



INSPIRE

Infrastructure for Spatial Information in Europe
Technical documents

Feasibility and cost-benefit considerations for implementing rules on interoperability of spatial data sets and services (v1.0)

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INSPIRE		Fcbc_for_ic
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 2 of 19

Acronyms

Used Term	Definition
BICEPS	Building an Information Capacity for Environmental Protection and Security
CT	Consolidation Team
EIA	Environmental Impact Assessment
EC	European Commission
EMODNET	European Marine Observation and Data Network project
EU	European Union
GDP	Gross Domestic Product
GI	Geographic Information
ICC	Cartographic Institute of Catalonia
IDEC	Catalan SDI
INSPIRE	Infrastructure for Spatial Information in Europe
ISTAT	Italian National Statistics Agency
LMO	Legally Mandated Organisation
RELIT	
SDI	Spatial Data Infrastructure
SDIC	Spatial Data Interest Community
SEA	Strategic Environmental Assessment
TWG	Thematic Working Group

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 3 of 19

Table of contents

Acronyms	2
Purpose of this document.....	4
1 Introduction.....	4
2 INSPIRE Cost-benefit consideration overview	5
2.1 Concept of the evidence.....	5
2.2 Building the evidence	11
2.2.1 Background.....	11
2.2.2 The Catalonia Study.....	12
2.2.3 The Lombardia Study	13
2.2.4 Data specifications and harmonization of existing data sets	14
3 Cost-benefit considerations in course of developing the Implementing rules on interoperability of spatial data sets and services.....	15
3.1 The participatory approach	15
3.2 Feasibility of the data specifications.....	16
3.3 Results of testing.....	17
4 Conclusions and recommendations.....	17
References.....	18

INSPIRE		Fcbc_for_ic
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 4 of 19

Purpose of this document

Art. 7 of the INSPIRE Directive (EC/2007/2)¹ requires that:

Relevant user requirements, existing initiatives and international standards for the harmonisation of spatial data sets, as well as feasibility and cost-benefit considerations shall be taken into account in the development of the implementing rules (extract from Art 7-1)

As a basis for developing the implementing rules provided for in paragraph 1, the Commission shall undertake analyses to ensure that the rules are feasible and proportionate in terms of their likely costs and benefits and shall share the results of such analyses with the committee referred to in Article 22(1). Member States shall, on request, provide the Commission with the information necessary to enable it to undertake such analyses (Art. 7-2).

The purpose of this document is to share with the INSPIRE Committee and relevant stakeholders the result of the activities undertaken to ensure that the requirements expressed in the paragraphs above are met.

This document refers in particular to the activities connected to the preparation of the proposed Implementing Rules for the Interoperability of Annex I Spatial Datasets, on which the INSPIRE Committee will express its opinion on 14th December 2009.

The document will be publicly available as a 'non-paper' as it does not represent an official position of the Commission, and as such can not be invoked in the context of legal procedures.

1 Introduction

This report presents the outcome of the cost-benefit considerations undertaken during the preparation of the Implementing Rules for the Interoperability of Spatial Data sets and Services, with a particular focus on Annex I data themes. These activities included the definition of the conceptual approach, a methodology for selecting adequate proofs of concept, and the approach for collecting evidence. The benefits of the technical arrangements for interoperability of spatial data sets and services are illustrated by aligning them with user requirements and with societal effects, while the endeavours for

¹ Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:EN:PDF>

INSPIRE		Fcbc_for_ic
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 5 of 19

reducing the related costs are detailed in the context of specific steps of the data specification process. The draft regulation on the interoperability of spatial data sets and services is based on data specifications that have taken into account the relevant user requirements, existing initiatives and standards, technical feasibility and cost-benefit aspects, as required by the INSPIRE Directive Article 7-2.

The report is organised as follows: Section 2 provides an overview of cost and benefit considerations in respect to the implementation of spatial data infrastructures to address environmental policies or policies that affect the environment. This includes quantitative evidence from recent studies, as well as qualitative evidence provided by the Member States, as a result of a request sent by the Commission in spring 2008. Section 3 focuses then on the proposed implementing rule, detailing the cost-benefit considerations at each step of the participatory approach. It includes the results of the testing phase of the INSPIRE data specifications, which supplied both qualitative and quantitative information about the implementation aspects. Section 4 summarises the main outcomes and concludes the report.

