Centre for Geo-Information

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Improving the accessibility of Remote Sensing data using Spatial Data Infrastructure concepts.

A research concerning the demands and requirements of RS data accessibility at the CGI

J.A.E. Teunissen BSc.

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WAGENINGEN UNIVERSITY
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A research concerning the demands and requirements of Remote Sensing data accessibility at the CGI

J.A.E. Teunissen BSc.

Registration number 800214-827-100

Supervisors:

Drs. H.M. Bartholomeus
Ir. J.W.H.C. Crompvoets MSc.

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Prologue

The research report that lies in front of you is written to fulfil the Master of Science Geo-information at the Wageningen University (WU). The research topic is chosen, because of my personal interest in subjects that deal with the management of geospatial data.

In addition to the fulfilment of the Msc. Geo-information, this report is written to provide applicants with information about analysing the demands of people regarding RS data accessibility. The employees of the Centre for Geo-information (CGI) and Wageningen University (WU) are assigned as the main target groups of this report. This research is namely executed in the CGI and WU framework. Other organisations that struggle with making RS data accessible could also extract useful information from this report.

Before I started with the actual research I made some personal objectives. These objectives are principally based on personal interests and self-reflection. The first objective is based on my personal interest in subjects that deal with management of geospatial data. By executing this research I want to increase my knowledge by getting more familiar with the aspects involved in managing Remotes Sensing data.
The second and third objectives are described to keep my focus during this research on verbal communication. During my previous course (BSc Soil and Water engineering), I discovered that it is a huge step for me to simply pick up the phone or go personally towards somebody to acquire information. I always prefer the use of Email, while a personal approach often results in getting familiar with organizations and contribute in the process to build a own network. A second point discovered during my previous course is the difficulty I experience with making myself understandable to others. Often I use many words to make myself clear, which sometimes resulted in the opposite.
These personal objectives are evaluated in the epilogue at the end of this report.

Finally, I want to thank some people. First, I want to thank my supervisors of the Wageningen University; Harm Bartholomeus and Joep Crompvoets. Both supervisors spend many efforts in order to keep an eye on the scientific quality of this report. The personal interest of these supervisors in the progression and results of the research added with the delightfulness of snacks, ended up in informative, inspiring and satisfying lunch meetings. Despite of their busy schedules both supervisors were always available. I experienced the assignment of these two supervisors as a privilege.
I also appreciate the support of my families and friends during the whole research period. Therefore, I want to say, thank you all!

Arnhem (the Netherlands), June 2005

Jasper Teunissen Bsc.

Summary

Improving the accessibility of Remote Sensing data using SDI concepts
(A research concerning the demands and requirements of RS data accessibility at the CGI)

Remote Sensing images are frequently used in research projects. After finishing a project, the acquired Remote Sensing images could be useful for other purposes (e.g. monitoring projects). In order to offer the opportunity to reuse available RS images easy access for RS data users has to be provided.

The Centre for Geo-Information (CGI) is struggling with making Remote Sensing (RS) data accessible. The CGI wants to implement Spatial Data Infrastructure (SDI) concepts in order to improve the RS data accessibility. In addition, the CGI prefers a web-based RS catalogue to make RS data accessible. Which SDI concepts are required and what the demands regarding the RS catalogue to make RS data accessible are unclear.

In order to determine the requirements and demands concerning RS data accessibility a RS Information System Development Methodology (ISDM) is constructed. This RS ISDM is called the Alternative Waterfall Approach 2005. This approach offers a set of stages to determine the demands and requirements regarding a RS catalogue. Four stages are executed.

In the first stage, the acknowledgement of the problem regarding RS data accessibility within the CGI is explored. The acknowledgement of the problem regarding RS data accessibility is caused by frustrations. The system used to manage the RS data collection does not invite people to use available RS data. In addition, the operation of the system irritates several CGI employees.

