 'Blue Growth', including for example marine environment, deep sea resources and coastal development.

1.3 Towards a European Geological Service

At European level, the surveys collaborate in many cross-border and EU-projects to develop interoperable, harmonized geoscientific information in multiple domains, based on their national knowledge and databases. Working towards the European societal challenges, representatives involved with EU policy are calling for better and more sustainable access to geological information at EU-level.

To support this, the geological surveys of Europe have joined forces to prepare for a European Geological Data Infrastructure (EGDI), under the framework of this EU-funded EGDI-Scope study. This is an important pillar under their joint strategy towards the development of a **European Geological Service** ()

The research topics in which the GSO's are involved – through participation in European projects – can be clearly related to the Horizon 2020 societal challenges, as shown in table 1.1. The table shows that 'Spatial Information' (in this case referring to geological information) is clearly a cross-topic issue, and has a generic relevance for all societal challenges. This illustrates the need of a European geological database as a basis for providing geological services at European level (for all mentioned research topics).

Proposed research topics	Health, demographic change and wellbeing	Food, Agriculture, Marine research, Bio-economy	Secure, clean and efficient energy	Smart, green and integrated transport	Climate, Environment, Resource efficiency, Raw materials	Inclusive, innovative and reflective societies	Secure Societies
Mineral Resources		X	X	X	X	X	X
Geo-Energy			X		X	X	X
Marine Geology		X	X	X	X		
Geohazards	X		X		X		X
Geochemistry	X	X			X		
Water resources	X	X			X		
Superficial Deposits	X	X		X	X		X
Spatial Information	Harmonised and interoperable datasets and information services						
International Cooperation and Development	Engage and collaborate with the international geological community						
Subsurface modelling	Systematic characterization to support sustainable management and use of subsurface space						

Table 1.1 Relevance of research topics of geological survey organisations for European societal challenges

1.4 EGDI-'Scope': Europe-wide access to valuable geological information

The EGDI will cover pan-European, interoperable, thematic geological data and information related to e.g. geohazards, mineral resources, groundwater, energy resources and soil quality. To describe its scope, different characteristics and 'levels' of geological data and information are relevant. These levels cover:

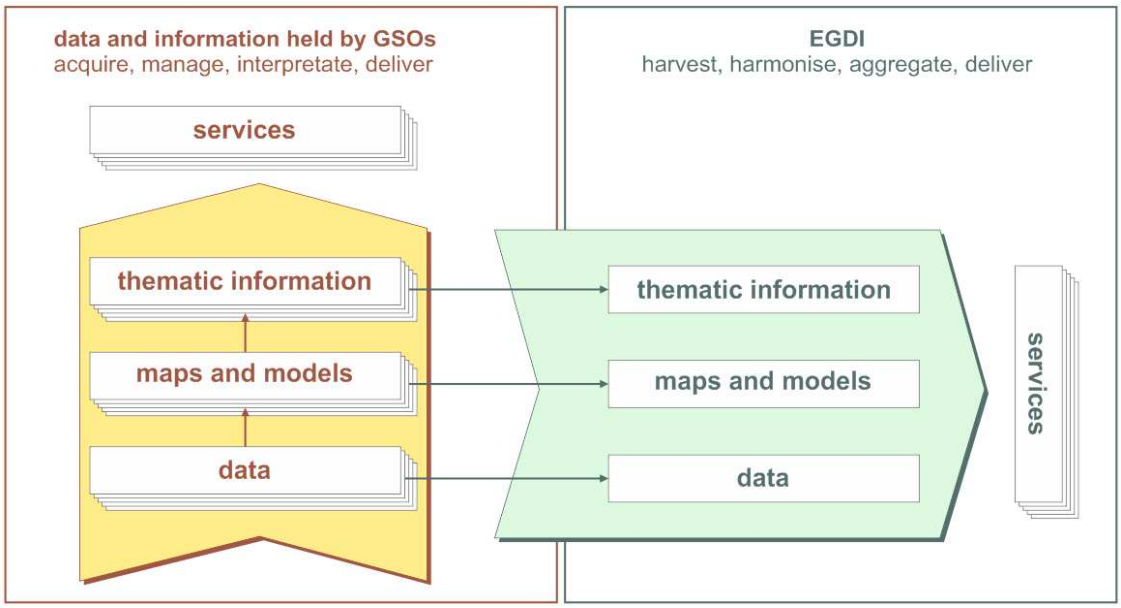
(1) baseline data, e.g. boreholes, lithology properties, monitoring of groundwater quality and quantity, seismic data, earth observation. It can also contain a variety of technical reports, exploration permit documentation, et cetera. (2) interpreted baseline data creating (digital) geological maps and models, which in their turn are used as a semi-product to create:

(3) thematic information products – in many cases developed with the collaboration of stakeholders and users from public and private organisations, applying specific queries and calculations that can be combined with their own data. It is envisaged that this information can directly provide services that help answer a variety of societal challenges. Examples of this may be ground stability hazard maps, metallogenic maps or a shale gas potential map.

The quality of geological services at a European level will depend on the long-term availability, updates and development of these 3 information levels. There are currently a number of EU-projects and programs that can be correlated to each of these levels such as:

1. *Baseline Data: eEarth, Geo-Seas, MINERALS4EU, EuroGeoSource, INSPIRE, …*
2. *(Geological) maps and models: OneGeology, EMODnet, …*
3. *Thematic Information: PanGeo, MINERALS4EU, EuroGeoSource, …*

This 'information chain' works out very differently for every country, and for every thematic domain, due to different methodologies and standards, legal, economic and institutional frameworks, historical settings and so on. The EGDI will be the 'node', where relevant data and information from national repositories will be assembled and made accessible at a central (European) level. This 'assembling' (harvest, harmonise, aggregate) and delivering is covered by continuous EU-projects in different domains, and the EGDI will provide the e-infrastructure to secure sustainable access and management of the most relevant results. Figure 1.1 shows a schematic representation.



On a national level, geological surveys store, manage and harmonise baseline data, which forms the basis for deriving generic geological maps and models, and, from these as well as additional data and information, for deriving thematic / added value information products. Data, maps and models are provided to national users through/as services.

The EGDI will provide the infrastructure (and guidance) to deliver aggregated information products (whether based in raw data, generic maps and models or thematic/ added value information products) to EU level users. Since aggregated products are often based on national products, the necessary chain from raw data to generic maps to added value products does in most cases not exist on EU level; it is possible to derive EU level added value information products directly from national products, without having to harmonise on the baseline data level first. In fact, because of the long data legacies of geological surveys, harmonisation at EU-level may become more difficult "downward" in this chain.

Figure 1.1 Schematic representation of the scope of EGDI

1.5 EGDI Roadmap

The complex character and substantial efforts needed to design and build the technical infrastructure, to establish suitable governance structures, to make arrangements between providers and with external stakeholders, to develop guidance and procedures, to implement legal frameworks, and to implement prioritised 'products' (data, added value information and tools) requires a phased approach covering a considerable period of time. Therefore the development of the EGDI should be viewed as a *program* rather than a *project*. The EGDI is designed to grow. The EGDI-program starts with the EGDI-Scope study, a 'mature' EGDI is at the horizon.

Based on the inventories, analyses and communications with providers and stakeholders from the EGDI-Scope study, a roadmap has been developed for the EGDI (-program). The roadmap (see figure 1.2) consists of the following main elements:

Phases:

1. *'Collate'*: this phase covers the *short term*, starting soon after the end of the EGDI-Scope study, and ending when substantial funding from EU-projects becomes available to cover the activities for further development of the EGDI. The estimated period for this phase is from mid-2014 until end-2015. The involved partners and stakeholders will make use of relevant project results and technology, the current governance framework of EuroGeosurveys and other relevant components that are useful to further prepare for the implementation of the EGDI. This phase will be covered by the so-called 'EGDI-Scope follow-up project' (see chapter 6), that will include co-ordination of infrastructure developments in relevant projects (e.g. Minerals4EU), further preparation of the operational and decisive structure, technical and legal topics, continued stakeholder involvement and acting on funding opportunities.
2. *'Implement'*: this phase covers the *medium term*. Driven forward by EC funding, the involved partners will work on the implementation of the EGDI towards a fully established infrastructure. The estimated period for this phase is from start-2016 until end-2018.
3. *'Scale up'*: this phase covers the *long term*, after 2018. The EGDI Infrastructure is sustainably maintained and fulfilling its role as information base for providing European Geological Service. The (adaptive) infrastructure will grow in terms of thematic and geographical coverage and scale in connection with stakeholders requirements.

Main components:

1. *'Products'*: This refers to the envisaged 'content' of the EGDI: initially, in most cases, results from EU-projects (datasets, web services, added value tools, etc.) will be incorporated. Requirements and prioritisations regarding products in different phases are described in sections 1.6 and chapter 2.
2. *'Governance'*: This refers to such aspects as organizational structures, business models, funding models, ownership aspects and membership. The envisaged development of the governance structure is described in sections 1.8 and chapter 5.
3. *'Technology'*: This refers to the requirements and options for technical design, deployment and maintenance of the EGDI. Technology development is described in sections 1.7 and chapter 3.

Connected to the components above, a number of guidance principles have been formulated, synthesizing different categories of functional and technical requirements:

- *Development principle*: in the first phases of the program the emphasis is on 'immediate' implementation of (available) data products and 'quick-wins', evolving towards more focus on achieving comprehensiveness in terms of (thematic and geographical) coverage and scale in later phases.
- *Governance principle*: the governance of the EGDI will facilitate continuous dialogue with stakeholders (internal and external) in all phases of the program.
- *Technology principles*: Reliability and performance come at first, the EGDI will comply with accepted and obliged standards (INSPIRE and other) and the infrastructure will be developed according to state-of-the-art technology rather than cutting-edge.

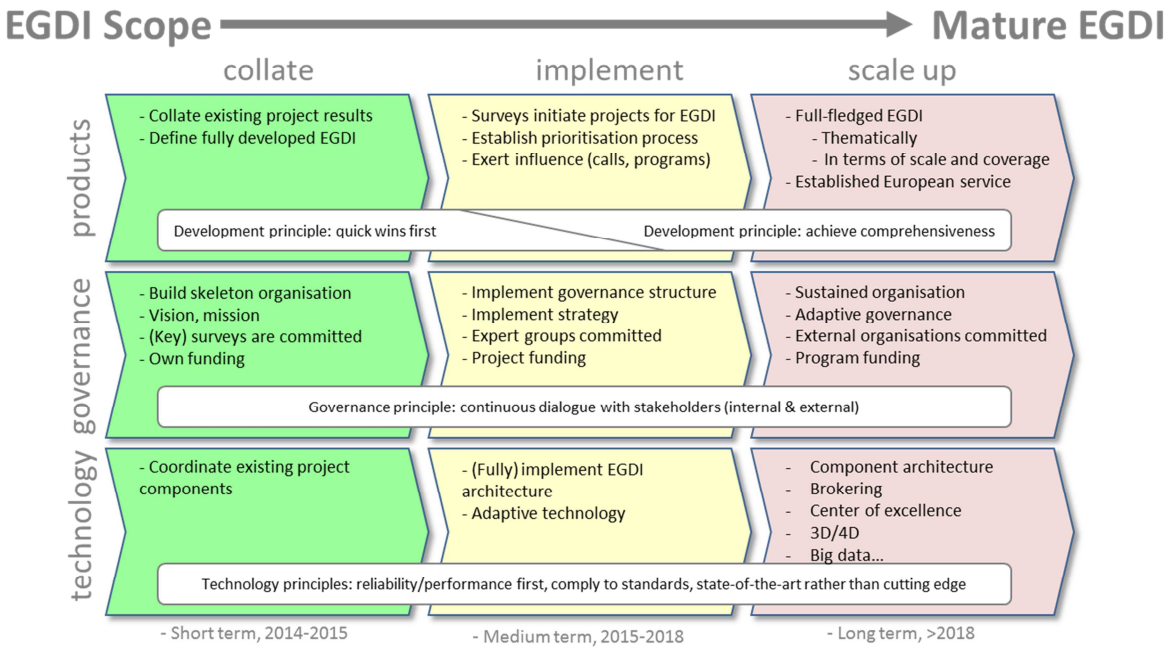


Figure 1.2 Schematic representation Roadmap EGDI

1.6 Prioritisation of EGDI 'products'

From previous sections it is clear that geology is a wide-ranging discipline and a future EGDI will potentially cover a large number of thematic domains to meet the needs of different (end) user categories. The EGDI will be based on data and services supplied by the GSO's of Europe. For specific domains, combinations with data and services from other suppliers can be applied. Intermediate steps in the different phases towards a 'fully-fledged' EGDI in the long term are required to select and prioritise 'products' (web services, etc.) to be implemented. EGDI-Scope applied the following approach:

- *Review of available data and services*. Extensive inventories have been carried out with regard to the availability of relevant data, web services and added value services and tools. This concerns datasets held by the GSO's in connection with their role regarding geological data management at national levels, as well as the results from many past and ongoing EU projects. The reviews also included datasets from some other relevant organisations such as the DG JRC (Joint Research Centre), EEA (European Environment Agency) and ESA (European Space Agency).
- *Consultation and involvement of key stakeholders*. The study has focused on stakeholders from (European) policy, and representatives from relevant European research projects and programs (listed at p.58-59 of this report). These stakeholders, representing both potential users as providers of geological information and services, have participated in a number of workshops to exchange about use cases and requirements for the EGDI. In addition, many bilateral exchanges have been organised. The different stakeholders and user categories are described in section 2.2.
- *Development of use cases*. A use case describes the steps that should be undertaken to fulfil the need of a specific type of (potential) user. The development and selection of relevant use cases is the result of stakeholder consultations and assessment of criteria such as feasibility, data availability and policy priorities, e.g. connected to EU directives and programs (Water Framework Directive, INSPIRE, etc.)
- *Assessment of user requirements* from stakeholders, the project and data reviews and from use cases. These involve functional and technical requirements at different levels. At a high level this concerns for example open and free availability of data, use of common standards and practices and ability to support societal challenges (section 1.3).
- *Sustainability:* A very important objective is to create a sustainable platform for the most relevant results from EU-projects, and to provide the basic and sustainable data infrastructure that enables the provision of a European geological service.

This approach led to the following selection and prioritisation, connected to the phases of the Roadmap:

Phase 1 - Short term ('collate'): Prepare implementation and maintenance of prioritised (existing) datasets, tools and functionalities from the following European projects:
– *OneGeologyEurope*: harmonised 1:1 million geological map data, serving these data for 21 countries through web services in a multilingual portal *(http://www.eurogeosurveys.org/projects/onegeology-europe/)*
– *EMODnet-Geology*: Data on seabed substrate, sea-floor geology, coastal behaviour, geological events and probabilities, and minerals (northern European waters) *(http://www.emodnet.eu/)*
– *EuroGeoSource (under framework Minerals4EU)*: aggregated geographical information on geo-energy (oil, gas, coal etc.) and mineral resources (metallic and non-metallic minerals, industrial minerals and construction materials) *(http://www.eurogeosource.eu/)(http://www.minerals4eu.eu/)*
– *IHME:* International Hydrological Map of Europe *(http://www.bgr.bund.de/EN/Themen/Wasser/Projekte/laufend/Beratung/Ihme1500/ihme1500_projektbeschr_en.html)*
– *PANGEO*: Geohazard information for many of the largest cities in Europe *(http://www.pangeoproject.eu/)*
– *GEMAS*: Geochemical mapping of agricultural and grazing land soil of Europe *(www.eurogeosurveys.org/)*
Phase2 - Medium term ('implement'): Maintenance of phase 1 products, establish selection and prioritisation process (annual work program) and initiate new projects for further development of datasets, tools and functionalities connected to:
– *OneGeologyEurope*: increase towards full, pan-European coverage and smaller scale levels
– *Minerals4EU*: (further) connect to the geological knowledge base on raw materials
– *EMODnet-Geology*: extend towards 1: 250 000 substrate map for all European waters
– Develop new functionalities and methodologies connected to datasets regarding *aggregate resources*
– *Terrafirma, Subcoast and PanGeo*: further development of subsidence data and information and combining datasets of these projects
Phase3 – Long term ('scale up'): Working towards the EGDI as the sustainable and established information basis providing access to all relevant pan-European interoperable, harmonised geological information to support European Geological Service for stakeholders from policy, industry, geological surveys and the general public; extend EGDI thematically and in terms of scale and coverage by means of multiple harmonization (EU-)projects:
– Development of new attributes to OneGeologyEurope, e.g. permeability data
– Include borehole data
– Further development and implementation of web services and tools regarding geohazards (landslides, floods, …), faults, basement maps, natural background levels, land-use
– other extensions of datasets and functionalities to be selected during the process.

Table 1.2 Selection and prioritisation of 'products' (content) for the EGDI

1.7 Technical infrastructure

In addition to functional and data (user) requirements also technical requirements have been derived, based on the exchanges with stakeholders, use cases and technical reviews of relevant EU projects and international programs. At high level these requirements include for example:

1. Follow principles of INSPIRE Directive, GEOSS and best practices;
2. Data remain as close as possible to the provider;
3. Efficient and effective exchange, e.g. re-use of tools;
4. Technical and semantic interoperability;
5. Connectivity to other programs and initiatives (EPOS, GEOSS, SEIS…) and domains (Marine, Water, Risks…)

The EGDI will provide a distributed system relying on national data providers (in most cases survey organisations). The data are delivered to the EGDI system by web services. The INSPIRE Directive already provides data models for some data sets to be delivered by Member States. For parts of the data, the EGDI system will also include a European database where (processed) data can be stored. This (periodically updated) data storage also enables the split between data collection and dissemination of databases as well as the application and re-use of software, tooling and web services at central level. In addition, the central database will facilitate more effective and efficient combination with data and tools from external sources, which increases the functionality of the generated information products.
The user interface to access the data and information will be a central data access portal (the EGDI portal) and a number of thematic portals. The thematic portals will typically be developed by dedicated EU projects, but the EGDI organisation (see section 1.8 about governance) will provide implementation guidelines and cross-domain coordination to ensure proper connection with the underlying data infrastructure and compliance with the identified user requirements. The overall architecture will consist of the following components (see figure 1.3):

- Access tier: containing the web services produced by the geological surveys at the national or regional level,
- Mediation tier: containing the common components that are required to register, view, access and process data,
- Client tier: the “visible” component of the “portal”, and contains the EGDI portal and client applications (including thematic portals, smartphone apps, …). It uses services delivered by the mediation layer or by the access layer.