2 INSPIRE Cost-benefit consideration overview

2.1 Concept of the evidence

The starting point of the INSPIRE cost-benefit considerations related to the interoperability of spatial data sets and services is the Extended Impact Assessment of INSPIRE prepared in 2003-04 prior to the adoption of the proposal by the Commission. At the time, a review of the available literature indicated that there were very few studies providing any evidence of the costs and benefits of spatial data infrastructures, although in one form or another such attempts has being developed since the early 1990s in many countries across the world (Masser 1999). Against this background, the INSPIRE Extended Impact Assessment made a series of clear and transparent assumptions on both costs and benefits which were subject of stakeholder review, including a public consultation in 2003², and where then accepted as the basis for moving ahead with adoption of the proposal by the Commission in 2004. Table 1 and 2 below summarise the estimated costs and benefits of INSPIRE:

² see http://inspire.jrc.ec.europa.eu/reports/fds_report.pdf and http://inspire.jrc.ec.europa.eu/reports/inspire_extended_impact_assessment.pdf

Table 1: Estimated investment costs for INSPIRE per annum (million Euros)

Blocks of INSPIRE policy measures	EU-level	National Organisations	Regional/local
Harmonisation	0,6	1,2	0,5
Metadata	0,2	1,9-2,2	33
Data Policy Framework		0,4	
Coordination and implementation including outreach	1,1	9,6	44-88
Total investment per annum over 10 years (€m) (rounded)	1,9	13	77-122

As indicated in Table 1, it was estimated that INSPIRE might require investments of some €115 per annum for 10 years (average of the last row in Table 1), of which approximately 67% for setting up the physical infrastructure (hardware, software), the coordinating structures and outreach measures, 31% for metadata creation and maintenance, and some 2% for data harmonisation. These were of course based on the assumptions and the evidence available at the time.

Table 2 below summarises the estimated benefits of INSPIRE, which were 7-8 times greater than the estimated investments. The most solid evidence was in relation to the more efficient Environmental Impact Assessments (EIAs) and Strategic Environmental Assessment (SEAs), which, combined with more efficient environmental monitoring and assessment, could almost cover the estimated costs.

Table 2: Summary of estimated benefits of INSPIRE per annum (million Euros)

Type of benefit	Quantitative estimates
More efficient EIA's and SEA's	60-121
More efficient environmental monitoring and assessment	64
More cost-effective expenditure on environmental protection	192
More cost-effective implementation of the environmental acquis	32
More effective implementation of EC projects	3-8
More effective expenditure on Trans European Networks	90
Reduced duplication of spatial data collection	25-160
Improved delivery of risk prevention policies	77-256
Improved delivery of health and environment policies	224
Total (in m€ per annum)	770-1150

The evidence was based on a study commissioned by DG ENV in 2002, which surveyed 50 companies in Europe preparing EIAs and SEAs (Vanderhaegen and Muro, 2005). The survey showed that the majority of respondents use spatial data for analyzing the impacts of their plans and projects on the environment. However, it also showed that 90% of respondents faced problems in using the data and 70% of the respondents identified access to existing data as the main problem, followed by finding out which data is available (54%). Problems connected with the interoperability of data from different suppliers and insufficient data quality issues have also been detected as relevant by over 40% of respondents. As a consequence, an increase in time and costs to produce EIA and SEA reports has been indicated by over 50% of respondents. Problems with spatial data

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 7 of 19

availability, quality and use were also felt to influence the quality and reliability of impact forecasts.

The importance of this study is that it is clearly user focused and based on a legal requirement across Europe. At the time of that survey, it was estimated that some 35,000 EIAs/SEAs were undertaken every year in EU 25. The average cost was €73,000 per study with an average duration of about 6 months. Therefore, the total estimated cost for carrying out EIAs/SEAs in 2002 was of the order of €1.9-3.5bn. Against this volume of investment, the identified problems related to availability of spatial data needed for these studies amount to 5-6% of cost and 8-10% of time. As a result, it was estimated that if with INSPIRE one could remove these costs, the savings are over € 60-121 m. per annum.

In the summer of 2009, the JRC organised another survey of EIA and SEA practitioners adapted from the one undertaken by DG Environment in 2002. The survey is ongoing but preliminary results are provided below to illustrate the issues practitioners continue to face across Europe. It should be understood that the sample in this case is different from the original survey, as many Member States have joined the EU since 2002.

The survey contains so far 102 valid responses that covered 21 European countries, involving 18 of the 27 Member States of the EU. However, respondents indicated that their activities took place across all Member States, as well as countries such as Norway, Switzerland and Turkey. It is worth noting that not all the participants completed the survey fully, so percentages reported below are calculated only on the real number of responses per question.

