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D.6.2: Report on the analysis of direct benefits and return on investment

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TABLE OF CONTENTS

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Abbreviation	Name
JRC	Joint Research Centre
ROI	Return On Investment
SBA	Societal Benefit Area
VMM	Value Measuring Methodology
WP	Work Package

1 INTRODUCTION

This deliverable (Report on the analysis of direct benefits and return on investment: D6.2) will analyse the benefits of increased interoperability in Europe with special focus on the thematic areas of the EuroGEOSS project (Forestry, Biodiversity and Drought) by using different methodologies such as the Value Measurement Methodology and meta-analysis, and demonstrate alternative approaches on selected case-studies in collaboration with the three thematic areas.

The focus of D6.2 will be on the methods used to perform such analysis, along with some initial results. Final results will be presented in the EuroGEOSS Final Report. D6.2 will be structured in two parts: 1) a focus on direct benefits and return on investment (ROI) external to the EuroGEOSS Project, conducted via a meta-analysis; and 2) internal EuroGEOSS analysis by means of direct benefit assessment via survey techniques.

2 EXTERNAL EUROGEOSS ANALYSIS

2.1 Meta-analysis

Understanding the earth system is essential for the investigation of global climate change feedbacks and the corresponding impacts on the socio-economic system. Spatial data is a key component of earth system research and is therefore essential for enhancing awareness of environmental and global changes. For this reason, spatial data is increasingly recognized as a national resource and basic infrastructure. Building systems for spatial data can assist framing policies, standards and procedures which promote more efficient use, co-ordination and production of spatial data. This, however, requires a substantial amount of resources often associated with high government spending. Accordingly, an extensive number of cost-benefit assessments attempts to justify the associated costs of Spatial Data Infrastructure (SDI) and Global Earth Observation System of Systems (GEOSS) investments. Previous research applied different approaches to evaluate the costs and benefits of SDIs and GEOSS so that results on the return on investment (ROI) vary considerably among studies, regions and sectors.

The objective of this study is to explain the variation in the average ROI of SDIs and GEOSS. For this purpose, a meta-analysis of 40 studies on cost-benefit assessments is conducted. Meta-analyses provide a method to combine results from different studies so that a general effect size can be calculated. Firstly, the studies are systematically reviewed and relevant information is extracted. Particular emphasis is given to the influence of the cost-benefit methodology, the metrics, the investing organisation and the influence of qualitative benefits. Secondly, a random effects model is estimated while controlling for the differences between the studies.

A meta-analysis is a statistical technique for summarizing and reviewing previous research on a specific topic by combining the results obtained from independent studies. There are various types of meta-analyses, including meta-analytic summaries and quantitative literature reviews. The most commonly applied method, however, is the quantitative literature review which investigates previous research and combines several individual study results to describe the overall strength of the effect.

By reviewing previous studies on the costs and benefits of Earth Observations (EO) and Spatial Data Infrastructures (SDI) we attempt to estimate an overall cost-benefit-ratio, the so-called general effect size, in order to gain precision on the costs and benefits of EOs and SDIs. We additionally extract all the relevant information that characterises the individual studies for

investigating inconsistencies and discrepancies between different study results. This enables us to identify factors and investment environments contributing to very high or low return on investments.

The validity of the meta-analysis, however, heavily depends on the quality of the systematic review. Therefore, we aimed for a complete coverage of all relevant studies. This includes the search on the web, in literature databases, libraries and sending e-mails to active researchers in the field (e.g. Roger Longhorn). In particular, we seek for heterogeneity by including various kinds of studies. In this report we describe the general methodology applied to perform the meta analysis. Results from this study will be provided in the EuroGEOSS Final Report.Generally, our meta-analysis consists of four main steps as outlined below.