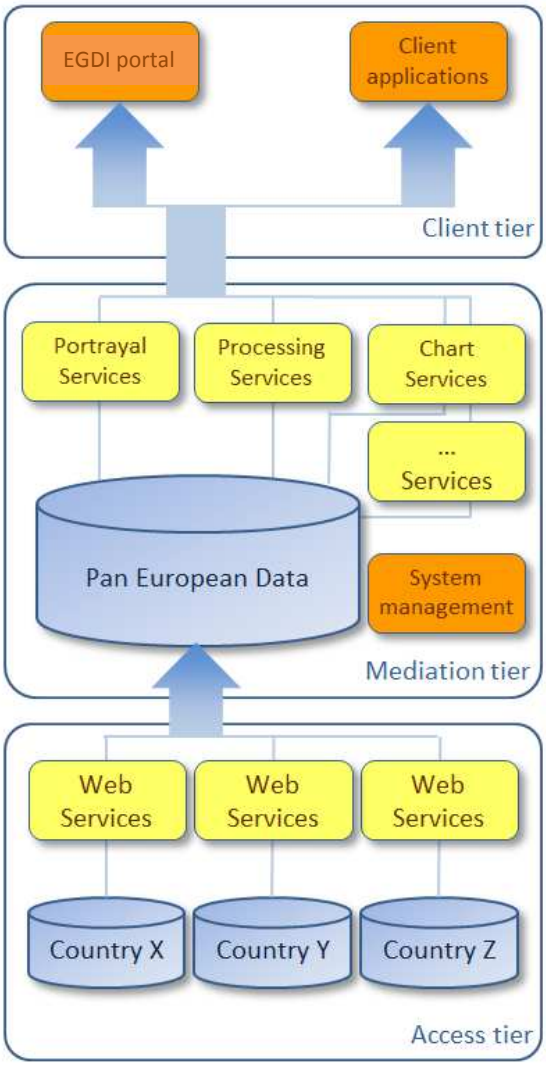


Figure 1.3 Schematic representation of technical infrastructure EGDI

Roadmap regarding technology development:

- Phase 1 will concentrate on co-ordination of infrastructure developments in relevant EU-projects to prepare for the infrastructure development (e.g. Minerals4EU) and maintenance of existing projects (e.g. OneGeologyEurope and its follow-up);
- Phase 2 will work towards the full establishment of the described architecture, using technology that is adaptive to evolving requirements;
- Phase 3 will explore further development opportunities for the infrastructure, such as 3D (and 4D) functionality , further connection and integration with relevant e-infrastructures and databases, and apply big data technology where applicable. The EGDI organisation working on these topics can develop towards a centre of excellence for the GSO's of Europe or even broader communities.

1.8 Governance

The governance of the EGDI has been developed within the broader framework of the governance of EuroGeoSurveys (EGS) and related long term activities such as development towards a European Geological Service and the Minerals4EU geological knowledge base on raw materials. It concerns principles and guidelines for appropriate steering mechanisms, organisational and membership models and funding models to be applied in different phases of the development. A special 'Task Force Governance' was established by EGS to cover these issues, and the EGDI-Scope team has collaborated closely with this Task Force.

For the development of the EGDI it is required that the current governance structure of EGS and collaborating GSO's at EU-level will evolve towards more appropriate structures (see D5.3 'Report on Governance Structure'). General requirements and boundary conditions are described in chapter 5 and summarized below:

1. The implementation and running of the EGDI requires an 'central EGDI facility' that is operational at a central (European) level;
2. Ability for EGDI-entity to participate in projects
3. Need to organise commitments at national levels (GSO's), up to pan-European collaboration;
4. Need to transfer relevant services from EU projects to the EGDI;
5. Need to develop and maintain 'EGDI' guidelines and specifications for EU-projects regarding technology, quality, alignment with other initiatives/ programs, etc.

It is envisaged that the governance structure can grow – along the phases of the EGDI Roadmap and with the current EGS organisational structure as starting point – as follows:

– Phase 1

Following the decision of the Directors of the GSO's (EGS members), the immediate follow-up of the EGDI-scope study will be organised as a project consortium, based on the contributions that have been committed by member surveys at the request of EGS. With this EGDI implementation plan as the leading framework providing the vision and mission, the project plan will be aligned with the proposed activities and guidelines of phase 1 of the EGDI Roadmap. The project will further explore governance, and step by step build a skeleton organisation in anticipation of the next phase. It is envisaged that the governance model for the end of phase 1 could look like the model of figure 1.4, which is called "intermediate", because it could function as a temporary model that will develop between the end of EGDI-Scope and the establishment of EGDI as a legal entity. The model takes the current EGS situation as a starting point, but adds a separate organizational part for EGDI.

One of the main tasks of this structure will be to provide periodic (annual) work plans that will guide the development of the EGDI. These work plans will be approved by representatives from the European geological surveys, in the first instance the EGS General Assembly. The EGDI will maintain close relations to other external organisations at an EU level, such as DG JRC (Joint Research Centre), EEA (European Environment Agency), ESA (European Space Agency) and other DG's, as well as with other infrastructures, networks, projects and programs, such as GEO, EPOS, CGI and OneGeology.

Further explanations are given in chapter 5.

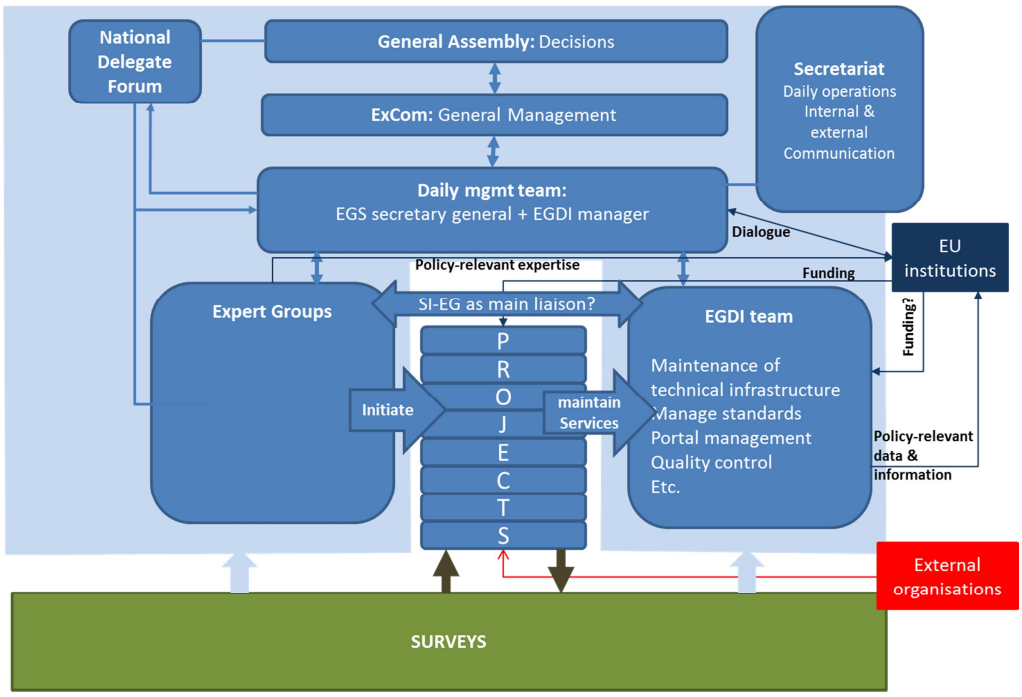


Figure 1.4 Organisational structure of the "Intermediate" model (end of phase 1)

– Phase 2

If more substantial (project) funding is successfully awarded, a more established governance structure can be anticipated. In this phase preparation should focus on establishing a separate legal entity for the EGDI. More regulated relationships between EGDI and the EGS expert groups could be part of this, especially regarding the Spatial Information Expert Group (SI-EG). It is envisaged that the governance model at the end of phase 2 could look like the model of figure 1.5.

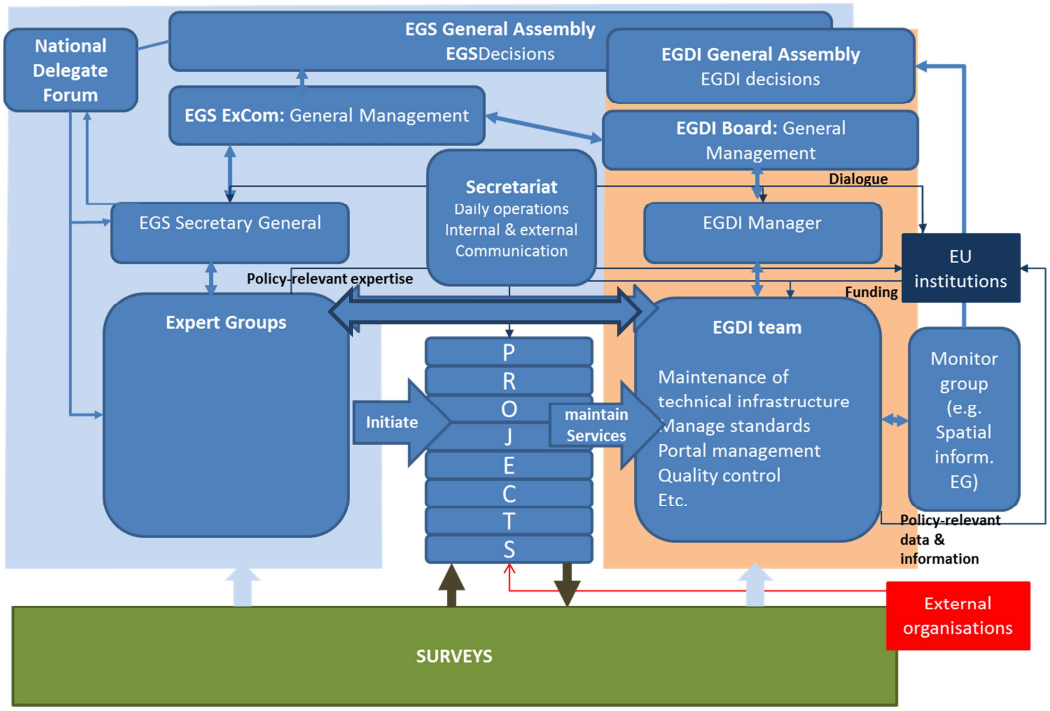


Figure 1.5 Organisational structure of the separate legal entity model (end of phase 2)

– Phase 3

Following the implementation of a functioning EGDI organisational structure and data content, it will be important to ensure the sustained governance structure for the longer term. This will become dependent on the availability of external programme funding, for which external organisations (at EU and national levels) need to be committed. The governance structure will need to be adaptive to such changing conditions.

Regarding the governance for the longer term, EGDI-Scope has explored a number of legal options for 'common entities' or 'permanent infrastructures'. A number of important considerations have been taken into account, such as pursued activities, cost and profit (or non-profit), complexity and membership. The considered options (see section 5.4) are:

1. ERIC (European Research Infrastructure)
2. EEIG (European Economic Interest Grouping)
3. EGTC (European Grouping of Territorial Cooperation)
4. Non-profit organization under Belgian law

1.9 Legal infrastructure: data accessibility

The EGDI will work within a legal and organizational framework that stimulates the open availability of geological data while taking into account the legal requirements and policy choices made on a global, European and national level. The EGDI will operate against a background of an elaborate existing European legal framework (INSPIRE, PSI re-use, etc.) and a wide number of national legislation and initiatives, which are still very much dispersed.

In its first stage, the EGDI will focus on access to open data that are publicly available and free of charge. In subsequent stages it might be required to include also restricted data, or to impose a fee for specific services offered. In this case, national legislations, which are not harmonized in this field, may work as an effective barrier against delivering EGDI services. EGDI has analyzed a wide number of licensing policies and guidelines, testing how these would interact in an encompassing EGDI dealing with an ever-increasing amount of data and continuously changing services. From this analysis, the EGDI has suggested particular licenses, which would serve the EGDI fully while reducing and eliminating some of the legal barriers under which the EGDI has to operate.

To ensure that the EGDI will be used to its maximum, the EGDI infrastructure also needs to invoke trust both from the providers and users in that they are certain that their rights and interests are being safeguarded, that they can count on the data, services, technology, policies and people that are part of the infrastructure. Although there is no single legal definition of trust, there are still elements creating the legal conditions for this trust to occur that can be found in legal provisions relating to a variety of different topics. The EGDI will ensure trust on 3 levels: trust in the data (e.g. quality), trust in the services (e.g. availability) and trust in the people (e.g. regarding access and use conditions).

2 Use cases and datasets for EGDI

2.1 Thematic domains and use cases

Geology is a wide-ranging discipline and a future EGDI will potentially cover a large number of thematic domains and numerous use cases representing the needs of different end user categories. Since the EGDI can't possibly cover everything from the outset, an important task of the EGDI-Scope project has been to consider where to start and how to proceed towards the next phases. Two complementary methodologies have been applied to facilitate the development of an implementation road map for a future EGDI;

1. Development of use cases from prioritized thematic areas and assessment of corresponding data requirements.
2. Assessment of data available from past and ongoing European projects, national geological survey organizations (including INSPIRE indicators) and other European institutions.

This section describes the results of these actions and proposes an overall phased plan for the integration of datasets into the EGDI.

2.2 Prioritisation of thematic areas

At the Full Consortium Meeting in Malta 9th September 2013, a break-out group was assigned to consider prioritisation in relation to the first implementation phase of EGDI. The discussions were based on a list of themes/use cases, which had been prepared in advance based on the outcome of the 1st EGDI-Scope stakeholder workshop (Brussels 14th November 2012). The prioritisation action was based on three factors; *political importance, scientific importance* and *short/medium/long-term feasibility* seen in relation to the data analysis conducted by WP3 (see deliverables D3.1 and D3.2). The group was asked to provide a list of five thematic areas that could/should realistically be integrated in the first phase of EGDI having in mind that pan-European coverage has a high priority for the European Union and hence for the EGDI. The list of themes recommended by the group (see below) was subsequently presented and adopted by the full consortium, and the EGDI-Scope consortium has since then mainly been focussing on these, however, not ignoring the fact that the project is dynamic, and that other themes may be added along the way.

Recommendation: The first phase of EGDI should include (but not be limited to) the following thematic areas:

- Geological maps (onshore and offshore)
- Mineral Resources
- Water Resources
- Geohazards
- Soil

2.3 Use Cases

For each prioritised thematic area, one or more use cases were developed by EGDI-Scope-WP2 in close cooperation with key stakeholders. Each use case requires certain datasets and also puts requirements on the coverage, resolution, harmonisation, data formats etc. The requirements were subsequently analysed by WP3 and reconciled against the INSPIRE indicators and the list of data available from National Survey Organisations, other institutions and previous European projects as illustrated in Figure 2.1. From this analysis, it was assessed whether the required data can be delivered in the short-, medium and long-term, and the methodologies that should be applied in order to produce derived datasets.

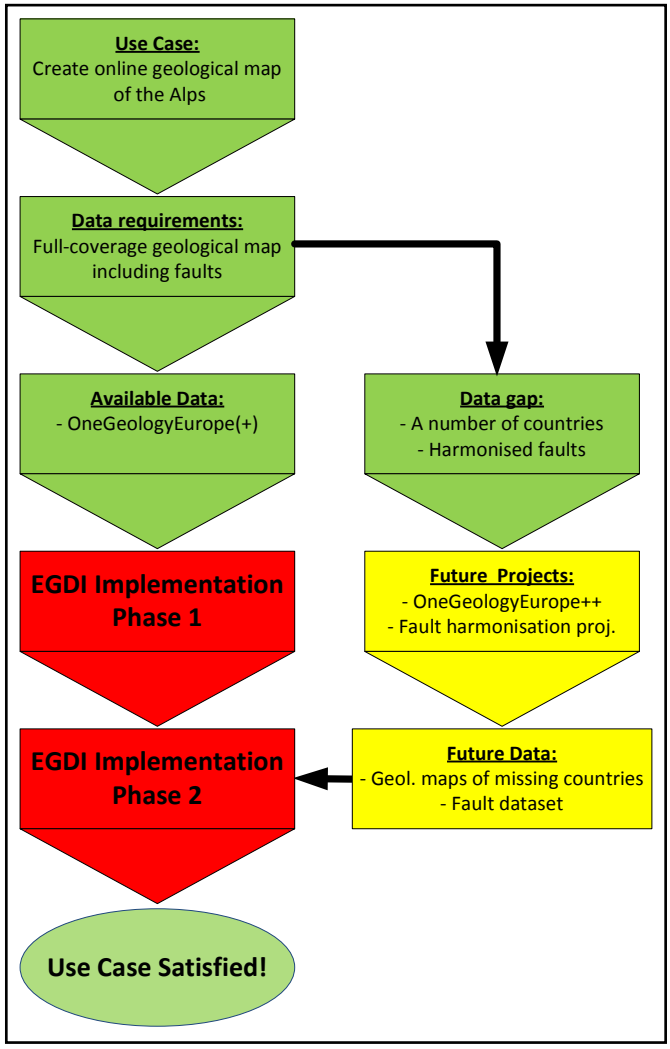


Figure 2.1. *Schematic overview of the applied methodology illustrating the chain from use case requirements to analysis of the data situation leading to integration of existing data in an early stage EGDI and future data in a later stage until the use case is eventually satisfied.*

The specific use cases were selected from a number of criteria. They had to be of high importance, realistic and representative of a wide range of scenarios to shed light on the most important requirements for the EGDI content, interfaces and underlying architecture. Consequently, the use cases have a number of important objectives;

1. To highlight the requirements for data and information.
2. To facilitate development of a roadmap for the implementation of the EGDI in combination with the WP3 analysis of available datasets.
3. To bridge the gap between end users with specific needs and technical considerations of standards, protocols, code lists etc. that are basically the needs of computers and infrastructures sharing data in an interoperable way.
4. To guide the architectural considerations undertaken by WP4.
5. To – through the requirement specification presented in D2.4 – support the development of user interfaces to meet a high degree of usability.

A total of eight specific use cases covering the five prioritised thematic areas were developed. The use cases were presented in D2.4 based on corresponding case studies from D2.3. A short summary of the use cases are given in Appendix A of this report where also the rationale for each of them is assessed. It is important to realise that there in theory are an infinite number of real use cases. The present use cases and their corresponding requirements should be analysed by a future EGDI

implementation project and supplemented with new use cases as needed given the situation at that specific point in time.

Recommendation: A future EGDI implementing team should carefully examine the use cases developed in the EGDI-Scope project. These are summarised in Appendix A of this report and further described in D2.4 with corresponding case studies in D2.3.

More use cases should be developed if needed (e.g. if new thematic domains are included).

2.4 User Categories

It was clear already early in the EGDI-Scope project that a future EGDI has to support various end user groups, who need data and information on different levels;

- *High-level users* such as European policy makers need information to answer questions critical for decision making. This type of products is referred to as "thematic information" (Figure 1.1) and mainly stem from interpretation and compilation of some underlying harmonised data. Examples of this could be mineral statistics or maps showing e.g. the largest gold deposits in Europe.
- *Expert users* are those possessing geological knowledge who will access the EGDI directly in order to find data and information of use in their line of business. An important group of such users are geologists from the geological survey organisations, who for example need to produce "information products" swiftly upon request by the European Commission. Expert users typically require harmonised and interoperable data, maps and models, which should be as detailed and comprehensive as possible and serviced through relatively rich user interfaces allowing searching, filtering, processing and downloading.
- *Virtual users* are not persons, but other e-infrastructures that need to integrate geological data and information from to support end users within their domain. The data needs will typically cover harmonised data, maps and models which should be provided through interfaces complying with international standards (ISO, OGC, CGI etc.) in order to ensure technical interoperability. Examples of virtual users are EPOS and GEOSS.

Recommendation: The EGDI content and interfaces should be flexible enough to honour the needs of high-level users, expert users and virtual users.