Spatial data was used by respondents for the following activities: visualisation (79%), identification of impacts (89%), simple analysis and forecasting (76%) and complex analysis and forecasting (51%). The major sources of spatial data were Environmental Protection Agencies (72%), Local Authorities (67%) and National Mapping Agencies (53%) while data produced by commercial companies accounted for one of the lowest categories (39%). Around 78% of respondents reported that they reused spatial data that was acquired for at least one previous report and over 40% noted producing their own data for EIAs and SEAs.

The vast majority of respondents (95%) face problems connected with obtaining and using spatial data. In particular, over 50% have problems connected to finding data, data quality, and cost of data. Over 40% of the respondents indicate that such problems caused higher uncertainty and lower accuracy of the estimated impacts, higher cost and time to produce the studies. The respondents estimate that the increase in cost and time is of the order of 15%. Compared to the results of the 2002 survey, we can see that the problems associated with finding, accessing, and using spatial data for EIAs and SEAs continues to be of the same order of magnitude, indicating the continued importance of implementing INSPIRE to address these problems.

Another example of the extent to which the barriers to environmental data users continue to be important and relevant today in spite of the progress made in SDI infrastructures comes from the marine community. Figures 3 and 4 summarise the results of a survey of stakeholders in 2007, in both private and public sectors, conducted by DG MARE in the framework of the development of the European Marine Observation and Data Network project (EMODNET). Figure 3 indicates the needs of the marine community for different data.

Figure 3 Usefulness of data for the marine community (expressed as percentages of number replying to question). The numbers on the right are the total number replying to this question

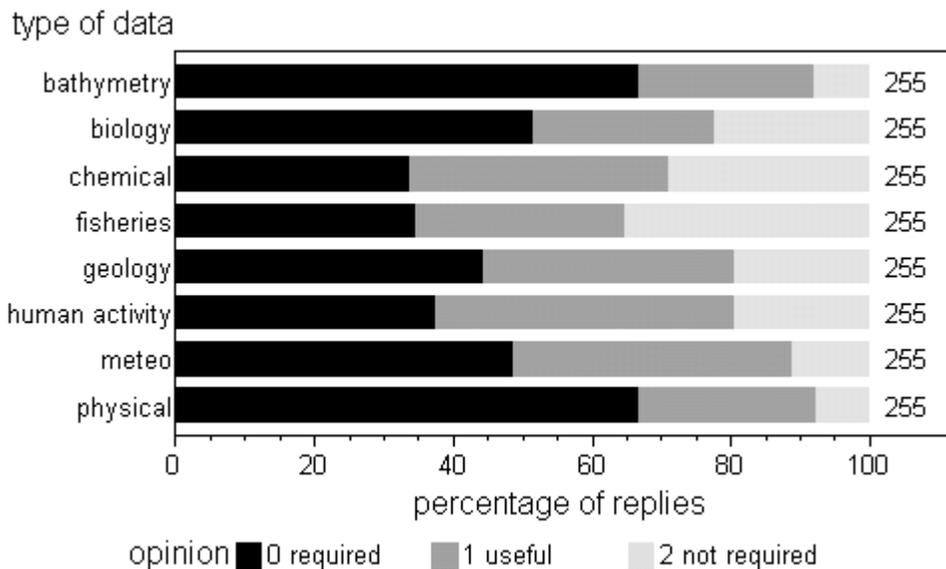
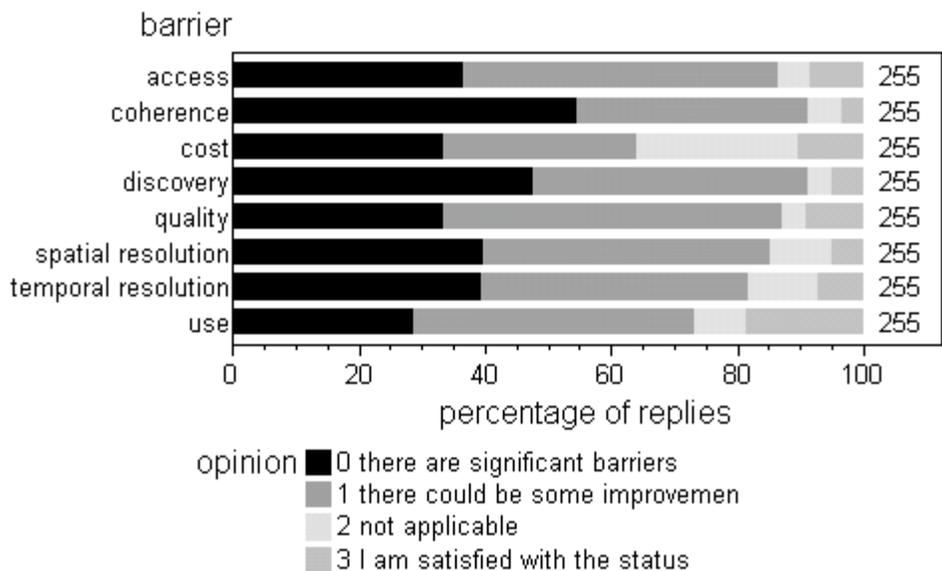