2.1.1 Step 1: Systematic literature review

In a first step, we systematically reviewed all the relevant literature. This step included the

- creation of a master candidate list of studies including reports, book chapters and peer-reviewed studies (http://lyra2.felis.uni-freiburg.de/eurogeoss/) (Appendix I),
- a systematic examination of each study,
- a ranking of the relevance of the studies,
- and the extraction of data and information (Appendix II).

2.1.2 Step 2a: Coding of extracted data

Following the extraction of information from the studies we needed to code all the qualitative details and characteristics of each study and calculate the effect sizes in the second step. Generally, we have two options for coding qualitative data: we can either use a continuous scale or categories. Both coding types require the development of clear coding rules in order to avoid ambiguities and because the reliability of the coding depends on the consistency of the coding scheme. We use a categorical scale rather than a continuous scale in order to account for different groups and classes of study characteristics.

2.1.3 Step 2b: Choice of explanatory variables

In our analysis, we code explanatory variables of various kinds (see Appendix II):

- The variable “organization” controls for organization-specific effects.

- The “location” or “country” controls for country-specific effects common to all investments within a country.
- The “type of the study” variable controls for differences caused by the scope of the study.
- “Elements of SDIs or GEOSS in the project” controls for infrastructure projects and economies of scale.
- “Investment” controls for economies of scale, because large-scale projects often have fixed-cost degression effects.
- “Non-marketable benefits” control for additional benefits that are difficult to quantify in monetary terms.
- “Area, theme or societal benefit area” controls for economies of scope in the project.
- The “scope of the study” variable controls for incompleteness of the benefit calculation in studies as some studies include the direct benefits only and other studies include indirect benefits.
- Some studies are model-based (ex-ante) and approximate the benefits whereas other studies evaluated completed investment projects (ex-post) which could affect the cost-benefit-ratio: the corresponding variable is “ex-ante vs ex-post”.
- The “methodology” for assessing benefits, including the cost benefit analysis (traditional, financial / monetary), cost effectiveness analysis, Value Measuring Methodology, GeoVMM (variant of VMM – NASA ROI work), social cost benefit analysis, multi-criteria analysis and the social multi-criteria analysis, controls for differences in the benefits caused by the underlying methodology.
- The “metric” controls for differences in the CB ratio caused by the metric.
- The “region” controls for region-specific effects common to all investments within a region.
- “Private vs. public funding” controls for inefficiency and quality differences between private and public investors.
- The variable “year” serves as a fixed effect to control for year-specific effects that are common to all investments.
- The “duration of investment” controls for expectation of repetitive payments.
- “Risk” controls for the uncertainty and risk in the investment.

2.1.4 Step 3: Meta-regression

In the third step we conduct the meta-regression and this mainly involves:

- the examination of the distribution of effect sizes and the analysis of the impact of each moderating variable,
- testing for heterogeneity,
- assessing the consistency or homogeneity of the study results,
- and testing for the significance of the overall effect.

For our purpose, we could identify two main meta-regression methods: (i) the fixed effects and (ii) the random effects approach. The fixed effects approach is used when the between-study heterogeneity is little and assumes that studies estimate the same effect. In contrast, the random-effects approach allows for between-study heterogeneity assuming that the effect varies between studies around a mean effect.

2.1.5 Step 4: Analysis

The Analysis step requires analysis of the results obtained from the meta-regression, which includes:

- summarizing the methods for the effect size calculation,
- interpreting and reporting the results,
- predicting of variations in effect sizes from the values of moderating values,
- deriving implications and identifying limitations,
- performing sensitivity analyses (robustness check on main findings) and
- a critical evaluation (internal and external validity).

A word of caution: we are looking at very different issues in the studies: Some are about GIS investments while others are SDIs, GMES, GEOSS, etc. The majority are ex-ante and very few ex-post. We are trying to control for these differences by introducing a variable that differentiates GIS from SDI or GEOSS. However, the differences are huge between investing in a GIS inside one organisation or in a multi-organisational structure and even more complex when investing in an SDI (in which the hardware and software components are very small, or as in GMES, which include the launching of satellites which is a very expensive business).