2.5 High-level requirements

In addition to developing use cases, WP2 has derived requirements for a future EGDI through consultation of key stakeholders. The result of this was reported in D2.2 and D2.3, and the most important high-level requirements to consider in the implementation plan for the EGDI with regard to data and information are listed below;

- Data should be open and freely available (European Commission)
- Data specification should be in line with the INSPIRE specifications (European Commission (JRC) and data providers (i.e. NGSO representatives))
- Data should be interoperable with data from other communities (European Commission, e.g. Marine Knowledge 2020).
- The European Parliament "…encourages the use of common standards and practices that would facilitate the exchange and exploitation of available geological data…" (Report on an effective raw materials strategy for Europe).
- EGDI should be coordinated with the European Innovative Partnership on Raw Materials (WP 3) (European Commission, DG ENTR)
- Data should support the work towards Europe's societal challenges (European Commission)
- The (re-)usability of data from past projects should be increased (European Commission - REA)
- Data should be maintained on a sustainable platform (European Commission)
- EGDI should complement WISE (Water Information System for Europe) and generation of new datasets to include/link into WISE would be welcome (EEA)

2.6 Selection of relevant datasets for EGDI

WP3 set out to prioritise the datasets that could be delivered in the short-, medium and long-term, and identify the methodologies by which derived datasets could be produced. The broad objectives are to deliver complete geographical coverage and higher resolution baseline geological spatial data in the short term with baseline geophysical and geochemical data where available, to publish pan-European derived datasets in the medium-term, and to progress towards delivery of 3D model data in the longer term.

2.6.1 *Assessment of data held available from past European projects*

WP3 also created an inventory of past European data-producing projects. These pan-European projects have, as would be expected, been primarily funded to produce more specific derived or 'thematic' data, but this is still sporadic in spatial distribution.

An inventory of 80 previous and current European geological projects was compiled as part of WP3 (detailed findings are documented in D3.1). Of these, 27 (34%) are classed as Natural Risk/Geohazard, 11 (14%) are developing data infrastructures, 10 (12%) and 8 (10%) are Economic resources/Energy and Geochemistry respectively. The distribution of these themes suggests some unusual characteristics in how datasets have been developed across Europe to identify 'threats' and/or 'benefits'. Natural risk and geohazards feature strongly in the results, reflecting a pan European desire to mitigate against identifiable susceptibilities (threats). Data infrastructure (benefits) is the second most common theme possibly reflecting the growing awareness of the power of understanding 'location' and spatial relationships and the growing availability/ease of use of spatial informatics. Mineral resource/Energy (benefits) and Environmental chemistry/Geochemistry (threats and benefits) are in third and fourth place. 'Baseline' data themes such as Geology, Soil/Climate and Oceanographic/Marine follow some way behind, but are clearly survey/observational necessities that underpin the other (more directly-impacting datasets).

Completed projects provide a static set of datasets/methods to take forward, it is expected that some issues concerning data/method currency (how up to date it is) may be present and their use may require EGDI resources to resolve. Ongoing projects provide the benefit of potential direct interaction between EGDI and the project teams in order to take the information forward and resolve technical/data issues. Overall, the 80 projects identified so far clearly represent a significant investment in spatial/environmental information across Europe, probably up to a few hundreds of million Euros. The full list of projects can be found in Appendix B.

2.6.2 *Assessment of data held by geological surveys*

A review of the data available within Geological Survey Organisation's (GSO's) across Europe produced an inventory of datasets (details are available in D3.2). The review also included national organisations other than GSO's that might hold national, and on occasion, trans-national data relevant to the EGDI. Once collated, these data were analysed for a range of parameters including availability, format, INSPIRE compliance, topic, theme, scale and scope.

From the analysis, it was clear that INSPIRE data mainly represent baseline scientific data that have a high degree of coverage in-country, available at a range of scales and in a variety of formats. Under the INSPIRE implementation programme, all spatial datasets should be available for download since December 2013 and IR-ISDSS conformance should be developed over the next 5 years with annex II and III being available in 2015.These data would be highly suitable to form the initial baseline input into the EGDI framework and form part of the foundation of the infrastructure. From these data, a range of 'thematic' products could subsequently be derived as required by the use cases.

2.6.3 *Assessment of data held by other organisations*

Non-geological survey organisations were also included in the WP3 review however, engagement proved difficult in the time available. The organisations contacted were:

- European Environment Agency (EEA)
- Joint Research Council (JRC)
- European Space Agency (ESA)

The organisations did provide website links to the readily available information. The external organisations were more actively engaged through the Stakeholder route (WP2) rather than being geological data providers themselves. Here there was positive engagement and an enthusiasm to help direct developments. The major topics highlighted in their currently available datasets include subsidence and landslide hazards and the hydro-environment.

2.7 Principles relating to prioritization of datasets for Implementation

The EGDI project needs to deliver an implementation plan for a stable and sustainable pan-European Geological Data Infrastructure. The Infrastructure is to enable European geological surveys to serve and maintain INSPIRE-compliant, interoperable geological data and information reflecting our understanding of the subsurface. Key to that infrastructure is an understanding of extant data and methodologies that have already delivered value added outputs under public funding. From the scoping work completed to date there are some key conclusions to draw:

- Inspire compliance is a fundamental requirement for data to be useful to future users
- Further clarification may be needed to be provided in scope of INSPIRE data (for which EGDI could play a role, particularly in managing metadata for proxy or analogous datasets from across the INSPIRE annexes)
- Significant Pan-European datasets exist (Offering quick wins for establishing baseline data around which to build the EGDI infrastructure)
- Significant EGS-member data exist (again offering EGDI a fundamental role in coordinating integration of national data into a pan European context, ensuring sustainability)
- Methodologies for Pan-European products exist, but are subject to issues of availability and documentation as project budgets recede (EGDI can act as a host and repository for these methods and products)
- Methodologies and tools for services and data provision (e.g. via cloud-based computing) exist and could potentially be incorporated into the EGDI
- The EGDI infrastructure can provide support for five key areas:
    1. Preservation and clarification of current/recent/past methods
    2. Options for harmonisation of disparate scale/scope data
    3. Options for structured vocabularies to integrate methods/data
    4. Options for cross-research to incorporate geological data with other spatial themes to develop new products relating geo-science impacts with societal, environmental, statutory, commercial and educational agendas
    5. Options for the use of, and further development of appropriate 'tools'.
- EGDI will stimulate cross-topic collaboration encouraging expert groups to engage with public, policy-makers and wider stakeholder communities.

2.8 Sustainability of prioritised project results

A primary objective of the EGDI is to create a framework to sustain results from past, on-going and future European projects (e.g. OneGeology Europe, EuroGeosource, PanGeo, eMODNet, etc.). The data-scoping workpackages have identified the following:

- There is a clear need for preservation (and metadata management/clarification) of current/recent/past Pan European data;
- Significant European datasets exist:
    - Some should be incorporated into EGDI as a priority (see listing below)
    - Some are harmonised and aligned to impact, or strategic agendas (and popular as baseline data)

- Some are variable in scale, scope and context (requiring thought on future completion/inclusion, re-purposing)
- Some are current (offering evolving content and completeness)
- others are legacy/frozen (offering options for re-use, baseline/temporal benchmarking)

- Significant EGS-member data exist
  - EGDI would be an ideal instrument for coordinating trans-national harmonisation
  - EGDI could develop mechanisms of integration to build national data into pan-european datasets
  - EGDI could offer additional support for campaigns to complete, harmonise, re-purpose national datasets
  - EGDI offers an opportunity to host legacy (european-focused) data as a distributed, centralised or cloud concept.

2.9 Roadmap for implementation of datasets and services

The recommended roadmap for implementation of datasets based on the above mentioned principles is illustrated in figure 2.2 and described in more detail in sections 2.9.1, 2.9.2 and 2.9.3. The plan treats the implementation of datasets and services that already reside in existing infrastructures and are available for immediate implementation, datasets and services being developed in recently closed and current projects ("quick wins") and new extensions connected to longer term developments. These categories can be related to the phases defined in section 1.5.

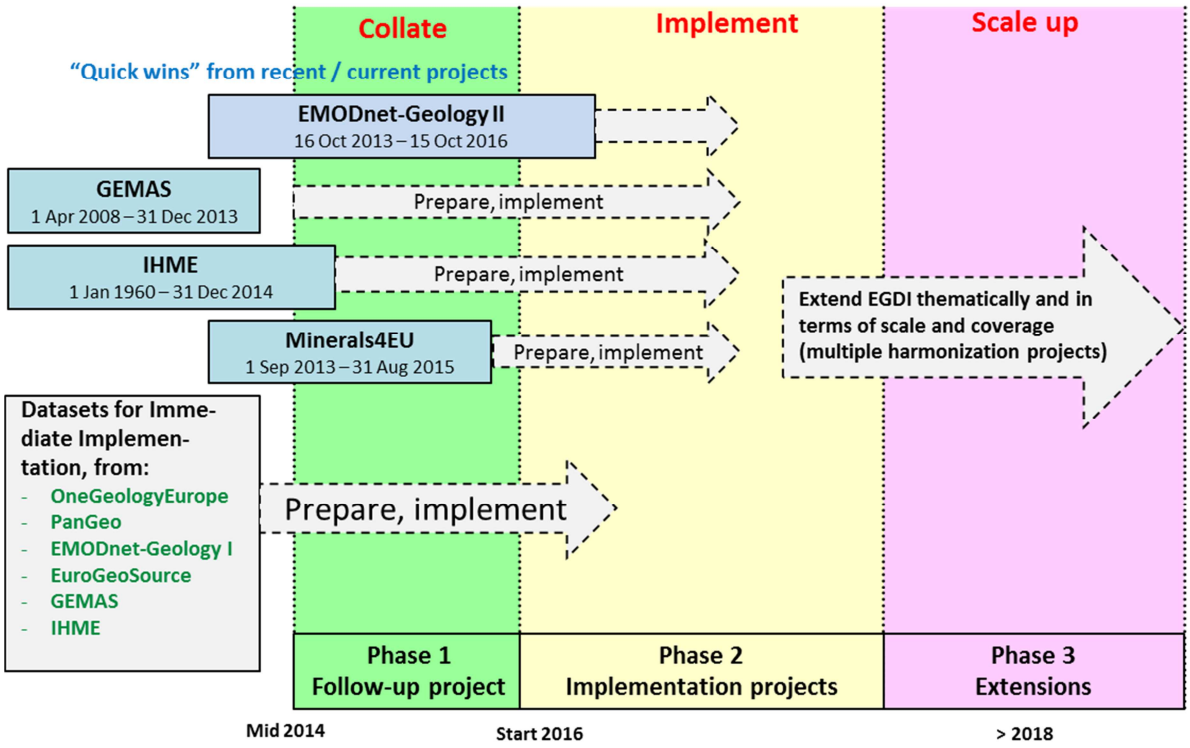


Figure 2.2 –Roadmap for implementation of datasets and services

2.9.1 *Prepare implementation of (existing) datasets (Phase 1*)*

*Finalize implementation in phase 2

The descriptions of the mentioned projects can be found in report D3.1.

Prepare implementation of data	Primary activity if adopted
OneGeologyEurope 1: 1 million surface geology - Part Europe coverage	1. Assess options for completeness* 2. Assess companion datasets for spatial stratification/upscaling 3. Assess options cross referencing with demographic/asset/environment datasets
EMODnet-Geology 1:1 million substrate map - Northern European seas coverage	1. Assess options for completeness* 2. Assess companion datasets for spatial stratification/upscaling 3. Assess options cross referencing with demographic/asset/environment datasets
EuroGeoSource - coordination under framework Minerals4EU	1. Assess options for completeness/integration
International Hydrogeological Map of Europe (IHME 1500)	1. Assess options for completeness* 2. Assess companion datasets for spatial stratification/upscaling 3. Assess options cross referencing with demographic/asset/environment datasets
PanGeo	1. Assess companion datasets for spatial stratification/upscaling * 2. Assess options cross referencing with demographic/asset/environment datasets 3. Assess underlying methods for re-use at different scales
GEMAS distribution maps of chemical compounds	1. Assess options for completeness/integration*

*see also 2.9.2 below for quick win development potentials

2.9.2 *Quick win development potential (Phase 2)*

Quick-win development and implementation
OneGeologyEurope 1: 1 million surface geology Increased coverage to 85-90% coverage
Minerals4EU Connected to the geological knowledge base on raw materials as result of the Minerals4EU project
EMODnet-Geology 1:250 000 substrate map - All European waters
NEW methodologies: **aggregate resources – sand and gravel**
NEW Subsidence data combining information from **Terrafirma, PanGeo** and **SubCoast**
Geogenic geochemical background values (incorporating GEMAS into OneGeologyEurope)
International Hydrogeological Map of Europe (IHME 1500)

2.9.3 *Longer-term recommendations (Phase 3)*

NEW Permeability data attributes added to the OneGeology-Europe base map
Land-use datasets compilations for multi-users
Other hazard data methodologies e.g. landslides, flood.
Borehole data
3D data models, e.g. connected to GeoMol*-project (GeoMol will provide consistent 3-dimensional subsurface information based on coherent evaluation methods and commonly developed criteria and guidelines)
Incorporate harmonised faults and other lineaments into OneGeologyEurope
Increase coverage of pan-European basement map
Offshore data coverage map to display density of data considered for the preparation of the EMODnet substrate map.
Assign Natural Background Levels of pollutants to the major lithological classes of the International Hydrogeological Map of Europe.

*GeoMol: Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources

3 EGDI infrastructure and technical architecture

3.1 Principles and infrastructure requirements

A list of relevant requirements is available in D2.4 (chapter 4), and connected to the EGDI system development in report D4.3.

The EGDI architecture will follow the INSPIRE Directive and other environmental information systems principles and best practices. A service oriented architecture will allow data to remain as close as possible to the provider and be exchanged efficiently and effectively. This distributed system will rely on information supplied by national data providers; mainly EGS members surveys.

It will be organised using the following 3 layers as in other major programmes (Inspire, GEOSS, etc. …):

- Access layer: containing the data services produced by the geological surveys at the national or regional level,
- Mediation layer: containing the common components that are required to register, view, access and process data,
- Client layer: the "visible" component of the "portal", and contains the EGDI portal, thematic portals, or smartphone apps for instance. It uses services delivered by the mediation layer or by the access layer.

Semantic interoperability will be achieved by:

- Documenting each dataset and service using metadata
- Using whenever possible INSPIRE defined data models and extending them when implementation Use Cases require specific information,
- Using common controlled vocabularies: INSPIRE defined ones are a starting point but they don't always cover all needs. A coordinated governance of the content will allow extensions to be properly developed.

Technical interoperability will be enabled using commonly defined and openly documented web service standards. At least the following service categories will be deployed: Discovery service, View service, Download, Spatial data service.

On top of this information backbone, human access interfaces (portals) will then be set up more easily.

Thematic projects (e.g. Minerals4EU) will mostlydeploy their own thematic portal, tailored towards meeting the requirements critical for the relevant end user groups, but utilising the underlying EGDI technical infrastructure.

One single portal - the EGDI Portal - will be the central node of the system. The EGDI Portal will provide simplistic access to all information in the central as well as distributed part of the underlying infrastructure. This includes data generated by thematic projects as well as more generic baseline

data. Its Catalogue, Registry and Viewer will enable the end user to easily identify the piece of information/project output that suits his needs.

Being deployed according to the main principles described above, EGDI must also be connected to other initiatives (GEOSS, EPOS, EU open data portal…) and domains (Marine, Water, Risks…).

3.2 General architecture(-s)

3.2.1 *Infrastructure components*

Most of the requirements identified are supported by the set of high-level components delineated in the picture below. They all fit into a 3 layer architecture. Each component has been described in deliverables D4.2 and D4.3. Some components are or have to be added (e.g: Access control, Quality control).

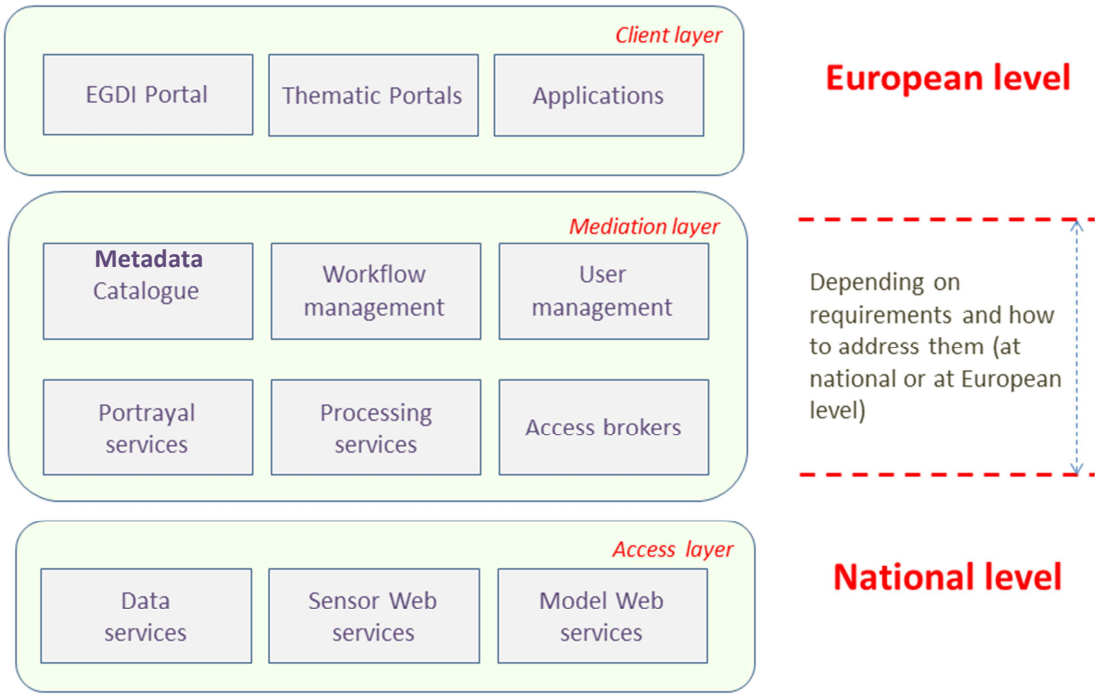


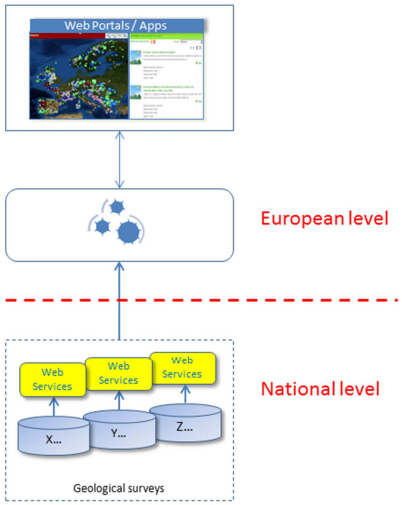
Figure 3.1 – proposed 3 layer infrastructure

Their deployment will be prioritised during implementation of the EGDI.