Figure 4 reports on the perceived barriers in obtaining the data required, namely:

- (1) Discovery – not being able to find them
- (2) Access – not having permission to access them
- (3) Use – restrictions imposed on end-use; for instance "for research purposes only"
- (4) Coherence – difficulty combining data from different sources
- (5) Cost – beyond the budget of the user
- (6) Quality – precision and accuracy unknown
- (7) Quantity – spatial and temporal resolution not sufficient for the purpose.

It can be observed from Figure 4 that the majority of users are unsatisfied with the status quo. Nearly all stakeholders reported that these barriers constituted an impediment to their working efficiency with a high 40% indicating that these were significant barriers. These barriers not only raise costs but also mean that data does not arrive in time to meet operational requirements.

Figure 4 Dissatisfaction of stakeholders of marine data with the status quo.



The implementation of INSPIRE will help overcome some of these barriers both in respect to specific data themes and by setting a technological and policy framework for the themes of INSPIRE Annex I, II and III and related communities. INSPIRE is expected to significantly improve the coherence of data due to the strict and consistent data modelling principles applied internally in the data themes and also in cross theme relevance.

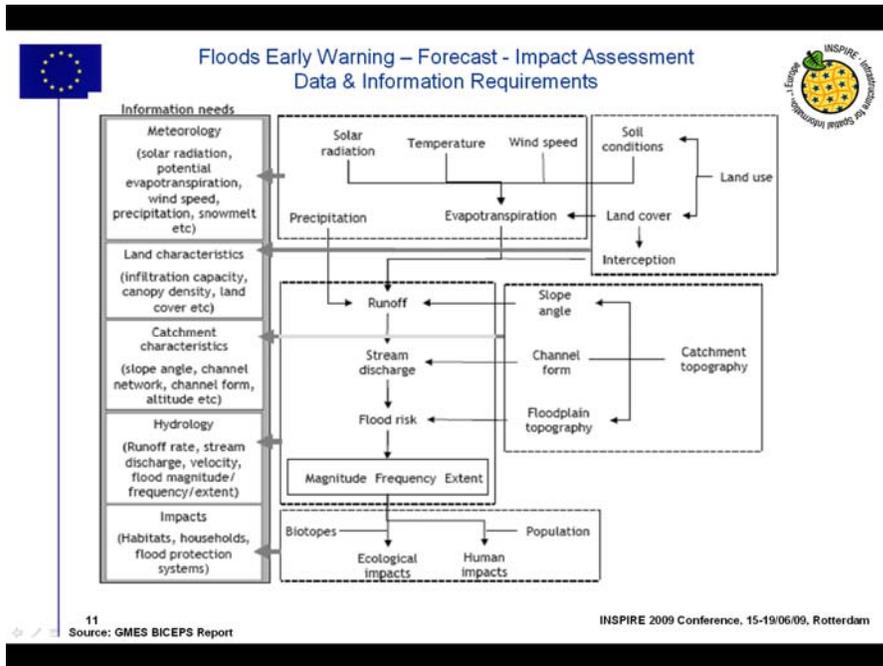
A further example of the contribution of INSPIRE in addressing environmental user requirements, comes from the BICEPS (Building an Information Capacity for Environmental Protection and Security) study³. Figure 5 shows the flows of information needed in relation to flooding extracted from this study, while Figure 6 maps the requirements against the thematic areas defined in INSPIRE Annex I, II and III. Again, interoperability of different information systems (e.g. the possibility to combine data from different sources in a coherent manner) creates economies (reducing ad-hoc data transformation) and other, mainly societal values (quick response, more reliable decision making, etc) to the users.

Based on these examples we can conclude that the major beneficiaries of the Annex I specifications will be the environmental users, who will be primarily concerned with using strong and interoperable reference data to link with other Annex II and III themes, for analysis and display. In other words, the full assessments of benefits for Annex I will only become possible in the course of the full implementation of INSPIRE.