3 INTERNAL EUROGEOSS ANALYSIS

This section details the internal EuroGEOSS analysis by means of direct benefit assessment via survey techniques. In particular, both the value measuring methodology (VMM) and expert questionnaires are described.

3.1 Value Measuring Methodology (VMM)

At the core of the EuroGEOSS VMM methodology is the analysis of a two-step questionnaire answered by experts specializing in the fields relevant to the Project. We are using the VMM technique to determine the value of the Project by comparing the current state (no EuroGEOSS in 2010), and the future state (with EuroGEOSS in 2012). The difficulty here is that numerous case studies estimate that the full outcomes are often felt more than a decade after the research is initiated. The initial “no EuroGEOSS” data was collected through an online questionnaire. Experts were asked to first assign a value to each question on a percent scale. Following this, they must define priority (importance) of each of the questions. Results are then quantitatively analyzed. We use deviations of individual expert opinions from a common average score to quantify the experts’ confidence in their responses and thus suggest possible uncertainty-related risk estimation in received information. A second questionnaire was completed, eight months before the end of the project. Here, we present initial findings from the second survey (Figs 1-2). Final results will be presented in the EuroGEOSS Final Report.

Figure 1: Percentage of participants in second survey not included in the first

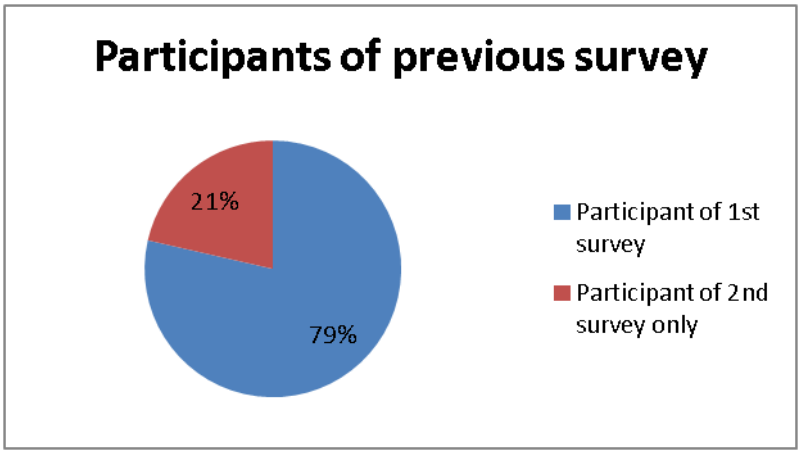
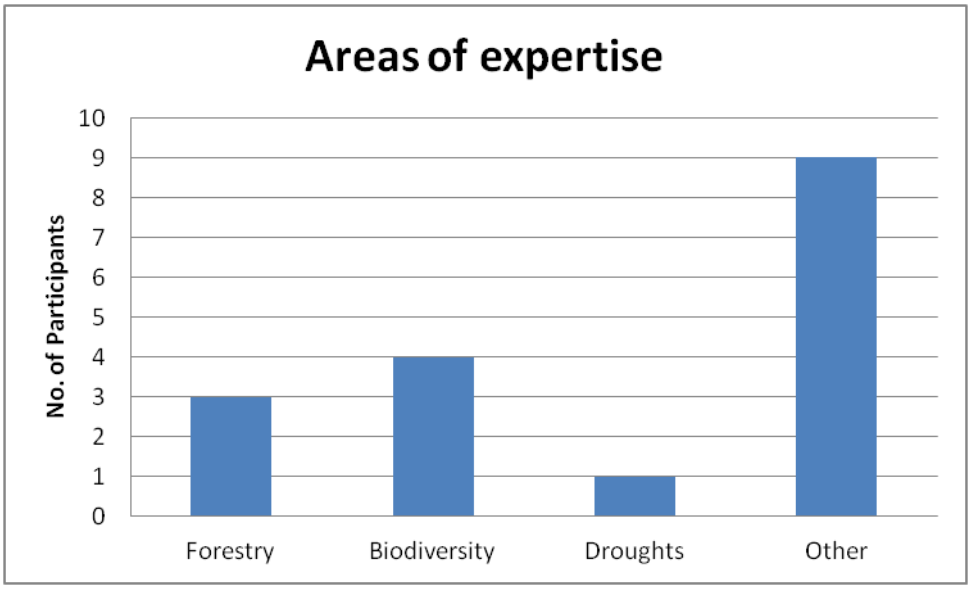