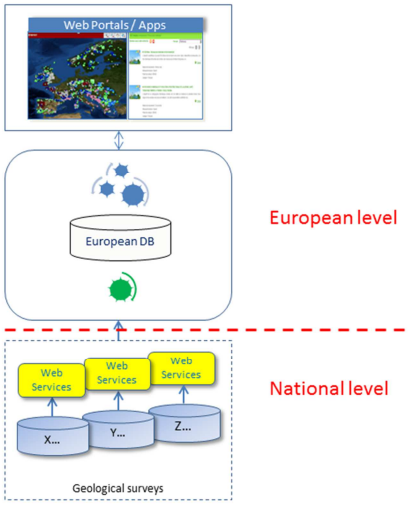
3.2.2 *Possible distributed architectures*

Various distributed architectures could be deployed by EGS thematic projects. It will be up to each project to define the one closer to its needs with overarching guidance from the central EGDI facility.

“No EU database “: 100% service based



“Single EU database“ : easier data validation, good basis for EU products generation (including strong GIS/3D processing)



“EU harvesting and dissemination database”: in-depth QA/QC, better Quality of Services on the distribution side.

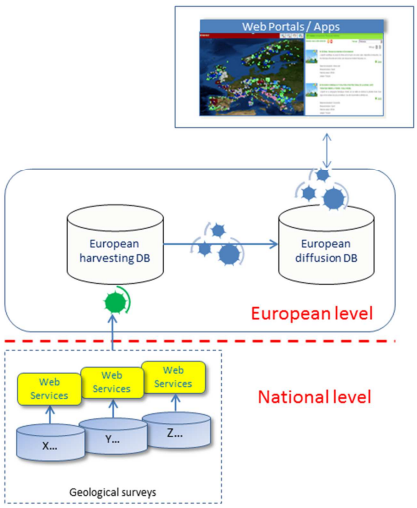


Figure 3.2 - Possible distributed architectures

3.2.3 *Service architecture*

Most of the services identified rely on OGC standards specifications: CSW, WMS, WMS-T, SLD, SE, WFS, WCS, SOS, WPS / WCPS, WFS-G/Open-LS. Open-source or vendor based implementations are most of the time available for those.

Specific work will have to be carried out on 3D models services as no specific standard is endorsed by OGC. However, currently existing initiatives already constitute a good starting point (GeoMol, EarthServer, DeepCity3D …). An inventory of projects and methodologies regarding 3D models has been reported in Deliverable D3.4.

3.2.4 *Thematic portals / front ends*

It is difficult to design one portal for the various thematic domains covered by geosciences in Europe. However, common elements could be picked up in the components, architecture, services, and semantic interoperability aspects.

Primarily, the EGDI Thematic Portals will certainly implement:

- A search function to explore datasets and services, as well as related documentation,
- A map viewer with functionalities that are common to users,
- A multilingual user interface and the possibility to acquire metadata titles, descriptions, or keywords in the selected language where available,
- Specific functions according to the data theme: statistics, subset of data selection / visualisation / download.

The most relevant components and practices will be brought under the 'umbrella' of the EGDI in order to facilitate a maximum reuse.

3.2.5 *Technology support and monitoring*

Not all GSO's have the required IT knowledge available. Moreover depending on the tools shared, the technology requirements may not be the same. One foreseen solution would be to set up the necessary tools in a Cloud-based environment, and thereby remove any tool installation issues at the level of individual providers..

Such a solution will lead to an evolution in the architecture with a two-option scenario, firstly those GSO's willing to deploy the tools in their own infrastructure and secondly, those using the same tools in a Cloud-based infrastructure.

Apart from reflections on cloud technologies, the central EGDI facility will provide a permanent technology watch to ensure that new upcoming technologies are properly evaluated under EGDI. This will, in turn, provide GSO's and European projects with consistent IT feedback on technologies such as heterogeneous data integration, ontologies, data mining, etc. (see figure 3.3).

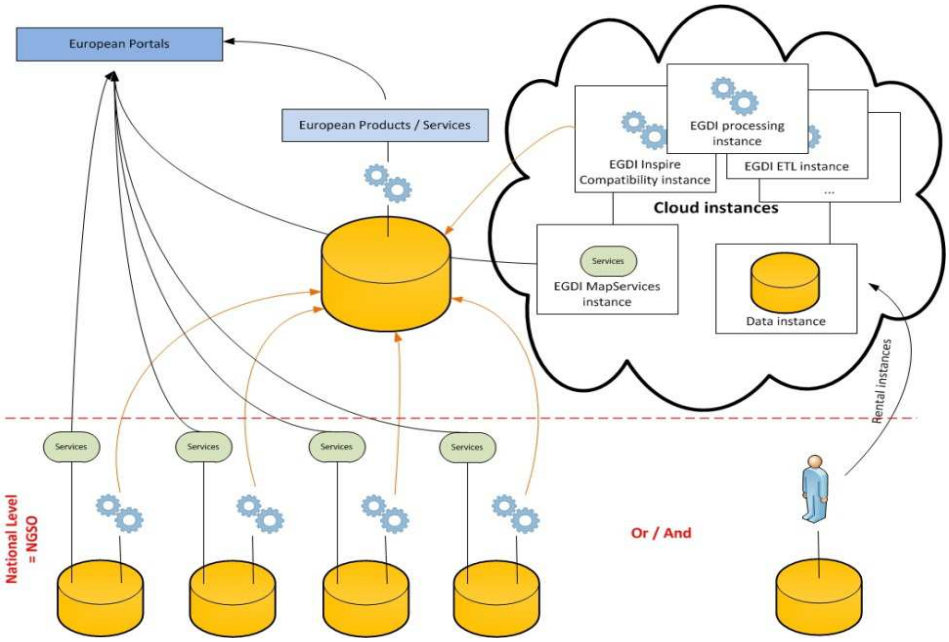


Figure 3.3: Mixed infrastructure including Cloud

3.2.6 *Methodology for new projects*

The central EGDI facility will develop methodologies and guidelines to implement results from new EU-projects.

This will enable new projects to:

1. Check what is already available in EGDI and can be reused by the new project,
2. Provide advice and coordination on semantic / technical interoperability, portal functionalities and reuse of pre-existing tools,
3. Follow EGDI technical rules for improving EGDI Repository with results from the new project.

3.3 Principles regarding development and code sharing

Since the most fundamental rationale for implementing an EGDI is long-term sustainability, the development and maintenance of technical components also need to be sustainable. The best way to achieve this is through the use of open source tools, commonly used programming languages, modular development and with a high degree of documentation. Furthermore, the rights to all of the components developed as part of the EGDI or brought into the system by individual partners (the software, data models, source codes, configuration files, diagrams, cookbooks, documentation, etc.) should be shared between all partners of the EGDI consortium. These principles will ensure that the system will be “portable” and enable various partners to work on different parts of the system – both in the initial implementation phase as well as in future thematic projects, or if future organisational changes to the EGDI consortium cause reassignment of roles.

3.4 Prepare and realize the EGDI infrastructure: phases 1 and 2

3.4.1 *Infrastructure components*

The European community of the geological surveys already knows how to implement an important part of the architecture; most of the identified elements have already been tested and deployed in joint EGS thematic projects.

In order to reach the target infrastructure progressively while working on EGDI Thematic projects, specific objectives of a core set of components has been identified.

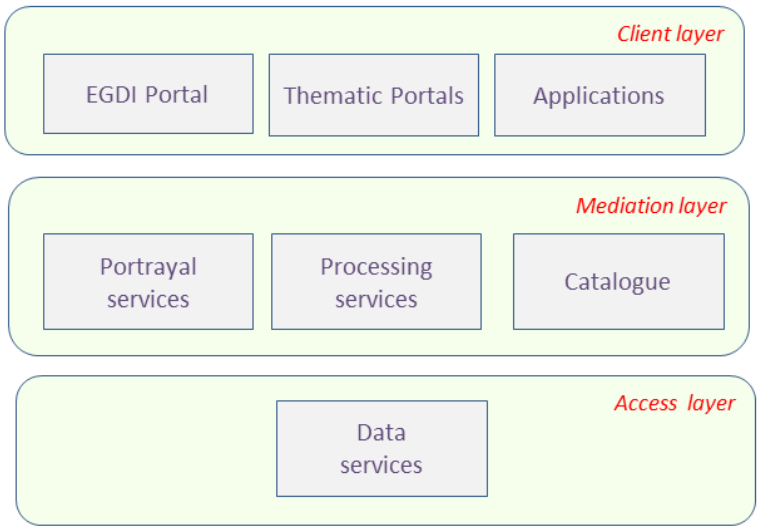


Figure 3.4 - Core set of Components

It is important to have the EGDI Portal catalogue of metadata, registry and viewer up and running quickly to ensure the continued visibility of the EGDI project. This should be coordinated with promoting the rationale to organisations responsible for thematic portals and ensuring proper data exchange between both Thematic portals and EGDI. Data Services deployed can also be prioritised: WMS and WFS being the minimum acceptable.

The architecture can then be developed step by step, adding new components, and new domains. A generic overview of architecture and components in a more developed stage is shown in figure 3.5.

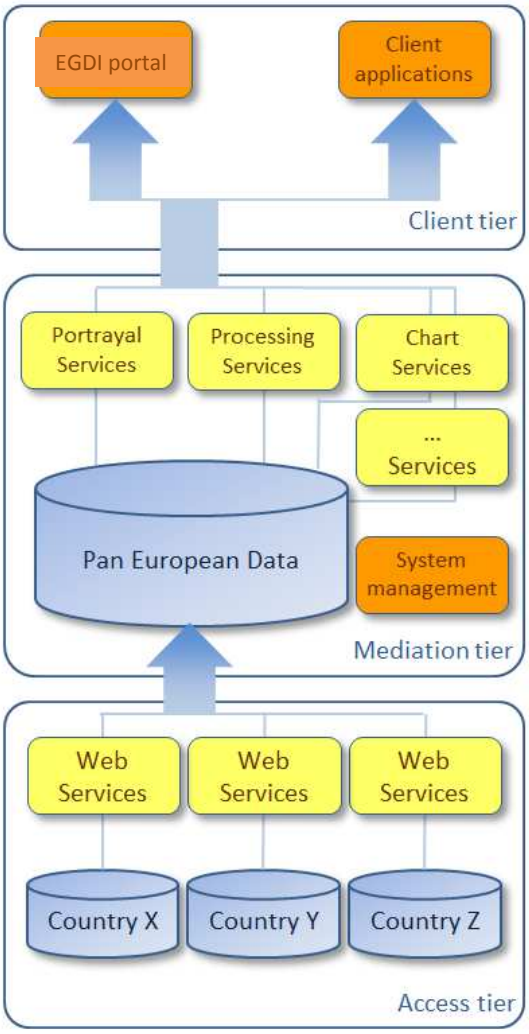


Figure 3.5 – overview developed EGDI architecture and components

3.4.2 *Not only a data infrastructure but an information system*

Over the course of the EGDI-Scope project (and in line with sections 1.3 and 1.4) it has become increasingly clear that in order to provide geological services there is not only the need for a *Data Infrastructure* but in fact for an *Information System*, which is more comprehensive. Essentially, this implementation plan and the including roadmap regarding 'product' development, governance and technology development is describing a program towards such more comprehensive system. Therefore, the EGDI could be viewed as more than a 'data infrastructure' and perhaps needs to be renamed in the next phase.

The Information System content goes beyond a pure Data Infrastructure as it sets up:

- Domain groups: to define domain needs, enhance data structures, define needs for value added data, quality (QA, QC), …
- IT groups: to coordinate best practices, help domain groups to structure their information needs, define data workflow and data update rules, support deployment of new data collection solutions at Member States level, …
- An IT backbone around its central node: architecture, collection/dissemination databases, viewer, portals, web services, …

It will become de-facto the reference geoscience information pipeline towards EU Commission and provide the link with other initiatives:

- INSPIRE: strongly implementing INSPIRE rules (extending when necessary),
- SEIS: becoming SEIS Geoscience information pillar,
- GEOSS: being GEOSS European counter for Geological data,
- EPOS: strengthening the link with research communities.

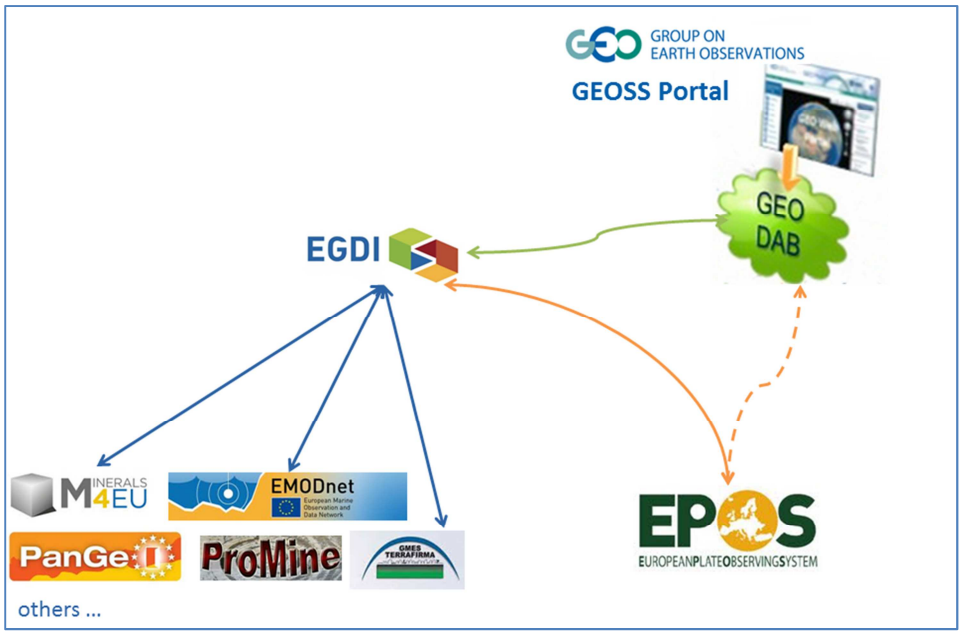


Figure 3.6 - Example of links with other initiatives (e.g. GEOSS and EPOS)

4 Legal infrastructure: data accessibility

4.1 Trust / authentication

At the start of setting up the EGDI and during the deployment of the EGDI, the entities involved will have to make a risk assessment, estimating the potential risks to the trust in the EGDI and setting out possible remedies to mitigate these risks.[1] It should also be kept in mind that these risks evolve – for instance, security mechanisms that were state of the art two years ago may be considered easy to breach now. Therefore, an evaluation is necessary every few years.[2]

Many of the topics addressed in this chapter have an impact on the technical infrastructure of the EGDI. However, as was mentioned a number of times, issues such as security, authentication, data protection or rights management, also have a governance component. The governance model of the EGDI will therefore also play in important role in ensuring trust in the infrastructure and its components, including the different entities involved in the EGDI, their internal organisation and the organisation of their multi- and/or bi-lateral relationships.

In addition, one should not forget the human factors that play a role in trust: systematic attention for the actors in the system or infrastructure from the perspective of their culture and behaviour is just as important as technological security measures or carefully designed trust policies.[3]

In summary, the following points of attention can be given for the inception and implementation of the EGDI.

Trust in the data

1. Metadata: It is recommended that for the non-INSPIRE data sets included in the EGDI, it is examined in how far the metadata requirements of INSPIRE can also be applied. Next, it should be examined in how far the metadata can include information on the quality of the data. Moreover, the metadata should contain information on their appropriateness to fit the users' requirements.
2. Quality information: the data providers in the EGDI should consider whether it would be useful and feasible to design a standard method for the description of quality of the geological data included in the EGDI.
3. Authentic sources: the EGDI data stems from public bodies responsible for the collection of the data: therefore it is recognized by law as authentic data. This type of data has to comply with stringent quality requirements that are different in each Member State. The EGDI data providers should consider how they will deal with the different national authentic sources. If they choose to create pan-European authentic sources, a process should be developed for the creation and recognition of these sources.

[1] [ENISA 2011].
[2] [ENISA 2011].
[3] J. Camp et al. (2001). "Trust: a collision of paradigms", *John F. Kennedy School of Government,Harvard University Faculty Research Working Papers Series*, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=262179 (accessed on 22/05/2013).

4. Security: the EGDI data and service providers should set up a security policy that provides sufficient security, but also maintains as much user-friendliness as possible. Such a security policy includes an assignment of responsibilities, including decisions on the entities responsible for developing and updating the security policy, maintaining logs for operations, serving as a point of contact for security breaches, performing the compliance audits, etc.

Trust in the services

1. Metadata and quality information: It is recommended that for non-INSPIRE services included in the EGDI, it is examined in how far the metadata requirements of INSPIRE can also be applied. Next, it should be examined in how far the metadata can include information on whether the services serve the user's requirements, and which other channels can be used for providing information on the characteristics of the services.
2. Security: The security policy that needs to be developed by the data and service providers in the EGDI needs to pay sufficient attention to services, particularly with regard to access management and guarantees for continuity. In developing this security policy, the role of each party in the EGDI governance structure needs to be clarified.
3. Service level agreements: Service level agreements or terms of service will have to be developed that are feasible for the service providers and that at the same time are sufficient for the users of the EGDI. The EGDI governance structure should consider whether it wants to propose common service levels for all or particular categories of services in the infrastructure.
4. Digital rights management: It should be considered to what extent rights management technology is required and what its exact function should be. Any such technology should be implemented in coordination with the licensing policy that is set up in the EGDI. The GeoRM and GeoREL standards should be used. A support and implementation strategy for implementing GeoRM in the participating organisations should be rolled out.

Trust in the people

1. Identity management system: an appropriate identity management system needs to be set up, that allows for cross-border transactions, and that does not impose too heavy a burden on the users of the system (e.g. often qualified electronic signatures are too 'heavy'). A federated identity management should be considered, and the appropriate software, policies and security for this should be agreed upon. It should be considered whether a third party will be the identity provider, or whether one of the entities in the EGDI will function as the identity provider. Tasks and responsibilities for managing this federated identity management should be allocated in an agreement between all parties in the EGDI that will use the system.
2. Personal data protection: for the processing of personal data from the identity management system, the tasks and responsibilities should be clearly set out and a controller should be assigned. This controller should make sure that
    - It is clearly established which national data protection legislation is applicable;

- A privacy policy is drafted for the EGDI that includes a division of tasks and responsibilities, and organizational and technical measures for the treatment, confidentiality, and security of the personal data. This privacy policy should be disseminated to all partners in the EGDI;
- Consent is obtained in writing from the data subject by using an appropriate standard form for consent;
- The purpose of the processing is legitimate and clearly delineated before the collection of the personal data starts, and the data are not used for any other purpose than the purpose that is communicated to the data subjects. This purpose will be the provision of the data and services, and making sure that only authorised persons get access to these data and services.
- Only the data that are strictly necessary for the purpose can be collected and processed. They have to be destroyed as soon as they are no longer necessary for the purpose.
- The data subjects are appropriately informed about the data processing and about their rights to access, correction and objection.
- The personal data are processed on the territory of a European Member State and not transferred to a country that does not have an adequate level of data protection;
- The competent national Data Protection Authority is notified about the data processing operations.

Moving the EGDI to the cloud

1. Risk assessment: The EGDI governance structure should make a thorough assessment of the advantages and the risks involved, in cooperation with the data and service providers involved in the EGDI. It should compare the services available on the market, and assess in how far they comply with the EGDI's requirements from a technical, organisational and legal perspective.