³ http://www.gmes.info/pages-principales/library/cross-cutting-studies/?no_cache=1&download=GMES_KeyIssues.pdf&did=10

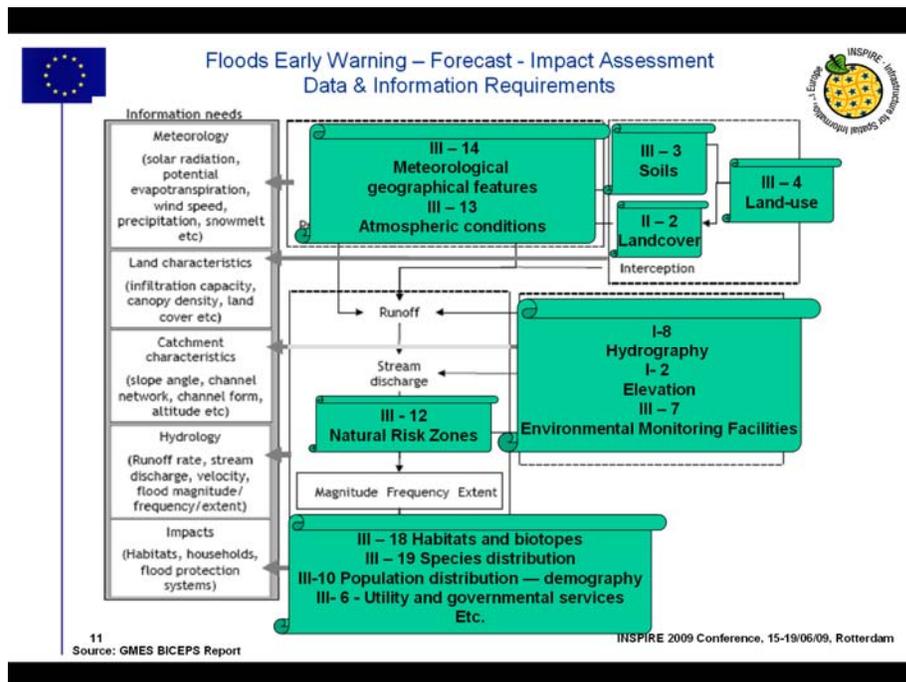
With these considerations in mind, the activities that have been put in place during the preparation of the implementing rules for the interoperability of spatial data and services include on the one hand studies to assess the benefits of spatial data infrastructures based on INSPIRE principles (Section 2.2) and on the other, the development of a participative process for the development of the IR that take into account relevant user requirements, existing initiatives and international standards as well as feasibility and cost-benefit considerations as required in Art 7, and described in Section 3.

Figure 5: User requirements for floods early warning



(Source De Groof, 2009)

Figure 6: Mapping of INSPIRE Annexes on user requirements for floods



(Source: De Groof 2009)

2.2 Building the evidence

2.2.1 Background

In view of the lack of published evidence on the impact of SDIs identified during the INSPIRE Extended Impact Assessment, the Joint Research Centre of the European Commission, in partnership with the US Federal Geographic Data Committee, GeoConnections Canada, and the Geoide Network, organised a workshop in January 2006 to review best practice, compare methodologies and findings, and see also what lessons could be learned from similar large scale infrastructures in other sectors such as e-government, telecommunications, utilities, transport.

The workshop⁴ identified that most available studies were ex-ante, i.e. developed in order to justify the investment in SDIs, with hardly any taking place ex-post or during the life time of an SDI and able to verify the assumptions made in the ex-ante studies. With this in mind, among the key recommendations of the workshop were to focus on assessing existing mature SDIs and to **pay particular attention to sub-national SDIs** in particular to application-driven approaches, as ways to catch specific differences of the current stage at the national level, identify more easily stakeholders, user communities, and

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http://ies.jrc.ec.europa.eu/uploads/fileadmin/Documentation/Reports/Spatial_Data_infrastructures/EUR_2006-2007/EUR_22294_EN.pdf

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 12 of 19

potential benefits. In addition, the workshop identified an appropriate methodological framework for analyzing the benefits of SDIs, which was deployed in two studies implementing these recommendations: i.e. of well developed sub-national SDIs, in Catalonia and Lombardia.

2.2.2 The Catalonia Study

The study of the socio-economic benefits of the SDI in Catalonia was undertaken in 2007 by the Centre of Land Policy and Valuations of the Universitat Politècnica de Catalunya. The Joint Research Centre of the European Commission commissioned the study and recommended the methodology. The study was based on a sample of 20 local authorities participating in the Catalan SDI (IDEC) together with 3 control local authorities not participating in the SDI, and 15 end-user organisations, of which 12 are private companies operating in the Geographic Information (GI) sector and 3 are large institutional users of GI. The findings of the interviews were presented in two separate workshops to the participating local authorities and end-user organisations, to validate the findings and discuss the outcomes. The key findings are reported below.