Figure 2: Number of survey participants in each project's themes



It appears from both Figure 3 and Figure 4 that regarding data availability and data search time, EuroGEOSS participants surveyed have witnessed improvement as a result of the EuroGEOSS Project. Improvement has however been moderate, with some participants recording no change, while others show twofold increases. Regarding data search time, participants generally agreed that a moderate improvement occured.

Figure 3: Data availability, before EuroGEOSS and after EuroGEOSS.

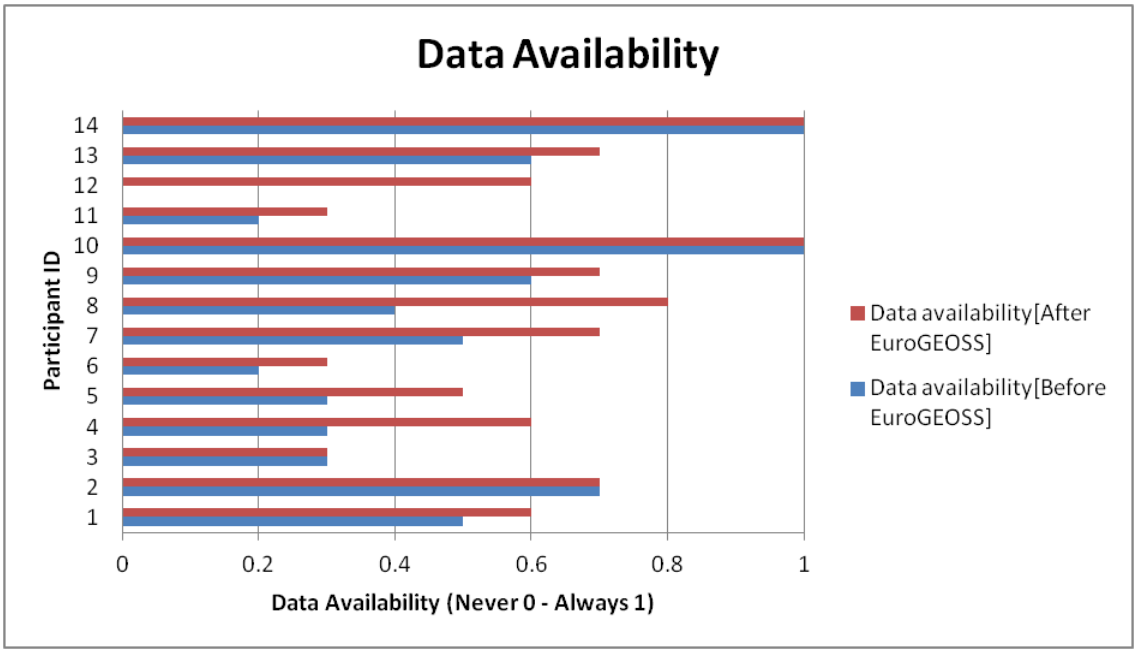
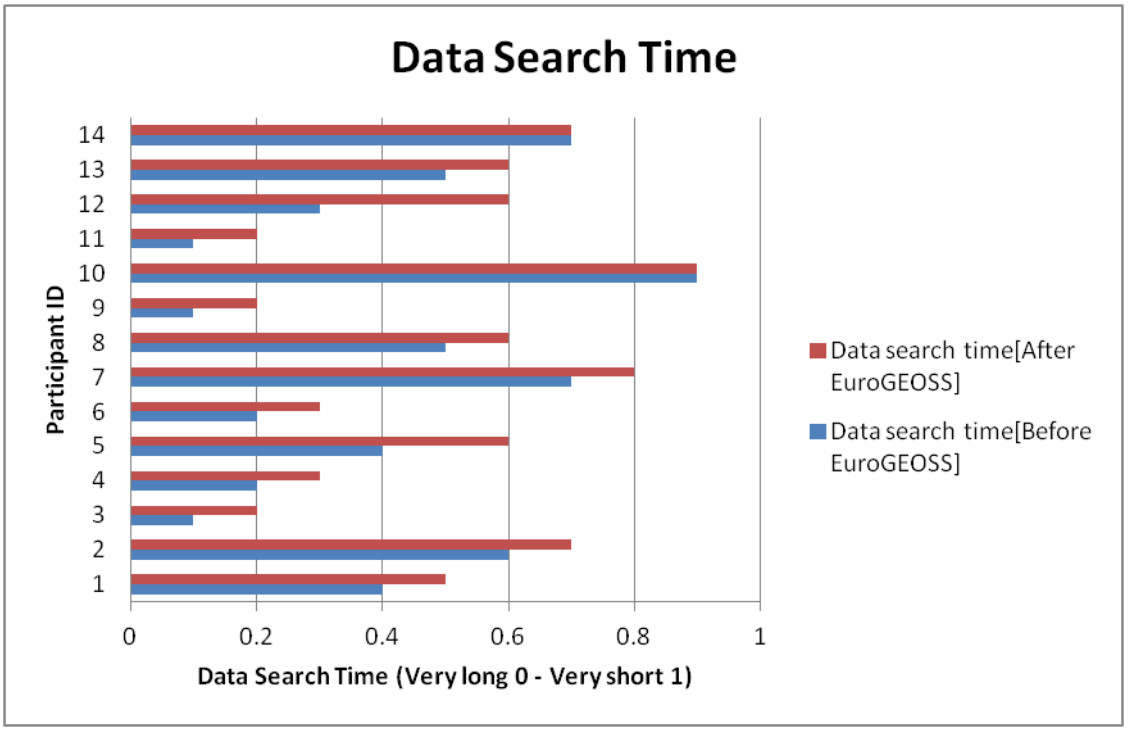