2. Negotiation: In as far as possible, the EGDI governance structure should negotiate with the cloud service providers so that the requirements of the infrastructure, the data and service providers, and the end users can be met. Points of negotiation could include, among others, exclusion or limitation of liabilities and remedies; service levels, including availability; security and privacy, particularly relating to the Data Protection Directive; lock-in and exit arrangements; providers' ability to change service features unilaterally; intellectual property rights; applicable law and jurisdiction.[4]

[4] [Kuan Hon et al. 2012].

4.2 Regulation and policies

4.2.1 *Overview legislative framework*

The EGDI operates against the background of an elaborate existing legal framework (global, European and national legislation) and builds on many existing projects and initiatives on increasing data accessibility.

First, European legal instruments that were taken into account include the 2007 INSPIRE Directive with regard to sharing spatial data for policy activities regarding the environment, and the 2003 directive on public access to environmental information. Next, the 2003 directive on the re-use of public sector information also plays an important role. Moreover, this 2003 directive has been updated recently by the 2013 directive on PSI re-use. These amendments will have a relative influence on the data policy of the EGDI. For example, the 2013 directive now includes a genuine right to re-use, all documents within scope (i.e. legally public) shall be re-usable for commercial or non-commercial purposes.

Second, these instruments have all been translated in and supplemented by national legislation on the availability of geological and other data (except for the 2013 directive which should be transposed by 2015). In addition, harmonised or open licensing policies were developed and previous research projects have provided valuable input for the development of the EGDI (i.e. OneGeology-Europe and ESDIN for example).

This existing national legislations, which differ greatly from each other and sometimes even prohibit the services EGDI aims to offer, pose a substantial barrier for the good workings of the EGDI. Therefore, EGDI has created a comparative overview of the different regulations and policies in order to test at a basic level how these would interact and create a number of requirements to a license for the EGDI in order to overcome most of these barriers.

Finally, the EGDI will start by focusing on data that is publically available at no charge in a first phase of the implementation. This should eliminate most of the barriers that stem from a lack of regulatory harmonisation. In a second or third phase, the EGDI will also include data that is offered under a number of conditions, i.e. data that is restricted. The EGDI will then also adapt its licensing policy as such, following the recommendations of the legal work package within EGDI-scope, thereby reducing most of the national barriers.

4.2.2 *Overview licensing policies and guidelines*

In Deliverable 5.2: regulation and policies, an overview was given of 15 existing licensing frameworks/licensing guidelines. The overview showed that most of them have many elements in common, at least at the generic level of categories. Most of these licenses are also easily adaptable to the needs of the EGDI scope project. This way a bespoke EGDI license should not necessary and would only reduce interoperability and efficiency.

Generally, there are some requirements for a standard license to be suitable for EGDI-scope:

- The license needs to be streamlined;
- A limited number of options making the license as clear, transparent and usable as possible avoiding any complexities or overflow of information and legal terms;
- Machine-readability;
- The license needs to be cost-effective;
- Suitable for re-use of public sector information thus compliant with all the relevant Directives;
- User friendliness avoiding advanced legal terms and problems;
- Suitable for data with a high amount of conditions and the access to which is not necessarily free of charge;
- Flexibility to tailor the desired license for any type of data/datasets with any type of conditions defined.

In order to satisfy the needs of all the Geological Surveys of the EU, it might be preferable to use two types of licenses, one for the data/ data sets available free of charge for private and commercial purposes, with minimum conditions and a second one for data/ data sets available at a charge and with more restrictive conditions. It is best to choose a minimum amount of standard licenses, and to present them as clear and transparent as possible. More types of licenses would only result in a reduced interoperability, efficiency and transparency.

Licenses that are not suitable for the EGDI-scope project include the Open Data Commons and any public domain license. The former does not grant protection for the individual elements of the protected database while the latter requires a full waiver of all intellectual property rights by the owners of the data.

Other licenses that are less suitable include the INSPIRE Licenses. They are drafted specifically to achieve greater harmonization of the access and licensing policies for spatial data in Europe. However, a disadvantage of these licenses are the fact that they are quite complex, with a high amount of text and legal issues described at an advanced level. This is particularly the case for the basic INSPIRE license. The specific INSPIRE license could be suitable for data with a higher number of conditions and the access to which is not necessarily free of charge. With specific adjustments this license could fit the purpose of EGDI scope.

Other licenses that are partially suitable are the Ordnance Survey License and the Creative Commons licenses. They both could be used to license data and/or datasets for which the number of conditions is limited and where the data is free of charge. As stated before, the Creative Commons licenses are among the most prominent and recognized licenses currently available. They are standardized, automated and this will reduce costs for both granting licenses and obtaining them. Version 4 of the Creative Commons licenses also addresses the sui generis database rights which makes them suitable to license both publications as well as datasets. There are however still a number of issues, described in detail above, that make them less suitable for the needs of the Geological Surveys when it comes to data to be licensed under restrictions or at a charge. The main problem would be a prohibition to re-use for commercial purposes and prohibition of creating derivative products which both would be in conflict with the PSI Directive. The Ordnance Survey

License in this respect, was created specifically for the re-use of public sector information which creates no danger of compliance issues. The Ordnance Survey License thus should fit the requirements of the Geological Surveys for those data/datasets that are available free of charge and that are allowed for private and commercial re-use.

At this point, a license that seems to fulfill most of the above requirements for the datasets available at a charge or with more restrictive conditions concerns the GeoShared license. Although this license has not yet been used very often in practice, it does seem a good fit for the geological datasets of EGDI scope. The license comes with a number of standard conditions, but is easily adaptable to a great number of situations while limiting the options and keeping the license streamlined and very user-friendly, which is key for the EGDI scope platform. This license is moreover suitable for public sector information and to a certain extent tailored to the specific characteristics of geological data.

5 Governance

EGDI Governance is discussed in Deliverable 5.3. This discussion is summarized in Deliverable 5.4, which also gives recommendations on the implementation of EGDI governance. This summary is basically repeated below, in sections 5.2 – 5.5.

5.1 Conceptual Governance framework

The report D5.3 shortly presents the EuroGeoSurveys strategy towards the development of a "European Geological Service", as well as the position of EGDI in this strategy. EGDI is one of the key pillars of this strategy, as it facilitates sharing, harmonisation and dissemination of pan-European, policy relevant geological datasets and information services.

Next, the report presents a conceptual governance framework (see figure below) that identifies three different levels important to spatial data infrastructures: "Data", "Systems" and "Services". At each of these levels, ownership, funding and necessary commitments, and consequently governance, may be different.

The report also discusses the position of EGDI, data-sharing projects (exemplified by the Minerals4EU project) and the European Geological Service with respect to this general framework (see also figure below). It makes clear that EGDI is focused on the system level, and as such can facilitate data sharing projects like Minerals4EU. This is in line with the idea that EGDI implementation should in part be done in the context of such on-going and future projects.

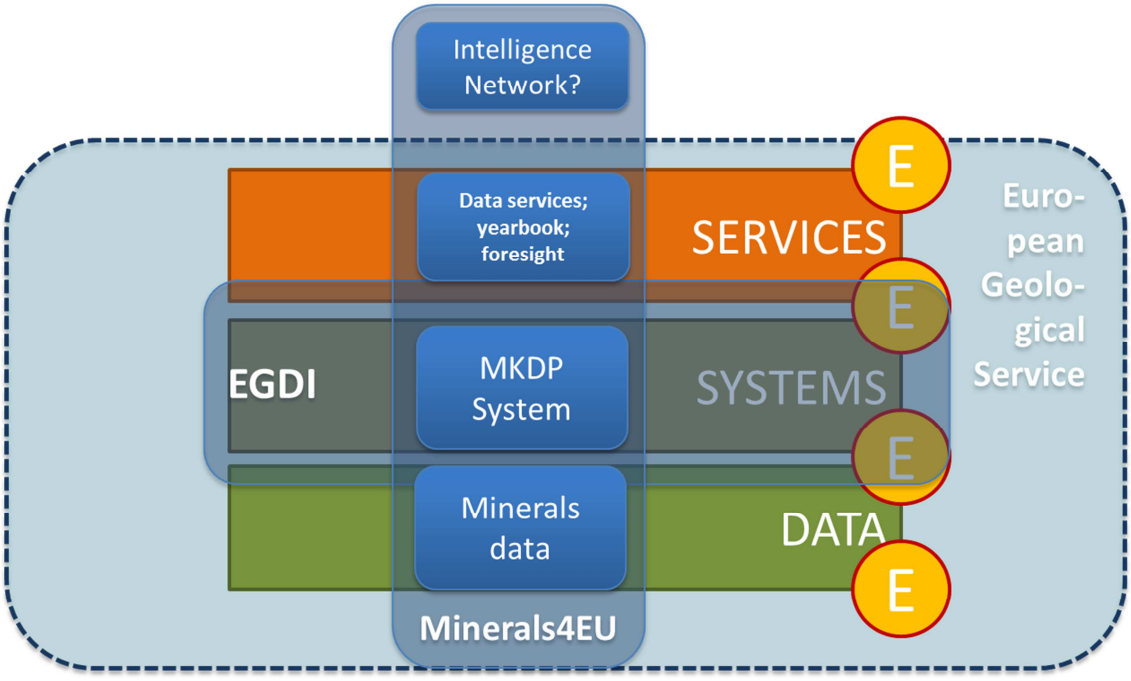


Figure 5.1 - Conceptual governance framework and position of EGDI, the Minerals4EU project and the European Geological Service with respect to this framework.

The relationship with parallel initiatives like INSPIRE, EPOS and GEO are also shortly discussed in the context of their impact on EGDI governance.

Recommendations:

- In implementing EGDI Governance, the wider context of the EGDI strategy towards development of a European Geological Service, as well as parallel initiatives such as INSPIRE, EPOS, etc. needs to be taken into account.
- EGDI Governance should facilitate alignment of its objectives with these other initiatives
- EGDI Governance should address differences in ownership, business models and required commitments at different levels of the conceptual framework.

5.2 Tasks of the central EGDI facility.

In the second part of the report, the tasks of the "central EGDI facility" needed to run the EGDI (at a minimum level, so exclusively relating to basic maintenance of the infrastructure as well as data and information services) are outlined. The section gives also a first estimate of the effort – in terms of manpower - and funding needed to carry out these tasks.

The tasks are grouped into three different categories: "Central-central" (tasks that have to be carried out by the central organisation itself"); "Central-delegated" (tasks that relate to the central EGDI facility, but could be delegated to a single member of the infrastructure); and "distributed" (tasks that need to be carried out locally at *each* member of the infrastructure).

Apart from the *practical* tasks needed to *run* the infrastructure, the report also identifies *legal and organisational* tasks needed to *set up and govern* the infrastructure.

Recommendations:

- EGDI should make a choice whether the tasks identified under "central-delegated" are indeed delegated to one or more individual member organisations.
- If this choice is made, then procedures should be put in place to determine who such tasks are delegated to (e.g. through a tendering procedure, which could be repeated on a regular basis), and under what conditions (e.g. through a system of service level agreements).
- "Distributed" tasks should also be clearly described and procedures for their performance should be indicated (again e.g. through service level agreements)

5.3 Boundary conditions and governance models.

Based on the foregoing sections, the report identifies a number of boundary conditions the EGDI governance structure needs to fulfil.

Subsequently, the report discusses a number of possible organizational models. As the EGDI is developed by the Geological Surveys of Europe in the context of their collaboration within EuroGeoSurveys, this section starts with a scheme of the current organizational model of EuroGeoSurveys (figure 5.2). The other models derive from this current model.

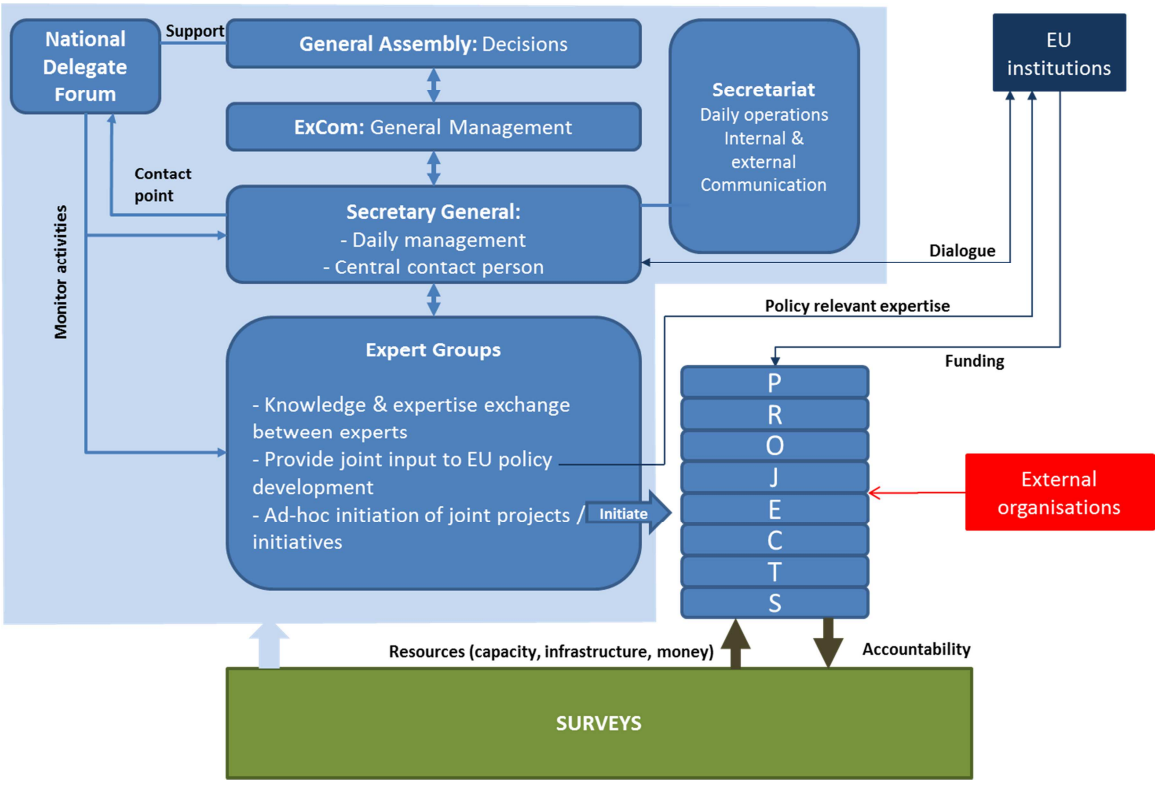


Figure 5.2: current EuroGeoSurveys organizational structure.

The first EGDI governance model is dubbed the "Intermediate model" (figure 5.3), as it could be used as a steering model in the period between the end of the EGDI-Scope project and the full-scale implementation of EGDI.

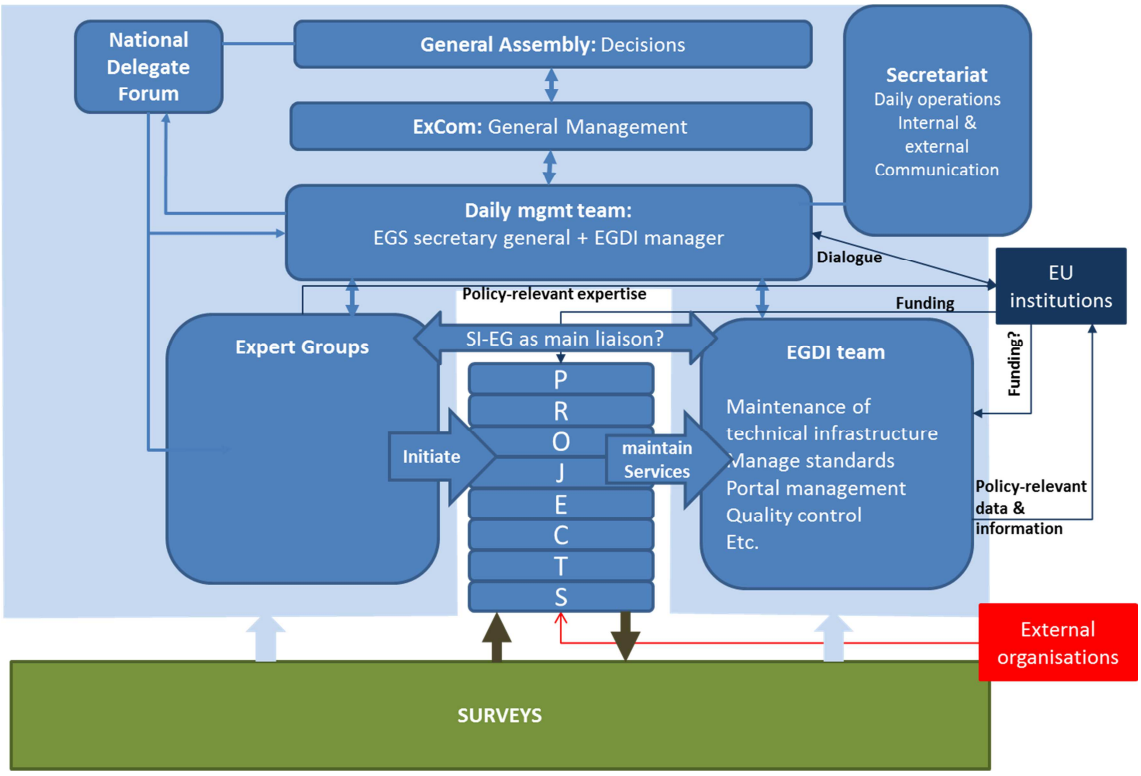


Figure 5.3: organizational structure of the "Intermediate" model

It sets up EGDI organization and governance as part of the current EGS organization, but with a separate mandate and budget compared to the existing EGS organisational elements.

- Decision making (General Assembly) and daily management (ExCom) bodies are made responsible for both EGS operations and operation of the EGDI.
- EGDI is managed by a separate EGDI manager, who:
    - Operates on an equal footing with the EGS Secretary General;
    - With the EGS Secretary General forms a daily management team;
    - Has his/her own tasks, responsibilities, budget, and staff;
    - Is elected and hired similar to the position of secretary general;
- Rules and procedures are put in place to ensure transfer of datasets developed within projects to EGDI, and to ensure commitment of EGS members to maintain datasets;
- The EGS Spatial Information Expert Group is included in this model as a possible liaison between EGDI and other EGS Expert Groups, who initiate many of the projects in which EGDI datasets are developed.

The second EGDI organizational model is dubbed “separate legal entity model” (figure 5.4).