Costs:

The total direct cost of establishing and operating the IDEC over a five year period (2002-06) was of €1.5 million, of which €325,000 for each of the first two years (2002-03) necessary to launch the SDI, and €283,000 per annum to operate and develop the infrastructure in the three subsequent years (2004-06). Human resources represented 76% of the costs during the launch period (the rest being capital investment) and 91% during operation. These costs do not include the creation and updating of topographic data, which is under the responsibility of the Cartographic Institute of Catalonia (ICC), and would happen regardless of the development of the SDI, nor the indirect costs associated with the physical and technological infrastructure (e.g. office space) provided by the ICC. They do include the following: metadata creation and maintenance, development of geo-services (including geoportal, catalogue, Web Map Service client), preparation of data for publication, applications, hardware and software, and management.

Benefits:

The evidence collected for 2006 clearly shows that the main benefits of the IDEC accrue at the level of local public administration through internal efficiency benefits (time saved in internal queries by technical staff, time saved in attending queries by the public, time saved in internal processes) and effectiveness benefits (time saved by the public and by companies in dealing with public administration). Extrapolating the detailed findings from 20 local authorities to the 100 that participate in the IDEC, the study estimated that the internal efficiency benefits account for over 500 hours per month. Using an hourly rate of €30 for technical staff in local government, these savings exceed €2.6 million per year. Effectiveness savings are just as large at another 500 hours per month. Even considering only the efficiency benefits for 2006 (i.e. ignoring those that may have accrued in 2004-05, as well as the effectiveness benefits), the study indicates that the total investment to set up the IDEC and develop it over a four year period (2002-05) is recovered in just over 6 months. Wider socio-economic benefits have also been identified

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 13 of 19

but not quantified. In particular, the study indicates that web-based spatial services allow smaller local authorities to narrow the digital dividing with larger ones in the provision of services to citizens and companies.

2.2.3 The Lombardia Study

This study was undertaken in 2008-09 by the JRC as part of a collaborative project with the Regione Lombardia which is one of the largest regions in Italy with over 10 million inhabitants, and contributing to over 20% of Italy's GDP. Given the earlier findings of the Catalonia study which focused primarily on the efficiency benefits internal to public administration in Catalonia, the Lombardia study focused primarily on benefits external to the public administration. For this purpose, it repeated the 2002 survey of companies undertaking EIAs and SEAs (Vanderhaegen and Muro, 2005) focusing in the Lombardia region. The survey was distributed to 60 practitioners and companies involved in EIA reports in Lombardy, where 17 of the 27 respondents also provided information about their use of the spatial data infrastructure to find, and access the relevant thematic data.

The survey showed that all respondents use spatial data for analyzing the impacts of their plans and projects on the environment. Given the heterogeneity of sources for information, it is maybe not surprising that 88% of respondents faced problems connected with spatial data use and in particular difficulties related to finding out what data is available and its quality, problems with accessing existing data and the rights to access them. However, the survey indicated that 60% of respondents accessed the Regional SDI regularly and indicated that the availability of its data and services contribute to a reduction in costs and time to produce environmental impact studies and environmental reports. In particular, 44% of participants estimated cost savings higher than 20% of the report's production cost and half of respondents envisaged time savings to produce such reports equal or higher than 30%.

Given that each year some 600 EIAs/SEAs are undertaken in Lombardy (average 2000-08), and that the average cost is €60-90 thousand each study, for an average duration of 3 month, the average savings from using the regional SDI (estimated at 11% of costs and 17% of time on average) amount to some €3 million per annum. Since the Region has invested approximately € 1.3 million per annum during the period 2006-08 to set up, develop, and maintain the regional SDI, it can be seen from these figures that the investment has more than repaid itself, even when considering only the case-studies of EIAs and SEAs.

It is also worth noticing that in the Regione Lombardia, the number of EIAs has more than doubled and SEAs increased by over 90 times since 2002. This is because the legislation on SEAs is more recent (Directive 2001/42/EC) and was ratified only in 2004 compared to that of EIAs which dates back from 1985(Directive 85/337/EEC). As a result, the number of total studies estimated in 2002 to be of the order of 35,000 across Europe, has probably increased very substantially and with that the volume of investments made to undertake these studies. Consequently, the benefits of INSPIRE for this application alone, are likely to be greater than those estimated in 2002.