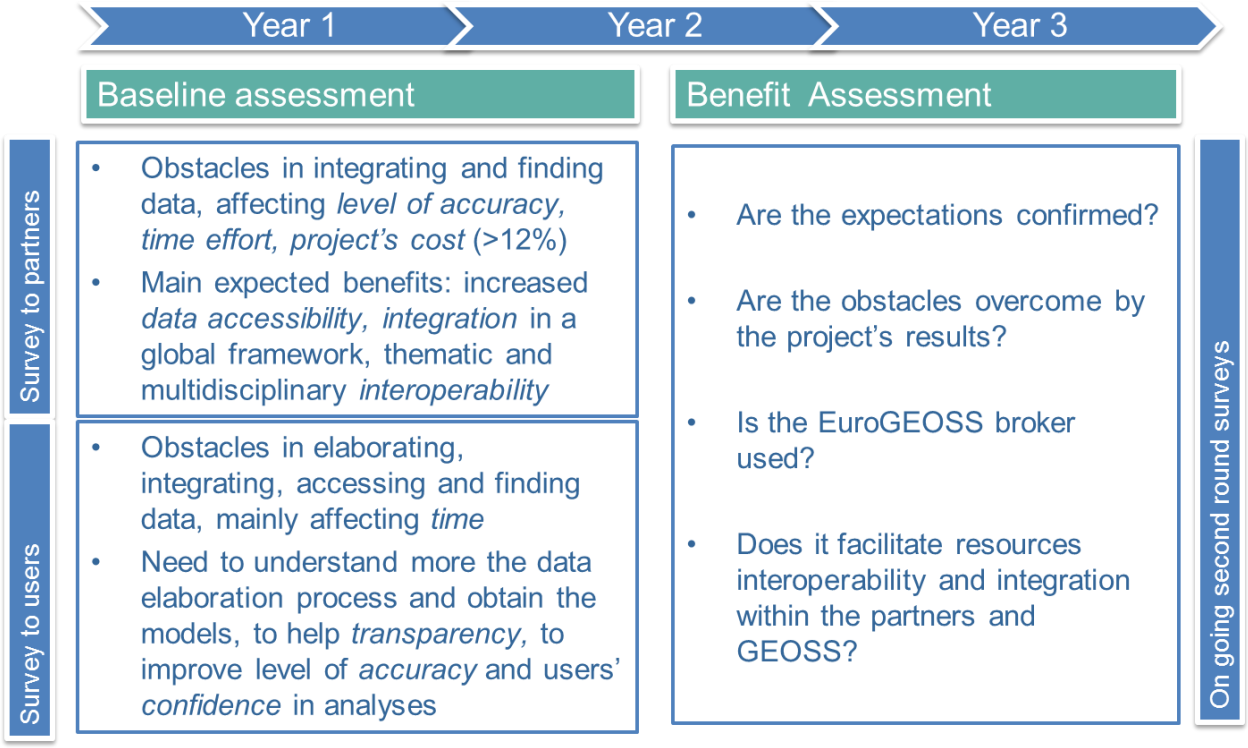
Figure 4: Data search time before EuroGEOSS and after EuroGEOSS.