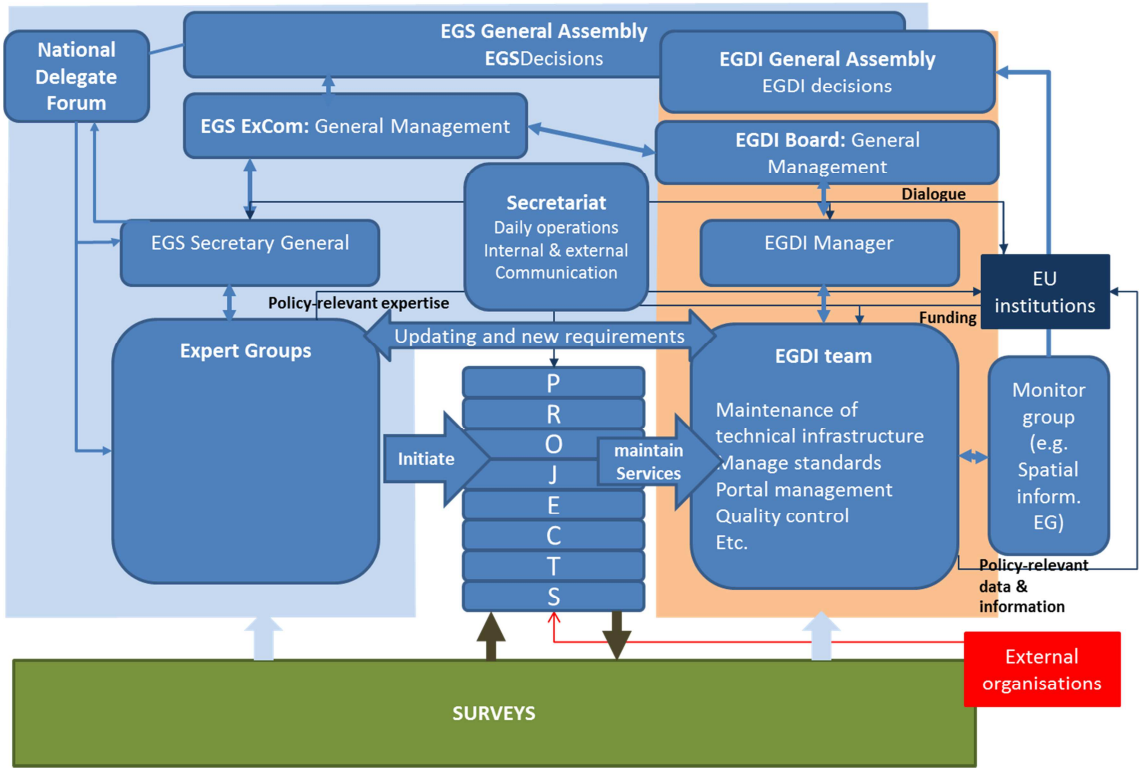


Figure 5.4: Structure of the separate legal entity model

In this model, the EGDI organization is set up as a legal entity separate from the current EGS structure. This model is suitable at a later stage than the “Intermediate” model, when the EGDI is fully implemented and substantial resources have become available. Characteristics of this model are:

- The EGS organisation remains largely as-is;
- The model allows individual organisations to be member of EGS, but not of EGDI, and vice-versa;
- EGDI and EGS have separate decision making bodies (although members of the EGDI General Assembly will likely be a subset of the EGS General assembly, and the EGDI board could be represented on the EGS board as well);
- The link between projects and EGDI is similar as in the intermediate model, but a direct relation between individual expert groups and EGDI is indicated;
- An EGDI "Monitor Group" is included as advisory and support group to the EGDI General Assembly. This role could be fulfilled by the current Spatial Information Expert Group.

Recommendations:

- In order to keep momentum, preparations for setting up the EGDI organizational structure should continue – within the EuroGeoSurveys community after the end of the EGDI-Scope project.
- Elements that should be put in place as quickly as possible include EGDI leadership; policies and procedures on ensuring that datasets produced in ongoing and future projects are transferred to EGDI as soon as it is implemented; policies and procedures on jointly engaging in such future projects.
- Choices should be made on the organisational model (or possibly for different models at different points in time), and drafting of statutes (changes / additions to EGS statutes and/or separate statues for the EGDI organization) should start (possibly in context of the EGS Task Force on Governance).

5.4 Legal bodies or permanent infrastructures for the EGDI

In Chapter 5 of Deliverable 5.3, a number of legal frameworks for the EGDI organization are discussed in detail. These are:

- European Research Infrastructure Consortium (ERIC)
- European Economic Interest Grouping (EEIG)
- European Grouping for Territorial Cooperation (EGTC)
- Non-profit organization (NPO)

The analysis of each model includes a general description of the model; the steps required to set up the organization; items that have to be included in the statutes; the internal structure of the legal framework (including bodies that must at least be present); Liability issues; rules on VAT; and applicable law.

Recommendations:

- A formal evaluation of, and choice for, one (if any) of the described models has not yet been made within the EGDI-scope project, as such a choice should involve all the foreseen members of the EGDI infrastructure at the appropriate decision making level. This should be done as quickly as possible after the end of the EGDI-Scope project, taking all other legal and organisational aspects discussed in Workpackage 5 into account.

5.5 Governance aspects of financial models

The final chapter of Deliverable 5.3 looks at potential sources of funding and resources for the EGDI, and their impact on EGDI governance. Identified sources include:

- In kind capacity from EGDI member organisations
- Cash contributions from EGDI member organisations (e.g. membership fees)
- Budgets from running projects
- Budgets from future projects
- Dedicated EU project or programme funding for EGDI implementation
- Funding from public-public partnership programmes (ERA-NET / Article 185)
- Funding by Industry

In reality, funding and resourcing of EGDI operations will be derived from mixed sources.

Recommendations:

- EGDI should take boundary conditions imposed by (potential) sources of funding and resources into account in the organizational framework.
- In particular, EGDI should look into possible organisational arrangements that would facilitate (direct or indirect) participation of all EGDI members in contractual activities (e.g. EU projects) at minimal administrative burden.

5.6 Connections to parallel programs, organizations, developments

5.6.1 *INSPIRE*

The INSPIRE Framework Directive is an important driver for the development of the EGDI. It provides a legal framework for harmonization of data, as well as data- and technical standards and requirements (see also D5.2, Chapter 2).Under the coordination of the EGS-Spatial Information Expert Group (SI-EG) EGDI can be used to support individual GSO's in their obligation to conform to INSPIRE legislation, to exchange knowledge and experience, etc. Working jointly on the development of the EGDI will enable GSO's to build services on top of INSPIRE and extend its application. EGDI also offers GSO's an opportunity to jointly take leadership for the maintenance and further development of (part of) the INSPIRE themes geology, minerals, energy, natural risk zones, and (ground)water. Such a leadership would require a clear mandate to and commitment of GSO's, and consequently has an impact on governance. Further exchanges on these topics between the SI-EG, DG JRC (see section 5.6.3) and coordinators of the EGDI will be organised in the next phases.

5.6.2 *EPOS*

EGDI aims to become a central, European facility for sharing and making available geological data and derived information services, as held mostly by GSO's – e.g. borehole data, groundwater data, data on mineral and energy resources, etc. EGDI focusses on data and information that is

- Harmonized on a pan-European level
- Aimed at supporting policy and strategy development, e.g. related to mineral and energy resources, subsurface spatial planning etc.

The European Plate Observing System (EPOS) is an integrated solid Earth Sciences research infrastructure approved by the European Strategy Forum on Research Infrastructures (ESFRI), with the main goal to "promote and make possible innovative approaches for a better understanding of the physical processes controlling earthquakes, volcanic eruptions, unrest episodes and tsunamis as well as those driving tectonics and Earth surface dynamics.

Both initiatives have a clearly different focus and goal: although there are overlaps, in most cases they represent different parts of the geoscientific community, different thematic areas and have different roles towards providing geological services at European level. Within the European geoscientific community both initiatives are clearly complementary, not competitive. With regard to the preparation and implementation of data infrastructures there is room for many synergies. EPOS and EGDI will further clarify their collaboration in the next phase of the EGDI development, which is enabled by the fact that many GSO's are involved in both EGDI and EPOS.

In terms of governance, issues that could be addressed include:

- At national level, GSO's could provide repositories for preserving and harmonizing also academic geological data, thus contributing to the success of both EGDI and EPOS;
- EGDI could cover certain specific data domains of EPOS, such as geological repositories. Discussions on this are already in place;
- Special provisions could be made for academic users to allow access of datasets and information services that are not available on EGDI free of charge.

The relations with EPOS will be further clarified in the next phase of the EGDI development.

5.6.3 *Joint Research Centre (JRC)*

The relevance of the activities and responsibilities of the European Directorate-General JRC in relation to EGDI is highly important, with regard to INSPIRE, but also regarding other roles that JRC has in the field of geoscientific data and information systems. The relations with JRC will be more clarified in the next phase of the EGDI development.

5.6.4 *Group on Earth Observations (GEO)*

GEO is a voluntary partnership of governments and international organizations that is coordinating efforts to build a Global Earth Observation System of Systems, or GEOSS. Originally focused on Earth Observation data from space and airborne platforms, GEO has an increasing focus on in-situ data (including geological data) as well. Like INSPIRE, GEO provides another important framework for data and architectural standards. In addition, GEO is a network with a global dimension. EuroGeoSurveys actively contributes to GEO.

5.6.5 *Research Data Alliance (RDA)*

The research data alliance is a fast growing community whose mission is to accelerate international data-driven innovation and discovery by facilitating research data sharing and exchange, use and re-use, standards harmonization, and discoverability. This will be achieved through the development and adoption of infrastructure, policy, practice, standards, and other deliverables.

This community will be important in setting the landscape for an EGDI and is likely to be engaged with at a member survey level.

5.6.6 *EU-projects*

It is foreseen that, after initial implementation, the further development of EGDI (new data services, new technology development) will be driven by individual EU projects. For that process to function properly, governance provisions are needed to:

- Ensure that appropriate project opportunities are identified at an earlier stage, and procedures are in place to jointly engage in such projects;
- Ensure that provision are included, already at the proposal stage of such projects, that projects will conform to technical and data requirements of EGDI, and project results will be made available to EGDI after the project ends;
- Enable the EGDI organization to participate directly in projects, or even coordinate them.

5.7 EGDI Roadmap and governance regarding ongoing initiatives

It is envisaged that the governance structure will develop along the phases of the EGDI Roadmap as described in section 1.8. From the governance perspective, it is important to acknowledge that the different phases of the EGDI Roadmap run in parallel with a number of ongoing initiatives involving the Geological Surveys of Europe. These are described below for the different phases of the roadmap:

Collate phase

Several projects that have a direct relation with EGDI are currently in progress. The most important of these is Minerals4EU. This project is building a "European Minerals Knowledge and Data Platform" (EUR-MKDP), which is seen as 1) a full-scale pilot (in terms of architecture) for EGDI, and 2) the first brick of the European Minerals Knowledge Base, which is established in the framework of the Strategic Implementation Plan of the European Innovation Partnership on Raw Materials. The EUR-MKDP will serve three main information services on non-energy raw materials: a European Minerals Yearbook, a Minerals Foresight study, and a web portal providing access to aggregated spatial information on mineral resources.

The Minerals4EU project is also building a "Minerals Intelligence Network", bringing together data providers, policy makers, industry, researchers and other stakeholders in the Raw Materials field. A key deliverable here is the creation of a "Permanent Body" before the end of the project, that should run the activities of the Minerals Intelligence Network as well as sustain the information services (including regular updates).

In terms of *products*, services developed in Minerals4EU have already been included in the list of products that need to be included in the EGDI (see also section 1.6 and table 1.2).

In terms of *governance*, there are important parallels between 1) the "central EGDI facility" that needs to be set up for the EGDI, 2) the "permanent body" that has to be delivered by the Minerals4EU project, and 3) the creation of a "European Geological Service", which is the main objective of the EuroGeoSurveys strategy. The EuroGeoSurveys Task Force Governance was specifically set up to address these parallels (see also figure 5.1). The current EuroGeoSurveys organisation and the EGDI operational structure will form key building blocks of the European Geological Service. The position of the Minerals Intelligence Network and Permanent Body with respect to these is still being discussed; either 1) the Permanent Body could also be driven mainly by

geological surveys, and have as main objective to deliver information services to stakeholders through the EUR-MKDP (which itself can later be incorporated into the EGDI); or 2) these information services could be delivered *by* the EUR-MKDP/EGDI, as part of the European Geological Service, *to* the Minerals Intelligence Network / Permanent Body, which would then be installed as a platform for bringing together stakeholders across the Raw Materials value chain. These issues will be further worked out during the collate phase, with key input from the EGS Task Force Governance.

In terms of *technology*, the EUR-MKDP will be a full scale pilot for EGDI. In turn, the Minerals4EU project has recently decided to base the EUR-MKDP partly on building blocks developed in the EuroGeoSource project, thus demonstrating the rationale of the collate phase to build further on already existing technology.

Implementation phase

A key assumption at this stage is the availability of dedicated EU funding for implementation of the EGDI. The most concrete option under the current Horizon 2020 programme is setting up EGDI as a "Virtual Research Environment" (see also section 6.2).

At the same time, EuroGeoSurveys has developed an initiative to establish an "ERA-NET on applied geoscience", as a pilot towards an "Article 185 initiative" (the latter would run in parallel to the "scale-up" phase of the roadmap). This ERA-NET and Article 185 are the key building blocks of the "Joint Research" pillar under the EuroGeoSurveys strategy. They are both research programmes, implemented to one (ERA-NET) or more (Article 185) proposals, funded through a public-public partnership of the participating EU member states and the European Commission.

In terms of *products*, a main objective of the ERA-NET would be to develop data services as prioritised in the EGDI-Scope project as well as in the ERA-NET Strategic Research Agenda, insofar as these cannot be covered by other future EU projects. These will likely include the development of (methodologies for) 3D geological models.

In terms of *governance*, the ERA-NET will require its own governance structure. As an ERA-NET (as well as an Article 185) is a collaboration between *Member States* rather than research organisation (in this case Geological Surveys), the ERA-NET governance structure will likely need to have its own legal personality. However, this should have a clear relation with the EGS and EGDI organisational structures.

In terms of *technology*, the main EGDI technology will be developed within the EGDI implementation project, but data service projects run in context of the ERA-NET could either develop additional, dedicated technology for specific data services, or could impose specific demands on EGDI architecture (e.g. for serving 3D geological models).

Scale-up phase

If the ERA-NET is successfully implemented in the Initiate phase, the Article 185 initiative mentioned above could run in parallel to the scale-up phase. The rationale and funding mechanism of the Article 185 initiative, as well as its relation to *products* and *technology* are similar to what is described above for the ERA-NET. However, an Article 185 initiative requires setting up a *dedicated implementation structure*, responsible for updating Strategic Research Agenda, implementing calls

and review procedures, negotiating contracts and managing funding, etc. Again, in terms of *governance*, the relations between the EGDI and EGS operational structures will need to be carefully worked out at this stage.

At the same time, and irrespective of the success of the Article 185 initiative, the scale-up phase will also run in parallel to the full development of the European Geological Service. This could involve the full incorporation of EGDI into the European Geological Service organisational structure.

Figure 5.5 shows the connection between the described ongoing initiatives and the EGDI roadmap.

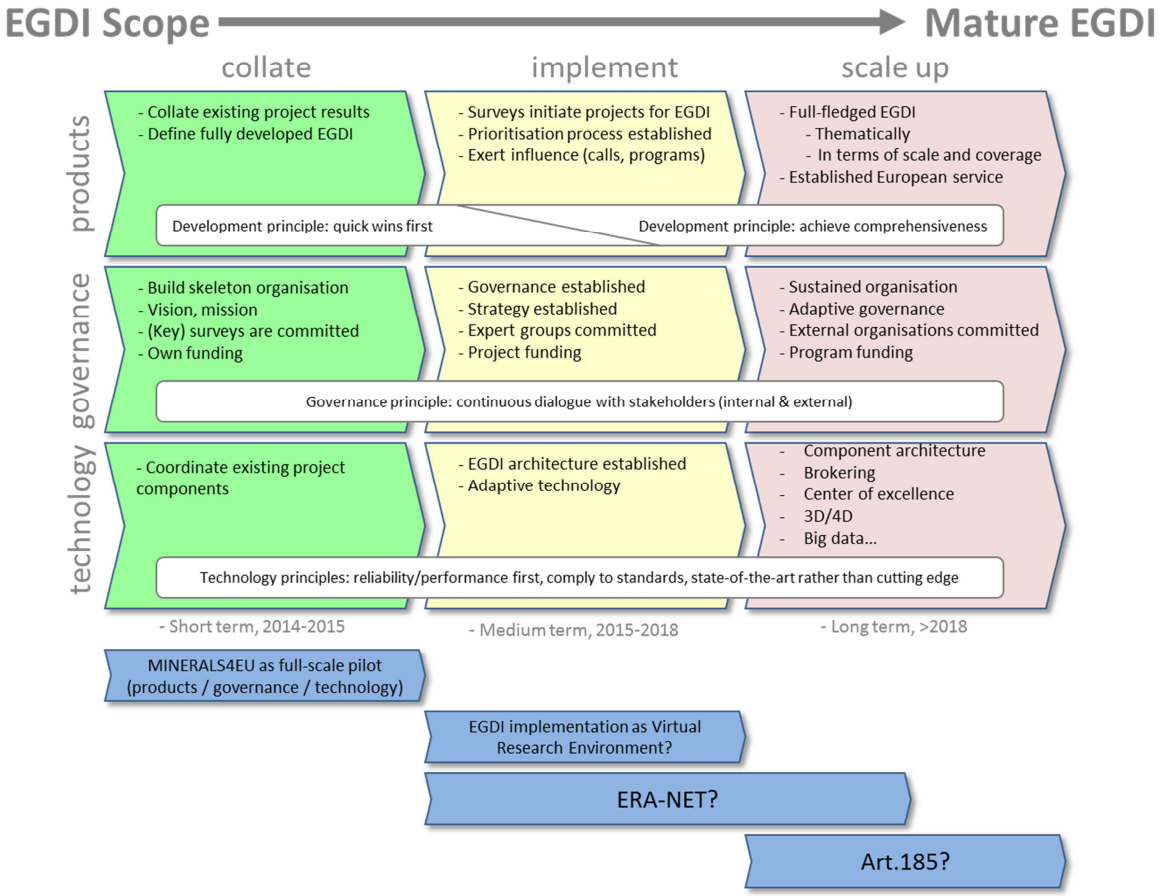


Figure 5.5 – EGDI roadmap and relation with ongoing initiatives Geological Surveys of Europe

6 Roadmap EGDI, work plan components and sustainability

The main principles and phases of the envisaged Roadmap for development of the EGDI have been described in section 1.5 of this report. This has been detailed for 'products', 'governance' and 'technology' in sections 1.6, 1.7 and 1.8 as well as corresponding chapters 2, 3 and 5. This chapter includes the description of three other key components of the Roadmap: work plans, sustainability and funding frameworks.

6.1 Phase 1 – EGDI-scope follow-up project

This phase will be covered by the so-called 'EGDI-Scope follow-up project' (see chapter 6), that will include co-ordination of infrastructure developments in relevant projects (e.g. Minerals4EU), further preparation of the operational and decisive structure, technical and legal topics, continued stakeholder involvement and acting on funding opportunities.

During the course of the EGDI-Scope study it became clear that external (EU-)funding options for the short term (2014-2015) for development of the EGDI are lacking. On the other hand, representatives from DG's, such as DG ENTR (EU Directorate-General for Enterprise and Industry), have informed the EGS community that they are very supportive to the EGDI-concept as part of the broader strategy of the NGO's towards the development of a "European Geological Service", and that they are willing to invest substantially in the near future if the European geological surveys show continued efforts towards realization and full collaboration at European level.