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 14 of 19

Finally, it is important to underline, that the survey in Lombardia confirmed that aside from increased efficiency and reduced costs, the overall quality of the EIA and SEA studies has increased and the dialogue between developers and authorizing authorities has improved because they can discuss from a shared knowledge base of data and assessments. This benefits the management of the territory and society as a whole.

2.2.4 Data specifications and harmonization of existing data sets

Back in May 2008, the 29 INSPIRE contact points (27 member states plus Norway and Switzerland) were asked to provide us with information on the costs and benefits of recent national projects that involved the development of new data specifications and/or the harmonization of existing data sets. Out of the 15 responses received, one country was not able to provide us with the requested information, while 4 were not able to quantify the costs of the project, although they listed the main cost components.

The total costs incurred varied substantially among the various projects (range from EUR 0.5 million to EUR 15 million). However despite this difference, all the INSPIRE contact points reported, from a qualitative point of view only, similar benefits.

The main advantages are summarized below:

a) Direct User Value/Benefit

- Citizens will save time and money
- Data availability is increased
- Use of the data and data integration is facilitated
- Better sharing ability is achieved

b) Social Value

- Enables better decision making
- Reduces barriers between organizations
- Reduces time of searching and integrating data
- Increases institutional effectiveness since the quality and the content of information provided to the citizens and organizations is increased
- Promotes more efficient use of taxpayer funds (most of the projects are subsidized by the State)

c) Institution's operational benefit

- Acquisition of know-how
- Important step towards modern and efficient operation
- Promotes intra-institutional collaboration and multiple use and integration of different types of data
- Promotes inter-institutional collaboration not only of the central government but also with the regional and local authorities
- Promotes re-use of existing data sets
- Reduces data integration cost

d) Institutional financial value

- Overall cost savings for information management

INSPIRE		Fcbc_for_ic
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 15 of 19

- Achieves cost avoidance (as opposed to savings)

e) Strategic and Political value

- Promotes e-government concept and applications
- Fosters closer working relationships not only among public bodies but also between public and private sector
- Supports improved decision making
- Supports other information infrastructure since it constitutes part of the distributed network architecture of the National Spatial Data Infrastructure.

Only a few projects were able to quantify the benefits. UK's National Land and Property Gazetteer (NLPG) is an example of good practice in the cost and benefit analysis of projects, demonstrating that the benefits deriving from the harmonization of geographical information and the development of new data specifications are by far greater than the investments associated with the project (analysis demonstrated a cost-benefit ratio of 1:3).

3 Cost-benefit considerations in course of developing the Implementing rules on interoperability of spatial data sets and services

3.1 The participatory approach

The implementing rules for the interoperability of spatial data sets and services provide the arrangements and technical measures necessary to achieve interoperability within the scope of data themes defined by three annexes of the Directive. Since INSPIRE should be based on the spatial data infrastructures established and operated by the Member States, the stakeholders had the opportunity to participate in the development of the data specifications of INSPIRE. For this reason, the Commission has put in place a consensus building process involving data users and providers together with representatives of industry, research, and government. These stakeholders, organised through Spatial Data Interest Communities (SDICs) and Legally Mandated Organizations (LMOs)⁵, have provided reference materials, participated in the user requirement and technical⁶ surveys, proposed experts for the Data Specification Drafting Team⁷ and Thematic Working Groups⁸, expressed their views on the drafts of the technical documents of the data

⁵ Number of SDICs and LMOs on 21/11/2008 was 276 and 162 respectively

⁶ Surveys on unique identifiers and usage of the elements of the spatial and temporal schema,

⁷ The Data Specification Drafting Team has been composed of experts from Austria, Belgium, Czech Republic, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Switzerland, UK, and the European Environmental Agency

⁸ The Thematic Working Groups of Annex I themes have been composed of experts from Belgium, Czech Republic, Denmark, France, Finland, Germany, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, UK, the European Commission, and the European Environmental Agency

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 16 of 19

specification development framework⁹, commented the draft structure of the Implementing Rule on Interoperability of Spatial Data Sets and Services as well as participated on Annex I themes data specification testing process.

The data specification development methodology elaborated for INSPIRE has been complemented by the Commission with additional elements describing how cost-benefit considerations have to be taken into account in each step of the data specification process. The cost-benefit considerations in the data specification process for INSPIRE included a chain of prudent decisions such as

- (1) selection of relevant and representative use-cases to be supported by the infrastructure,
- (2) analysing the status quo situation (state of the art of data supply within the Member States),
- (3) developing initial data specifications fulfilling the data requirements of the identified use-cases
- (4) comparing the status quo situation with the initial specification (gap analysis),
- (5) modifying the specifications based on the gap analysis (avoiding not justified or excessive costs)
- (6) testing and reviewing the data specification
- (7) fine tuning of the data specifications base on the result of the tests and of the consultation of stakeholders.