3.2 Expert Survey Techniques

In the framework of the cost-benefit analysis within EuroGEOSS WP6, in the first year of the project JRC prepared two sets of surveys, in order to establish a baseline to be then compared with the situation at the end of the project. The first survey was directed to the project's partners, aimed at collecting information about the current obstacles with the use of spatial data and the expectations from the projects, in each thematic area. The second survey was addressed to the main users of the partners' datasets and models to know the processes they go through when using them and the problems occurring. In the Figure 5 below, the left side describes the main outcomes of these two surveys, in terms of obstacles identified and expected benefits. The survey to partners has been repeated at the end of the project to understand the benefits and improvements brought about by the EuroGEOSS project, while the second survey to the users was conducted during the final EuroGEOSS Conference in Madrid.

Figure 5: EuroGEOSS Value Added Assessment – survey overview



The results of the baseline assessment surveys have been reported in D.6.1.2. This section describes the results of the second survey to the partners, carried out in October 2011. Twelve experts from partners who had replied to the first questionnaire were contacted and asked to give their opinion through oral interview or written questionnaire. The aim of the survey was to understand their views about possible tangible and intangible benefits that the partner organisations have obtained thanks to the EuroGEOSS project. The following questions were asked:

1. Were the expectations stated in the first survey's responses, met by the projects' results?
2. What has been in particular for you the added value of the EuroGEOSS project?
3. There are many benefits that it is not possible to quantify: would you share your thoughts about this?

To guide the interviewees in developing their reflections, we have asked to think about their replies, giving also examples, in particular in terms of:

- increased data accessibility,
- increased data sharing
- time and cost savings
- increased thematic interoperability
- increased multidisciplinary interoperability
- integration of European systems into a global framework
- better decision support process
- any other aspect in which they have experienced benefits in these years (e.g. better networking with external colleagues, major awareness of the problems and so on)

The rate of response was 8/12. Unfortunately, we were not able to gather more views; however, the obtained ones are very detailed and give already interesting insights.