The second stage is executed to gain information about RS data accessibility inside and outside the CGI. Several activities are executed, which resulted in much valuable information. An analysis of the system used to manage the RS data collection determined that the system is seriously outdated. A literature study provided information about similar projects, SDI components and ISDM's. Interviews determined that the CGI is not the only organization who is struggling with RS data accessibility. Finally, several RS-portals present on the World Wide Web (WWW) are evaluated, which supplied information about aspects included in RS-portals.

The third stage of the Alternative Waterfall Methodology 2005 provided information about demands and user requirements regarding the RS catalogue, metadata and other subjects. These demands are acquired by involving CGI employees in the development process of the RS catalogue.

In the fourth stage, the core SDI concepts needed to establish a RS catalogue framework are determined based on information gained in the previous stages. The core SDI concepts determined are; metadata, software, people, datasets and network. In addition, the requirements regarding the web-based facility are verified.

After executing these four stages the demands regarding RS data accessibility are summarized in one sentence; one central, easy accessible for everybody, web-based facility that provides efficient and effective discovery, evaluation and use of available RS data.

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1 Introduction

The last few decades remote sensing technology has been used increasingly by the scientific community to describe and monitor a variety of systems on a local or global scale (Dahdouh-Guebas, 2002). Data from earth observation satellites are often the only source of information available on the condition and dynamics of large parts of the earth's surface and atmosphere at appropriate spatial and temporal scales (Harris & Olby, 2001).
The scientific community uses not only actual Remote Sensing (RS) data, also old data is used. The amount of monitoring project papers whereby RS data is used shows the practical value of old data (Graham Cogley & Adams, 2000)(Douglas et al, 2003)(Reis et al, 2003). Old RS data creates the possibility to analyse the past in order to understand the present.
The use of old RS data depends on the accessibility and documentation of the data. According to Nogueras-Iso et al (2004), numerous studies have remarked that although the value of geospatial data is recognized by both government and society, the effective use of geospatial data is inhibited by poor knowledge of the existence of data, poorly documented information about the data sets, and data inconsistencies.

For the development and transfer of scientific knowledge in the field of Geo-Information (GI) and Remote Sensing, Wageningen University (WU) and Alterra established -via a close cooperation- the Centre for Geo-information (CGI) (Url 1, 10-11-2004).
The GIRS (GI Science with special emphasis on Remote Sensing) chair is an elementary component of the WU. This chair possesses a RS data collection acquired for a variety of research projects.

The GIRS RS data collection manager (Drs. H. Bartholomeus, personal communication) cites that the CGI is not satisfied with the system used to manage the RS data (RS images and metadata). The system does not invite people to use the available data. In addition, the operation of the system is causing frustrations.
A cardboard box is used to store the complete GIRS RS collection. The box contains a large amount of CD-ROM's. These CD-ROM's contain RS images. Metadata is used to describe the RS images. The metadata is stored in a plaintext metadata list, which is accessible by a File Transport Protocol (FTP) server. To access the metadata list, CGI employees have to be familiar with the FTP address. Retrieving RS data by using the metadata list is complicated. Many metadata descriptions are stored on the list. The only possibility to retrieve metadata is by browsing through all the metadata descriptions. This is a time-consuming activity. After finding a particular RS image in the metadata, the corresponding data retrieval is laborious. A non-automatized method is used to extract a RS image out of the cardboard box.

Due to the value (scientific and economical) of RS data, the CGI would like to guarantee the effective use of available RS data (Drs. H. Bartholomeus, personal communication). The CGI assumes that the GIRS RS collection is valuable. By improving the accessibility, the effective use of available RS data will be stimulated. In this project, accessibility is referred as the possibility to discover available RS data, determining the fitness for use (evaluation) and the possibility to retrieve RS data (use).
In attempt to improve the accessibility, the CGI acts as a test bed for other companies who struggle with the same problems.