Each of the above steps has been underpinned by using reference materials (245 submitted by stakeholders until February 2007), specific contributions, and the feedback of the stakeholders' communities.

3.2 Feasibility of the data specifications

To ensure the proposed Implementing rules will be feasible and proportionate in terms of their likely costs and benefits a testing process has been established for Annex I, where stakeholders assessed the feasibility of transformations necessary to present their data in conformity with the INSPIRE under their real conditions. Testing was open for all registered SDICs and LMOs and performed in a volunteer basis.

The transformation testing has confirmed the technical feasibility of the specifications. Ninety testing reports were submitted and analysed. A report from testing can contain results related to one or more Annex I Theme. The results will be published in a dedicated report

The reports from the testing participants confirmed that the proposed INSPIRE Annex I themes data specification are technically feasible and provided relevant recommendations for the data specifications version 3.0 and their implementation. This has been done together with the outcome of the SDIC and LMO consultation.

⁹Four documents describing common principles for data specifications across all spatial data themes. See further details in the text.

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 17 of 19

3.3 Results of testing

The testing of INSPIRE Annex I themes data specifications was also focused on evaluation of cost-benefit considerations relevant for the specific testing conditions. The testing participants have been asked to summarize or estimate the costs and benefits occurred during testing.

The transformation testing provided a first assessment of the effort required by data providers to transform their data according to the INSPIRE data specifications for a given theme. 62% of the participants did not recognise any additional costs associated with the transformation testing while 38% indicated costs, mainly related to the re-modelling of the data to be transformed, training for personnel, hardware components, and architecture maintenance. This indicates the readiness of participants to fulfil the new INSPIRE requirements. Among the testing participants 58 quantified the efforts connected to testing calculated in terms of man-days. The average effort was 43 man-days per data theme with a minimum of 1 and maximum of 250 man-days.

As for benefits, 26% of the testers indicated benefits. The most frequent ones were the improved data comparability and consistency, reducing barriers among organisations, promoting inter-institutional collaboration, and cost savings in information management and supporting the decision making processes. It should be noted that these benefits were mainly reported at data provider side due to the relatively low participation of the user communities. It is very likely that users will enjoy further benefits of interoperability, especially when specifications for Annex II and III will be ready. Moreover, also due to the short period available for testing, only seven tests were performed on applications, while 89 were performed on transformation. Consequently it was not possible to collect information on the benefit from the application view point and data users.

The testing process also has verified the cost-benefit considerations done in the previous steps of the data specification process. The results of testing have been carefully analysed by the European Commission and the expert groups (Data Specification Drafting Team, Thematic Working Groups) responsible for developing the data specifications. The outcome of the testing process has been used for finalising the proposed specifications.

4 Conclusions and recommendations

The development and establishment of the European spatial data infrastructure is a challenge, which requires not only the consideration of the technical feasibility, but also the proper assessment of the related costs and benefits. Such considerations are a core part of the process of establishing the regulation related to the interoperability of spatial data sets and services. The qualitative aspects of community feedback together with the quantitative results of SDI studies and testing provide a solid basis for concluding about the feasibility and proportionality.

INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 18 of 19

The experience indicates that the process of developing and establishing a spatial data infrastructure in close collaboration with the interested parties at several steps of the process makes possible to reduce costs and maximise the benefits. This is expressed in the choices taken when developing the data specifications as framework data model that can be extended to accommodate other related applications that may be necessary in future. As an example, this is the case of the INSPIRE data model developed for Hydrography which has been extended for the specific needs of the Water Framework Directive in collaboration with the WISE Technical Group. Similar examples indicate that the benefits can be extensively accessed once the infrastructure is in place. It is equally important to raise awareness especially among the users of the need to monitor the benefits, which will not occur immediately, but only when they start to use INSPIRE conforming data in their daily business. It is expected that the benefits of interoperable Annex I data will become fully apparent once similar arrangements are put in place for Annex II and III, where referencing thematic information to the data of Annex I is expected to be widely used.

In order to facilitate a cost-effective implementation of the data component of INSPIRE, the regulation for the interoperability of spatial data and services is accompanied by guidelines giving further explanations and practical advice for implementation.

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INSPIRE	Fcbc_for_ic	
Consolidation Team	Feasibility and cost-benefit considerations for implementing rule on interoperability of spatial data sets and services.	Page 19 of 19