The first question was positively answered by all the respondents. In particular, they have underlined that the newly developed metadata catalogue facilitates data accessibility, and that data providers could disseminate their data to a wider public, increasing data sharing (e.g. biodiversity data via GBIF network). Moreover, the availability of one entry point for accessing multithematic data (the broker) reduced time and costs needed for searching, requesting, accessing data.
EuroGEOSS is perceived by some partners as the starting point of an interoperable infrastructure within the thematic areas (e.g. for biodiversity with focus on Protected Areas and birds); and at the same time, the EuroGEOSS broker has given the possibility of accessing, consulting and integrating thematic European data for integrated assessments (e.g. eHabitat scenario). The

project has also allowed the expansion of area of collection of data at wider scales than EU (e.g. Africa), direct access to global data, thus facilitating the integration of EU systems in the global framework.

From the personal perspective, the respondents have given a wide variety of reasons why the EuroGEOSS project may be considered successful. Among others, the following factors were mentioned most frequently:

- Networking and close contacts with local and international partners and other organisations in the Environment and Geographic Information arena, in view of future collaborations;
- Awareness of common difficulties but different views, to solve the problems as a team, and to share knowledge and experiences;
- Increased awareness of GEOSS and its Societal Benefit Areas;
- First assessments of the benefits of interoperable services;
- Support in INSPIRE web-services implementation.

At the same time, the respondents highlighted some challenges encountered during the implementation of the project. In their view, the thematic interoperability would require further research and the political will of supporting the GEOSS data sharing principles. On the other hand, the potential for data sharing disclosed by projects like EuroGEOSS could lead to misuse and misinterpretation of key datasets, therefore their owners are likely to prevent a full access to the data to the whole community. According to some partners, outside of such a project, it is unlikely that data will be shared in such an efficient way as in EuroGEOSS.

As regard multidisciplinary interoperability, a respondent stated that “the need to perfectly understand the origin of the data used from other communities for modelling purposes requires a very clear documentation of the (meta)data as well as a “blind trust” in the data used”. The quality of the metadata was also mentioned as one of the problems still faced in the development of the metadata catalogues.
Following the results of a parallel survey in the WP3 (Forestry) one of the respondents considered that a cultural change would be needed to meet the above challenges, a change that would lead field scientists and modellers to understand the potential of sharing their data and models, which is still not well understood. This is linked to the difficulty that non-expert people (or people from outside the project) could have in entering the EuroGEOSS logical of multidisciplinary interoperability, data and model sharing, which are very advanced concepts.

On the practical side, some respondents gave their concerns about the fact that, even being part of the project, they have difficulties in installing and accessing the broker, with possible consequences of lack of interest and disuse of the system.

4 SUMMARY

This Deliverable D6.2 highlights the fact that the analysis of the direct benefits and return on investment is well underway. It is important to remember that the full outcomes are often felt more than a decade after the research is initiated. Thus it is a difficult task to measure the benefits of a Project which is still under development, and the results of which are only now starting to become widely known. Therefore, we have turned to several different techniques to achieve our goals.

The report focuses on two broad areas – namely on the broader field of cost-benefit assessment and ROI external to the project, and the direct benefits derived from the EuroGEOSS Project itself. External to the Project, we employ a meta-study searching the literature in this field with the objective to state globally the common findings and trends in benefit assessment and ROI. Furthermore, we employ surveys relying on project participants and related data users and experts based on what they know about the current situation, and what they envision the Project will achieve.

All results from the methods outlined in this report will be available in the final report.

5 ANNEXES

5.1 Appendix I - Studies currently in http://lyra2.felis.uni-freiburg.de/eurogeoss/

A '+' in front of a citation indicates an applicable study for inclusion in the meta-study. A '-' in front of a citation indicates studies not applicable to the meta-study.