Therefore, the urgency has increased especially for immediate follow-up of the EGDI-scope study. A few generic options for this have been presented at the National Delegates Meeting at 11th February 2014 and the EGS General Meeting at 25th March 2014. The Directors have decided to establish a so-called 'EGDI follow-up project'. Following this decision EuroGeoSurveys has sent a request to each Member Survey to specify their possible contribution to the EGDI project, covering the period from mid-2014 until end-2015 (Phase 1 of the EGDI Roadmap). Within the framework of the (preliminary) results of this inventory and according to recommendations and conclusions of the EGDI-Scope project, the main objectives of the EGDI follow-up project are:

- To coordinate between key projects with regard to the (data) infrastructure developments within these projects; this includes also to carry out any necessary work to maintain the results of a number of on-going or recently finalized key projects, in conformity with the prioritisations of 'products' mentioned in sections 1.6 and 2.9.
- To prepare for the operational and decisive structure of the EGDI (see D5.3, sections 5.3 and 5.4);
- To keep engaged with relevant stakeholders approached within EGDI-scope, and involve them in further developments;
- To investigate and act on funding opportunities, including the preparation of (a) proposal(s) to relevant H2020 or other EU calls for an EGDI implementation project.
- To further investigate technical and legal topics, including coordination of EGDI development and further development of relevant INSPIRE data specifications, in collaboration with the SI Expert Group.

These objectives will be the framework for a work plan for the EGDI follow-up project, that will cover phase 1 of the Roadmap, combined with activities in currently running key projects such as Minerals4EU and eMODNET, and other relevant programs and initiatives.

The work plan will follow the relevant recommendations and conclusions from this Implementation Plan. At this stage, when the implementation plan was finalized, it became clear that a great majority of GSO's were willing to contribute in-kind expert capacity as well as related travel costs to the EGDI follow-project. This represents a substantial commitment towards European collaboration of the GSO's, that mainly depend on funding resources from national government departments.

The EGDI follow-up project will be setup like a European collaborative project, for which the working procedures and principles have to be elaborated and agreed in the first stage of the project. In general, it is envisaged that the coordinator will take up the overall coordination and will function as first contact point. The 'core executive team' of WP leaders and the coordinator will take the lead and main responsibility for the project. Every WP leader will coordinate the inputs of all team members that contribute to their WP. Of course close collaboration is foreseen with the SI-EG, e.g. regarding the review of deliverables.

6.2 Phase 2 – Tasks of the "central EGDI facility"

The need for a central EGDI facility is introduced in sections 1.8 and 5.2. It is envisaged that this facility will be established and become operational in phase 2 of the EGDI Roadmap. Table 6.1 gives an overview of the tasks of the central facility, and an estimate of the minimal effort per year required to carry out these tasks (these numbers refer to effort required for *maintenance* of the infrastructure; the effort for *building* the infrastructure is probably much larger). The table makes a distinction between:

- "Central tasks" that are carried out at the central infrastructure level; these are subdivided again into:
    - Central: tasks that need to be carried out by a body or person who is independent of individual geological surveys;
    - Delegated: tasks that relate to the central infrastructure but **could** be delegated to an individual survey (e.g. hosting and management of the central database)
- "Distributed tasks" that are carried out at *each* individual survey (or data provider).

As can be noted in table 6.1, the estimated effort for *data standard management* and *central database management* has a wide range; for these tasks a *minimum* level (pure maintenance; only concern is that system keeps working) and *maximum* level (continuous effort to keep system at optimal performance) effort was estimated. For other tasks, the effort depends on the number of services served by (or numbers of projects connected to / using) the EGDI.

Each of the tasks is described in more detail below:

Daily management: a daily manager has to be in place who has overall responsibility for managing all EGDI related affairs

Survey contacts: there has to be an assigned contact person at each survey who is responsible for maintaining contacts with the central facility, and oversees implementation of local actions at their local survey.

	Central Tasks		***Distributed tasks*** *(effort per survey / data provider)*
	Central	***Delegated***	
Daily management	0,5 fte		
Survey contacts EGDI			5 days
Annual work plan	0,2 fte		1 day
Write tender, specify requirements for outsourced (delegated) tasks	<0,1 fte		
Daily maintenance of technical infrastructure		0,3 fte/50K€	5 days
Central database management		min 0,1 fte max 2 fte	
Data standard Management - Maintenance standards INSPIRE / OGC		min 0,2 fte, max 2,0 fte	0 - 0,2 fte
Portal management Software tools		1 fte (4 projects) 2 fte (10 projects)	
Connection with new projects for EGDI		< 0,1 fte	
Quality and content control	< 0,1 fte		0,1 fte
Central contact point	0,1 fte		
Helpdesk - IT - Content		1 fte	
Secretariat & Communication	1 fte		
Legal tasks		0,1 fte	0,1 fte
Results: **For 4 projects** *For 10 projects*	**Min: 5 FTE** **Max: 7 FTE** *8 – 10 FTE*		**Min: 0,2** **Max: 0,4** *0,6 FTE (x31)*

Table 6.1: tasks of the EGDI central facility (required for maintenance of the infrastructure) and estimated annual effort (NB: these are very rough first estimates).

Annual work plan: annual activities and priorities, estimates of related efforts and budget, etc. have to be written down in an annual work plan, in such a way that all parties involved in the EGDI can monitor and steer these activities. This is mainly an effort of the central facility, but also requires input from individual surveys

Write tender, specify requirements for outsourced (delegated) tasks: As shown in the table, some of the tasks of the central facility must be carried out at "truly" central level, but others could be outsourced to individual surveys or even to external parties. However the requirements for such tasks should be clearly defined. Also, there might be several candidates to carry out a certain task, in which case it could be decided to tender the task and award it to the best bidder (in whatever

terms). Writing out such tenders, and specifying requirements for delegated tasks, is done at central level.

Daily maintenance of technical infrastructure: maintenance of the hardware and software on which the EGDI is run. This may require both manpower and cash (for buying hardware or e.g. for external hosting).

Central database management: Data providers will deliver national data and information services via webservices to the central infrastructure in a central database. Users will access information services (via webportal(s)) through this central database (see e.g. deliverable 4.3). Estimated effort varies between minimum (few dataservices, pure maintenance) and maximum (larger number of dataservices, continuous optimization).

Data standard management: EGDI information services need to comply to European and international datastandards (such as OGC, INSPIRE, etc.), which are itself subject to change. Estimated effort varies from minimum (reactive: occasional updating of data standards in case of minor changes – major changes in standards would require additional efforts and thus additional funding) to pro-active (EGDI takes itself an active role in the further development of standards).

Portal management: information services served by EGDI are accessible to users via (a) web portal (s). At these portals, users are able to search, display and download data, overlay several data types, and (possibly) to work with selected data (e.g. acquire statistics on selected data, draw cross-sections, etc.). The complexity of this task depends on the complexity of the provided information service, and on the number of datasets served. It also depends on whether data are served through a single EGDI portal, or specific portals dedicated to specific data services, or both (see e.g. deliverable 4.3)

Connection with new projects for EGDI: The EGDI will gradually be extended with new data services, which are developed within dedicated projects. Extension of the EGDI will be mostly done within the context of these projects, so the effort identified in table 5.1 is fairly small (most additional effort will be likely required in the development phase of such projects).

Quality and content control: Data providers need to ensure that the data and information services they provide to the central facility are of sufficient quality, and comply with standards required by the central facility.

Central contact point: dealing with all central inquiries related to the infrastructure

Helpdesk: separated in IT (both to external (users of information services) and internal (data providers) users) and content (support and explanations on the content and proper use of data services)

Secretariat and communication: support to management of the infrastructure: communication (website, newsletters, brochures, presentations, press releases etc.), preparing reports and workplans, keep financial accounts, prepare meetings, support decision making processes, etc.

Legal tasks: all tasks related to maintenance of and issues related to data licenses, as well as to the further development of the central facilities' legal structure

6.3 Sustainability strategy for EGDI

Long-term sustainability is key to the success of the EGDI concept. Four interrelated elements are crucial towards achieving sustainability:

- Funding & Resources
- Governance
- Commitment
- Adaptive technology

6.3.1 *Sustainability: funding & Resources*

A number of possible sources for funding and resources – as well as their impact on governance – are described in Chapter 6 of Deliverable 5.3. EGDI implementation and sustainability will require a mixture of these sources, but this mixture will likely vary in the different stages of the roadmap:

phase 1: collate

- In kind (capacity from surveys)
- Cash (from surveys)
- budgets from running projects: EModnet 2, Minerals4 EU, EURare,…
- JRC Danube case, connected to 1 GE-plus project

phase 2: implementation

- In kind (capacity from surveys)
- Cash (from surveys)
- Capacity from running projects: EModnet 2, Minerals4 EU, EURare, and others?
- EGDI project development under Horizon 2020 (calls to be prepared in phase 1)

Phase 3: scale up

- In kind (capacity from surveys)
- Cash (from surveys)
- General arrangement between surveys: every EU-project will include some budget to integrate relevant results into the EGDI
- > 2018: ERANET, Article 185…
- EU-Projects (H2020)
- Other EU and national funding programs

Crucial to the implementation phase will be the availability of dedicated funding from Horizon 2020. An analysis of possible opportunities within current and future H2020 calls was made. These opportunities include:

Research Infrastructures Call 2014-2015:

- *INFRADEV-1: Design studies for new world-class Research Infrastructures*

This would be a first step towards possible inclusion of EGDI in the ESFRI Roadmap. This is however not seen as the most appropriate way forward since 1) the scope of such a design study would be similar to that of the EGDI-Scope study; 2) discussion with the commission indicate that there is

currently no support for inclusion of EGDI in the ESFRI list, in addition to EPOS (which is currently at the end of the Preparatory Phase for ESFRI projects)

- *EINFRA-9-2015 – e-Infrastructures for virtual research environments (VRE)*

This was specifically identified as an opportunity for EGDI implementation in discussions with the EGDI-Scope Project Officer. One of the main objectives of the EGDI-Bridge project, which will run in the "Collate" phase of the roadmap, will be to write and submit a proposal to the EINFRA-9-2015 call.

Research Infrastructures Call 2016-2017:

- *INFRAIA: Integrating and opening existing national and regional research infrastructures of European interest*

INFRAIA offers a good alternative for the Virtual Research Environments call, as the objective of EGDI is to provide integrated access to existing national geological survey databases. In 2012, EGDI-Scope provided input to a "Consultation on possible topics for future activities for integrating and opening existing national research infrastructures". In the February 2013 "Assessment report" related to this consultation, EGDI was included in the "List of topics with high potential and with merit for future Horizon 2020 actions for integrating and opening existing national research infrastructures". A number of topics on this list, but no including EGDI, was listed in the INFRAIA-1-2014/2015. We have understood that other topics on this list may be included in future INFRAIA calls.

6.3.2 *Sustainability: governance*

Setup of a permanent, legally based operational structure at European level for maintaining and development of EGDI is crucial towards its sustainability. Options, boundary conditions and models for such an operational structure are extensively discussed in Deliverables 5.3 and 5.4, and in sections xx of this report. Governance arrangements include a.o.:

- a permanent **decision structure,** where all members of the legal structure are represented; as well as a clear management structure;
- agreements on the performance of contributors to EGDI (such as delivery and keeping updated of data and information services), which relates to commitment;
- appropriate legal framework ensure data accessibility and trust (as discussed in chapter 4 of this report)

6.3.3 *Sustainability: commitment*

Long term and strong commitments, especially of the main contributors to EGDI – the Geological Survey Organizations – are crucial. Commitments are an important part of governance (as already described in the previous paragraph, but the establishment of governance structures will not succeed if prior commitment is not already established. Strong existing commitment of the surveys towards the development of the EGDI is demonstrated by:

- The unanimous support of EuroGeoSurveys members for the EuroGeoSurveys strategy, which includes EGDI as one of the three main supporting pillars;
- Continued involvement in, and support to (as expressed in consecutive EGS General Meetings), the further EGS strategy development process;
- Commitment - in the form of in-kind capacity – to the proposed EGDI-follow-up project.

6.3.4 *Sustainability: adaptive technology*

EGDI sustainability will rely on continuous development of Technology, including architecture, IT components, data standards etc. This is extensively discussed in chapter 3. In order to decrease vulnerability related to changes in staff and membership composition, to avoid lock-in, and to maintain trust between and optimize added value for EGDI members, it is important to establish:

- "Portable" system design, allowing the "movement" of crucial system elements (central database, portals, components, etc.) to different providers (internal or external);
- Shared IP rights on development and use of jointly developed components in context of EGDI;
- Etc.

List of recommendations

Section 2.2
The first phase of EGDI should include (but not be limited to) the following thematic areas:

- Geological maps (onshore and offshore)
- Mineral Resources
- Water Resources
- Geohazards
- Soil

Section 2.3
A future EGDI implementing team should carefully examine the use cases developed in the EGDI-Scope project. These are summarised in Appendix A of this report and further described in D2.4 with corresponding case studies in D2.3.
More use cases should be developed as needed (e.g. if new thematic domains are included).

Section 2.4
The EGDI content and interfaces should be flexible enough to honour the needs of high-level users, expert users and virtual users.

Section 5.1
In implementing EGDI Governance, the wider context of the EGDI strategy towards development of a European Geological Service, as well as parallel initiatives such as INSPIRE, EPOS, etc. needs to be taken into account.
EGDI Governance should facilitate alignment of its objectives with these other initiatives
EGDI Governance should address differences in ownership, business models and required commitments at different levels of the conceptual framework.

Section 5.2
EGDI should make a choice whether the tasks identified under “central-delegated” are indeed delegated to one or more individual member organisations.
If this choice is made, then procedures should be put in place to determine who such tasks are delegated to (e.g. through a tendering procedure, which could be repeated on a regular basis), and under what conditions (e.g. through a system of service level agreements).
“Distributed” tasks should also be clearly described and procedures for their performance should be indicated (again e.g. through service level agreements).

Section 5.3
In order to keep momentum, preparations for setting up the EGDI organizational structure should continue within the EuroGeoSurveys community after the end of the EGDI-Scope project.
Elements that should be put in place as quickly as possible include EGDI leadership; policies and procedures on ensuring that datasets produced in ongoing and future projects are transferred to EGDI as soon as it is implemented; policies and procedures on jointly engaging in such future projects.
Choices should be made on the organisational model (or possibly for different models at different points in time), and drafting of statutes (changes / additions to EGS statutes and/or separate statues for the EGDI organization) should start (possibly in context of the EGS Task Force on Governance).

Section 5.4
A formal evaluation of, and choice for, one (if any) of the described models has not yet been made within the EGDI-scope project, as such a choice should involve all the foreseen members of the EGDI

infrastructure at the appropriate decision making level. This should be done as quickly as possible after the end of the EGDI-Scope project, taking all other legal and organisational aspects discussed in Workpackage 5 into account.

Section 5.5
EGDI should take boundary conditions imposed by (potential) sources of funding and resources into account in the organizational framework.
In particular, EGDI should look into possible organisational arrangements that would facilitate (direct or indirect) participation of all EGDI members in contractual activities (e.g. EU projects) at minimal administrative burden.

Reference list

Ref No	Reference / deliverable name
[1]	[ENISA 2011]
[2]	[ENISA 2011]
[3]	[J. Camp et al. 2001] "Trust: a collision of paradigms", John F. Kennedy School of Government, Harvard University Faculty Research Working Papers Series. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=262179 (accessed on 22/05/2013)
[4]	[Kuan Hon et al. 2012]
	EGDI-Scope Reports:
D2.2	User Needs for Datasets and Services
D2.3	Functional User Requirements and Use Cases
D2.4	Final Report of User Needs and Functional Requirements
D3.1	Review of Previous and Ongoing Projects
D3.2	Review of Relevant Datasets Available within Europe
D3.3	Implementation and Prioritisation Plan for Rolling Out Datasets on the EGDI
D3.4	Technical Requirements for Serving 3D Geological Models
D4.2	Report on Data Models, Vocabularies, Services, and Portal Specifications for the EGDI
D4.3	Report on Infrastructure Needs: Report on Infrastructure (hardware, software) and Skills Training Needs for Individual NGSO
D4.4	Report on Recommendations for Implementation of the EGDI
D.5.2	Report on Regulation and Policies
D.5.3	Report on Governance Structure
D.5.4	Guidelines on the Legal and Organizational Framework

List of external stakeholders, organisations and project consortia

European Institutions

• DG Connect	Directorate General for Communications Networks, Content and Technology
• DG ENTR	Directorate-General for Enterprise and Industry
• DG ENV	Directorate-General for the Environment
• DG RTD	Directorate-General for Research and Innovation's
• DG MARE	Directorate-General for Maritime Affairs and Fisheries
• DG - JRC	Directorate General–Joint Research Centre
• EEA	European Environment Agency
• ESFRI	European Strategy Forum on Research Infrastructures; strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach
• REA	Research Executive Agency (European Commission)
• ESA	European Space Agency

European Communities

• EFG	European Federation of Geologists (Non-governmental organization with 24 national association members)
• EuroGeoGraphics	European National Mapping, Cadastral and Land Registry Authorities
• ETP-SMR	European Technology Platform on Sustainable Mineral Resources
• Euromines	European Association of Mining Industries, Metal Ores & Industrial Minerals
• Insurance Europe	European insurance and reinsurance federation

Non-European Communities

• GSAF	The Geological Society of Africa; encourages geoscientific collaboration and cooperation across the continent.
• Minerals and Metals Group	Mid-tier global resources company that explores, develops and mines base metal deposits around the world
• OAGS	Organisation of African Geological Surveys; represents the Geological Surveys of countries on the African continent
• EarthCube	Initiative to create a community-driven data and knowledge management system that will allow for unprecedented data sharing across the geosciences.