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5.2 Appendix II - Definition of explanatory variables in the systematic literature review

Variable	Definition or Question	Example	Economic Meaning
Nr	Number of study	1,2,3	-
Date	Date of study	January 2011	-
Organization	*Which organization conducted the study?*	Price Waterhouse Coopers KPMG	E.g. control variable for organization-specific effects
Location or country	*In which country or city is the organization located or where has been invested?*	KPMG in Berlin, Germany PWC in Australia assessed investment in New Zealand	E.g. control variable for location-specific effects
Type of study	*What is the type of study?*	Cost-benefit-analysis Report Investment analysis Impact assessment	E.g. control variable for comparability of cost-benefit ratios
Min. Benefit : Cost	*What is the minimum cost-benefit ratio?*	- 1:2	Which min. could be expected?
Max. Benefit : Cost	*What is the maximum cost-benefit ratio?*	- 1:40	Which max. could be expected?
Benefit : Cost	*What is the general ratio of costs and benefits?*	- 1:4	Which cost-benefit could be generally expected?
Elements of an SDI/GEOSS in place?	*Is the investment on a system or on GIS?*	- SDI yes - GEOSS yes	Control variable for infrastructure projects
Investment	*What is the level of investment?*	- 3 M€	E.g. controls for economies of scale; e.g. large-scale projects often have fixed-cost degression effects
Other comments	*Are there any other specifics about the study that are important to notice?*	Anything you consider as relevant for determining costs or benefits of the project may be included in this field	-
Non-marketable benefit	*Are there any intangible benefits (benefits that are difficult to measure in monetary terms)?*	Improved decision making Standardization of products Environmental gains	May used to adjust low cost-benefit ratios or to control for additional benefits
Area, theme, societal benefit area	*Which societal area or economic sector benefits from the investment?*	Logistics Agricultural sector	E.g. control variable for economies of scope
Scope	*Did the study consider the complete chain of benefits?*	some studies only consider certain benefit areas or certain benefits other studies consider the complete benefit chain or future benefits	E.g. controls for incompleteness of benefit or may serve as an adjustment variable

Variable	Definition or Question	Example	Economic Meaning
Ex-ante vs. ex-post analysis	*Is the study based on a model calculation or real investment?*	Model Investment	Controls for model-based studies
Cost-benefit methodology	*What type of methodology is used to assess the benefits?*	CBA (traditional, financial / monetary) Cost Effectiveness Analysis Value Measuring Methodology GeoVMM (variant of VMM – NASA ROI work) Social Cost Benefit Analysis Multi-Criteria Analysis Social Multi-Criteria Analysis	Controls for differences in the CB ratio caused by the methodology
Metric/ benefit measure	*What type of metric does the study use?*	Internal rate of return Return on investment Net present value Economic value (value to the economy in x years) Other metrics? (e.g. time until amortization, necessary investment to do another investment)	Controls for differences in the CB ratio caused by the metric
Country/EU	*Is the Investment on a national level or within a larger community?*	EU Italy	Economies of scale Controls for country-specific effects common to all investments within a country
Region (sub-national)	*Is the investment on a regional level?*	Emilia Romagna	Controls for region-specific effects common to all investments within a region
Private vs. public funding	*Did a private or public organization invest?*	Government Consulting Agency	Controls for inefficiency and quality differences
Year	*In which year was the study initiated?*	1990	Needed to adjust for inflation Year serves as a fixed effect to control for year-specific effects that are common to all investments
Duration of investment	*Is the investment non-recurring or repetitive?*	Once in 1990 In 1990, 1991, 1992	The expectation of repetitive payments
Annual ROI	*What is the annual return on investment?*	- 5%	Control variable
Discount Rate	*Is there a discount rate?*	the discount rate discounts future benefits to a current value most likely to be found in model-based study but sometimes also in investment studies that account for additional benefits in the future	If the discount rate differs among studies we may have to adjust the cost-benefit ratio for each study
Net benefit	*What is the net benefit?*	Net benefit=benefits-costs	For general information
Risk	*What is the risk of the investment or does the study account for risks?*	The potential of the investment to lead to a loss	Controls for uncertainty and risk