European Projects

• EPOS	European Plate Observing System; integrated solid Earth Sciences research infrastructure
• EMODnet-Geology (I & II)	European Marine Observation and Data Network (brings together harmonised off-shore data)
• GeoSeas	Implementing an e-infrastructure of 26 marine geological and geophysical data centres
• ODIP	Ocean Data Interoperability Platform; contribute to removal of barriers hindering the effective sharing of data across scientific domains and international boundaries
• Minerals4EU	Minerals Intelligence Network for Europe; provide data, information and knowledge on mineral resources
• EURare	Develops a sustainable exploitation scheme for Europe's Rare Earth ore deposits
• EuroGeoSource	Data portal with access to the aggregated geographical information on geo-energy and mineral resources
• ProMine	One of main objectives: to develop the first pan-European GIS-based database containing the known and predicted metalliferous and non-metalliferous resources, which together define the strategic reserves (including secondary resources) of the EU
• InGeoClouds	The INspired GEOdata CLOUD Services; demonstrates the feasibility of employing a cloud-based infrastructure
• Pangeo	Enables Access to Geological Information in Support of GMES; enabling free and open access to geohazard information
• SubCoast	Develops a GMES-downstream service for assessing and monitoring subsidence hazards in coastal lowland areas
• Terrafirma	provides a Pan-European ground motion information service which provides identification, assessment, understanding and monitoring of ground motions
• GeoMol	Assesses subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources
• GEMAS	Geochemical mapping of agricultural and grazing land soil
• COOPEUS	Connects research infrastructures; brings together scientists and users being involved in Europe’s major environmental related research infra-structure projects

Global Communities

• GEO Secretariat	Group on Earth Observations; Improves policy decisions by coordinating strategies among participating voluntary governments and international organizations
• OGC	Open Geospatial Consortium; Encourages development and implementation of open standards for geospatial content and services, GIS data processing and data sharing
• UNECE	United Nations Economic Commission for Europe; promotes pan-European economic integration
• UNESCO	United Nations Educational, Scientific and Cultural Organization

List of Abbrevations

API	Application Programming Interface
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
CGMW	Commission for the Geological Map of the World
CSW	Common SoftWare
DG	Directorate-General
DG ENTR	Directorate General for Enterprise and Industry
EEA	European Environment Agency
EEIG	European Economic Interest Grouping
EGDI	European Geological Data Infrastructure
EGS	EuroGeoSurveys
EGTC	European Grouping of Territorial Cooperation
EMODnet	European Marine Observation and Data Network
ENTR	Enter Technology Corporation
EPOS	Earthquake Phenomena Observation System
ERIC	European Research Infrastructure
ESA	European Space Agency
ESDIN	European Spatial Data Infrastructure
1GE(+)	OneGeologyEurope (Plus)
GEMAS	GEochemical Mapping of Agricultural and grazing land Soil
GeoREL / GeoRM	Geographic Rights Expression Language / Geospatial Rights Management
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information System
GSO	Geological Survey Organisation
IHME	International Hydrogeological Map of Europe
INSPIRE	Infrastructure for Spatial Information in the European Community
ISDSS	Integrated Spatial Decision Support System
(DG) JRC	(Directorate-General) Joint Research Centre
NGSO	National Geological Survey Organisation
OGC	Open GIS Consortium
PSI	Persistent Scattered Interferometry
QA / QC	Quality Assurance / Quality Control
REA	Research Executive Agency (European Commission)
SEIS	Shared Environmental Information System
SET	Strategic Energy Technology
SI-EG	(EGS-) Spatial Information Expert Group
SLD	Styled Layer Descriptor
SOS	Sensor Observation Service
WCPS	Web Coverage Processing Service
WCS / WPS	Web Coverage Service / Web Processing Service
WFS / WMS	Web Feature Service / Web Map Service
WISE	Water Information System for Europe

Appendix A: Thematic Domains and Use Cases

Use Case 1: Planning for offshore wind farms

Story: A private consultants accesses the EGDI in order to obtain information about seabed substrates for the development of an overview habitat map in an area of interest (in this case, the North Sea). Such a habitat map would be an important part of the Environment Impact Assessment, which has to be delivered to the relevant legal authority to ensure that the habitats of critical species are not obstructed by the wind farm.

Rationale: When planning for wind farms, contractors often require the most detailed information possible from the area of interest. However, access to more coarse-grained – preferably harmonised - information is in many cases most welcome, because it supplies relatively fast overview of larger areas to help first stage screening of more local areas of interest. Providing open access to marine data and knowledge is a high priority of the European Commission as it facilitates competitiveness in the private sector and eventually will lead to economic growth and job creation. A further motivation for considering this use case for the EGDI is that it also supports EU's aim to get 20% of its energy from renewable sources by 2020

Data needs and availability:

Harmonised seabed substrate map: Such a map should be as detailed as possible and comply with common European standards to ensure a homogeneous understanding of substrate classes and their relevance for certain benthic species. The EMODnet-geology preparatory action which ran from 2008 to 2010 produced a harmonised 1:1 million seamless, marine substrate map covering the Baltic Sea, the Greater North Sea and the Celtic Sea which is already today served through the OneGeologyEurope portal and, hence, could easily be integrated in an early stage of the EGDI. The newly started EMODnet-geology II project will aim to increase the resolution to 1: 250 000 and extend coverage to all European sea areas.

Data coverage map: The density of geophysical and geological data that has been taken into consideration when preparing the substrate map will provide a measure of the data quality in specific areas of the map, and hence a data coverage map will be a valuable layer to include in the EGDI.

Functional requirements from use case:

Basic functionality: Standard interactive GIS functionality as well as the possibility to view metadata for the composite European map as well as for the individual contributions.

Advanced functionality: The possibility to download the entire dataset (or alternatively selected parts of it) as GIS files for use in desktop GIS applications as ArcGIS and MapInfo.

Other considerations relating to geology

Geological maps can potentially by applicable to many different use cases. For example, it would be possible to categorise polygons in terms of aggregate resources (e.g. sand and gravel), land slide susceptibility maps can be produced from knowledge of the geological composition of hilly areas and areas of groundwater formation can be outlined by applying permeability numbers to the various classes of the surface geological map. All of these use cases, however, require a high degree of harmonisation. The present surface geological map of OneGeologyEurope differs from country to country in various ways. The maps of some countries represent the near-to-surface (or basically bedrock) geology, whereas other countries provide true surface geology – facts that impede the use of the map for pan-European (and often also for cross-border) analyses. This issue can be difficult to solve due to different mapping cultures in different geological survey organisations. Nonetheless, it is recommended that the limitations caused by these factors are addressed in future phases of the EGDI.

Mineral Resources

Securing sustainable access to critical raw materials is a highly important topic for the EU at present. Furthermore the currently running Minerals4EU and EURare projects make this theme very relevant for the first phase of EGDI implementation and close liaison will be undertaken.

Use Case 2: Assessment of Rare Earth Element Potential in Europe

Story: The European Commission contacts EuroGeoSurveys (EGS) and asks for an overview of ten exploitable rare earth element deposits in Europe. EGS forwards the request to the Minerals Intelligence Network (established through the Minerals4EU project), which - by searching and assessing the content of the EGDI - produces a report with maps and descriptions of the relevant deposits, targeting many politically relevant issues such as economy (tonnage, grade, composition, bi-products, costs of extraction, infrastructure), health (e.g. Uranium content of deposits), environment (proximity to important biotopes, ground water reservoirs, lakes, rivers, nearby sources of sustainable energy), land use (proximity to ground water bodies, shale gas reservoirs, nature parks, settlements etc.), private sector aspects (existing licenses etc.).

Rationale: The use case is highly relevant as it illustrates how the concept of a European Geological Service is envisaged as a symbiosis of a geological knowledge base (the EGDI) and a pool of mineral resources experts that can act swiftly upon request by the European Commission and the European Parliament.

Data needs and availability:

Mineral Resources data: The use case requires harmonised, complete and comprehensive data on mineral resources including name(s), location, resource numbers, commodity, mining activity, grade of main commodity(ies) as well as bi-products, deposit type, geological setting and mineralogy.

Other EGDI datasets: The availability of other types of EGDI datasets from other thematic domains will be an asset for this use case – especially considering issues relating to land use. For example, the possibility to overlay selected mineral deposits with information about ground water bodies, oil- and gas fields or shale gas reservoirs will be quite valuable.

Datasets from other domains: Datasets (harmonised and INSPIRE compliant) from other non-geological domains are also required by this use case. This is for example licensing information, land cover, infrastructure, maps of vulnerable ecosystems, nature parks etc.

Functional requirements from use case:

Basic functionality: This use case requires standard interactive GIS functionality such as panning and zooming, but also the possibility to switch layers on and off (including layers from other sources such) is important. The possibility to view metadata both for the "European datasets" as well as the distributed contributions is essential and should include the possibility to view information such as responsible persons, last update date etc. For the user to do European-level assessment of data across countries, specific search facilities should be available such as "Commodity=REE" to search transparently through datasets from all data providers. Furthermore, the possibility to view detailed data on individual mineral occurrences and manipulate result sets through filtering and sorting should be established as well as the possibility to download result sets in various file formats such as Excel.

Advanced functionality: As for some of the previously mentioned use cases, some kind of make-a-map facility would help the user produce tailor made figures displaying e.g. maps of deposits with geology as background and overlain with themes like lakes, rivers, roads, ground water reservoirs etc. Furthermore, a nice-to-have facility would be for privileged expert users to predefine thematic maps that could be easily displayed when a user request a map e.g. the largest REE deposits in Europe.

Water Resources

Securing clean ground water is an area with high societal impact since it in many countries constitutes the main drinking water resource and because the interaction of ground water with important aquatic ecosystems such as lakes and rivers is an important factor to consider in relation to the prevention of biodiversity loss.

Use Case 3: Natural Background Levels of As in groundwater reservoirs

Story: A private consultant company is hired to assess the chemical status of groundwater bodies in Germany by comparing Arsenic content in ground water samples with Natural Background Levels (and/or threshold values) for relevant aquifer types as either reported by the member states pursuant to the Groundwater Directive or calculated by a common harmonised method.

Rationale: The Natural Background Level (NBL) of pollutants in groundwater to a large degree depends on the lithology of the reservoir rocks. The present use case suggests how lithological classes from a harmonised pan-European geological map can be attributed with certain parameters (like in this case NBL intervals for specific substances) to qualify things like for example if a specific chemical ground water sample has elevated levels of pollutants in relation to what could be expected in the specific reservoir type. Hence, the use case demonstrates an added-value application of geological maps in support of the Groundwater Directive.

Data needs and availability:

Harmonised near-to-surface geological map: The use case requires a pan-European, harmonised geological map of the rocks present in the depths of ground water extraction, i.e. near-to-surface rocks. The best candidate of such a map is the recently launched International Hydrogeological Map of Europe (IHME) in scale 1: 1.5 million containing four lithology levels and an aquifer type layer. The production of this map was coordinated by BGR and with UNESCO, IAH, CGMW and EGS as partners. The digital version is almost finished, and BGR has informed that they are highly interested in contributing the map to the European representation of groundwater data in cooperating with EGS through the water resources expert group.

Natural Background Levels: At present no comprehensive and harmonised dataset exists that correlates NBL's of the main critical groundwater pollutants with lithology. The FP6-funded BRIDGE project (2005-2006) involved scientists from 11 European countries that worked jointly on the definition of a harmonised European aquifer typology map as a mean to conduct regional differentiation of natural background levels (NBLs) and TVs of pollutants in groundwaters of Europe. The methodologies developed by this project could well be used in a future European project to produce NBL's for the major groundwater-bearing lithological classes represented in the IHME map.

Functional requirements from use case:

Basic functionality: This use case requires provisioning of the IHME map as WMS to support analysis of local groundwater sample data with NBL values from lithologies in the sample reservoirs.

Advanced functionality: This could involve the possibility to upload ground water chemical dataset to the portal and have a map produced showing samples with e.g. As values above the corresponding NBL's as red dots and samples with As below NBL as green dots.

Geohazards

This is a highly important topic for many European Geological Surveys, other organisations, policy-makers and planners and affects many European citizens. The geohazards theme can be subdivided into different hazard categories such as flooding, earthquakes, subsidence and landslides. Over recent years, a large amount of detailed research has been carried out across Europe and numerous EU-projects (as identified by WP3) have been funded. Two of these include the high-profile PanGeo project and the SubCoast Project, both of which deal with subsidence-related hazards. Therefore it was agreed that these project results would be used and integrated in both the use cases in WP2 and as a potential methodology for incorporation into the EGDI.

Use Case 4: Ground instability in densely populated areas

Story: A decision-maker in the municipality of London requests information about geohazard risks in a certain area along the Thames in order to make qualified decisions regarding local planning in the area. The technical department swiftly discovers the EGDI portal on the Internet by searching for "geohazards London", finds, analyses and downloads the ground instability information and write a report to the decision-maker.

Rationale: The use case is important since it demonstrates how existing can potentially be integrated into the EGDI to benefit not only from the sustainability of the data and portal platform, but also from possible added-value developments such as gazetteer services and integrated time series analysis tools.

Data needs and availability:

Ground stability information: The recently ended PanGeo project successfully defined and described areas of subsidence in some major European cities. This dataset is largely INSPIRE compliant and provisioned from distributed WMS services hosted by the responsible data providers. Therefore, it could well be integrated into an early-phase EGDI, but metadata would need to be produced for each of the distributed datasets during that process.

Persistent Scattered Interferometry (PSI) data: These data are available for each of the involved cities and comprise both imagery and time series of ground motion in individual points. The PSI data are partly owned by the PSI providers and partly made freely available by the TerraFirma Legacy project.

Data from other sources: The use case requires that the geohazard information can be viewed together with data from the European Commission's Urban Atlas, to allow for assessment of vulnerable communities/resilience.

Functional requirements from use case:

Basic functionality: The use case requires basic interactive GIS functionality like zoom, pan, click-info and legend-display, but also requires zoom-dependant map display (e.g. only display ground stability polygons when scale exceeds a certain level). Furthermore, the use case requires easy access to metadata for the displayed datasets, the possibility to download the geohazard reports associated with the ground stability polygons and publication of the data as WMS/WFS services and interoperability with Google Earth type API's.

Advanced functionality: The use case is a good example of how gazetteer services can help users to more easily find requested information by e.g. typing in "ground instability London" in an Internet search engine. The use case also requires display of average annual velocities and cumulative displacements as time series. Furthermore, the use case requires that some GIS themes can be downloaded as files that can be used in standard desktop GIS application like ArcGIS and MapInfo.

Soil

This theme generally relates to environmental issues. Primary drivers concern ecosystem mapping, Natural capital assessment, Agri-technology and food security. There are two areas of specific 'cross-over' with EuroGeoSurveys . One concerns Parent Material Mapping (mapping of weathered geological materials from which soil forms), the other concerns soil-geochemistry assessment of geogenic chemical signatures that are measured within soil profiles (e.g projects such as GEMAS or G-Base). The two use cases presented below were prepared in cooperation with the European Environment Agency (EEA).

Use Case 5: Ecosystem mapping

Story: The EEA wants to refine their 100x100 m ecosystem map based on knowledge of the surface geology in the grid cells.

Rationale: All applications of the geological maps in the support of EU's line of business are highly relevant for the EGDI.

Data needs and availability:

Surface geological map: The EEA only deals with ecosystem mapping and assessment on a true pan-European scale and the use case therefore requires a full-coverage geological map of Europe. Since the OneGeologyEurope map still has holes, it is at present insufficient to satisfy the use case.

Functional requirements from use case:

Basic functionality: The use case requires the possibility to view metadata for the aggregated OneGeologyEurope map – not just for the underlying national contributions.

Advanced functionality: The use case requires the possibility to download the aggregated OneGeologyEurope map as files (geometry and symbolisation) that are suited for standard desktop GIS applications.

Use Case 6: Ecosystem assessment

Story: EEA wants to assess the effect of Phosphorus on some European ecosystems in order to map certain species to habitats. This is done by applying business rules through a number of grid- and other geoprocessing calculations to obtain new maps showing the relationship between certain species and geochemically characterised ecosystem classes.

Rationale: The use case demonstrates a good application of soil geochemical data.

Data needs and availability:

Distribution maps of chemical compounds: Such contour maps have recently been produced in the scope of the GEMAS project based on chemical analyses of systematically sampled soils from agricultural and grazing land areas across Europe. The sample density is, however, too low to be of direct use in a use case like this, but future refinement of the sample grid for certain compounds

may produce higher resolution datasets that could be integrated in the EGDI to support use cases like this.

Functional requirements from use case:

Basic functionality: Because the samples are analysed for a large number of compounds, many distribution maps should be handled, which requires that the portal presenting these is able to handle layer grouping and display of metadata for each layer in the group.

Advanced functionality: Like some of the previous use cases, a strong requirement is the possibility to download GIS datasets (in this case grids) as files (geometry and symbolisation) that are suited for standard desktop GIS applications.

Geology – onshore and offshore

Geology is not considered a thematic area, but rather baseline data that are used to support thematic information in many domains. However, to shed light on various aspects relating to the general use of geological maps, two tentative use cases were presented in D.2.4 and synthesised below.

Use Case 7: Geological Map of the Alps

Story: A geologist is planning an excursion and wants to prepare and print an overview geological map of the Alps showing the distribution of the main lithological units and the location of the major faults and thrusts and with the road network displayed on top for route planning purposes.

Rationale: Visualising a geological map with corresponding legend is one of the most basic uses of geological map data. Many national geological surveys already expose online geological maps in various ways, but one of the added values of a "European dataset" will be the possibility to create cross-border maps for various purposes. Even though this use cases does not directly influence European policy making, it is so basic that its inclusion in a future EGDI will inevitably support a large range of use cases.

Data requirements and availability:

Geological Units: The use case requires a geological map covering all alp countries. Such a dataset in scale 1: 1 million has already been produced by the OneGeologyEurope project and has subsequently been complemented through the OneGeologyEurope-Plus follow-up project. Some gaps still exist in other parts of Europe and in order to be able to extend the use case to other areas, *a truly pan-European dataset needs to be developed* to satisfy the use case in a broader sense.

Faults: The structural grain of the crust is intuitively visualised by the course of faults, thrusts and other lineaments on geological maps. For the present use case, a fault layer is a required theme on the geological map, but a fault dataset could potentially be incorporated into other possible use cases. At the moment, some countries provide lineaments as part of the OneGeologyEurope map, whereas others do not. In order by make a harmonised European fault dataset, there need to be a future data harmonisation project. The outcome of such a project could well be integrated with the

dataset on active faults produced by the recently ended FP7 project *SHARE* in order to create a dataset with more applications than just viewing on a geological map.

External Data: For some use cases – like this one – the possibility to relate features to themes like lakes, rivers, towns and roads is essential for the usability. The current use case requires some kind of *topographic overlay*, which should be included from an external source.

Functional requirements from use case:

Basic functionality: This use case requires at least normal interactive GIS functionality like panning and zooming, but an essential prerequisite is furthermore the possibility to view a geological legend together with the geological map.

Advanced functionality: Since the total number of different units on the geological map of Europe is quite significant, a display of the gross legend together with a specific view area will be unmanageable and make very little sense. Therefore, some kind of dynamic legend generation to display only the units visible in the zoom area will be a big help for the users. Furthermore, this use case requires that maps can be laid out and printed directly from the internet – a feature that would be of generic value for many of the possible datasets in question.

Use Case 8: Visualise distribution of Archaean rocks in Europe

Story: A geology student is writing an exercise about Archaean rocks in Europe and wants to include a distribution map illustrating rock complexes from that specific time period.

Rationale: The use case is an example illustrating the importance of harmonisation and the requirements derived from the use case should be viewed in a bigger perspective. If the degree of harmonisation supports, the current use case, it will also support many other added value applications of the map.

Data needs and availability:

Harmonised Geological Units: Like use case 1, this use case requires a truly pan-European geological map, and again the *OneGeologyEurope* map is the obvious candidate. However, the OneGeologyEurope map with the biggest degree of coverage is a surface geological map, whereas the current use case requires a bedrock or at least close-to-surface geological map. The bedrock map that is currently available from the OneGeologyEurope project only covers the Fennoscandian Shield, the British Isles and Luxembourg.

Functional requirements from use case:

Basic functionality: Symbolisation according to age (in line with the current OneGeologyEurope map)

Advanced functionality: This use case requires a “thematic analysis tool” similar to the one currently available on the OneGeologyEurope portal. However, the possibility to activate this tool directly from the legend (e.g. right-click and select “view only rocks of this age on the map”) would be very intuitive.