1.1 Problem definition

The CGI wants to guarantee efficiency and effectiveness in the use of available RS data. Therefore, the CGI wants to implement Spatial Data Infrastructure (SDI) concepts to improve the RS data accessibility. Rajabifard and Williamson (2003) define an SDI as an initiative that underpins the design, implementation and maintenance of mechanisms that facilitate the sharing, access and utilisation of spatial data across different communities to better achieve their objectives. In addition, the CGI prefers a web-based RS catalogue to establish a central access point for RS data.
Making RS data accessible by implementing SDI concepts is more than a technical matter. According to Rajabifard and Williamson (2003), it is important to understand the human and community issues as well as technical issues, because they contribute to the success of SDI developments. Issues like culture for data sharing and community requirements are as important as technical issues like spatial data access and networks.

The SDI concepts needed to improve the RS data accessibility are not clear. These SDI concepts have to satisfy the demands and requirements of the people involved in this research to make RS data accessible. People involved in making the RS data accessible by using a RS catalogue are referred as stakeholders. The exact stakeholders of the RS catalogue are undefined, as well as their requirements and demands concerning the SDI concepts.

The web-based RS catalogue is the SDI mechanism, which have to provide RS data accessibility in an efficient and effective way. The design of the user interfaces plays a vital role in making the RS data accessible. The RS catalogue users interact with the catalogue interfaces in order to satisfy their RS data needs. The design and aspects included in the user interface (search tools, functions, etc) determine the efficiency and effectiveness of the accessibility of the RS data. In order to design the interfaces it has to be transparent which aspects (search tools, functions, etc) are required to make the RS data accessible. In addition to the design and aspects of the RS catalogue, a good description of individual datasets should be provided. This allows the RS catalogue users to determine if a certain dataset can be used or not.

The CGI prefers a structured methodology to analyze the demands regarding RS data accessibility. A structured methodology exhibits the executed steps in order to meet the final goal; the implementation of a RS catalogue in the CGI framework to improve the RS data accessibility. The executed steps provide valuable information for other organizations that struggle with RS data accessibility.

Within this research, some restrictions are made to keep it feasible to finish the research within the predefined planning.

→ For the dissemination of RS data via a digital catalogue, data legislation is a very important aspect. However, to avoid non-GI related discussions about e.g.; copyrights, privacy, contracts etc., juridical data legislation subjects are excluded in this research;

→ The GIRS RS collection forms the initial concept of this research. No attention will be paid to another RS collections present within the Wageningen University and Research centre (WUR).

1.2 Research questions

The central research question of this research is:

What are the demands to access Remote Sensing data using Spatial Data Infrastructure (SDI) concepts applied within CGI?

The central research question is split up in several sub research questions to specify the orientation of this research.

Sub research questions:
→ What are the demands of the stakeholders towards the RS data accessibility?
→ Which core SDI concepts are recommended to make RS data accessible and fit the stakeholders demands?
→ What are the demands with regard to RS data for making this data accessible by a web-based RS catalogue?
→ What are the user requirements towards the description of the RS data and usability of the system?
→ What are the implementation steps of a web-based RS catalogue?

1.3 Objectives

A main objective is formulated from the central research question:
→ Determine the stakeholders of the RS catalogue and analyse their demands concerning RS data accessibility.

In addition, several sub objectives are defined:
→ Gain relevant knowledge about SDI's, RS data accessibility and a structured method to analyse the demands and requirements of the stakeholders;
→ Integrate SDI-concepts with RS-data accessibility in order to improve the effective use of RS data;
→ Make a description of the appearance of the web-based RS catalogue.

In the prologue the personal objectives of the researcher are described. In the epilogue is a retrospective view on the earlier defined personal objectives described.

2 Theory and concepts

A Geo-Information (GI) literature consultancy provided information about subjects dealing with making RS data accessible. The information gained by the literature review is described in this chapter.

2.1 SDI

Rajabifard and Williamson (2002-A, 2003)(Crompvoets & Bregt, 2004) describe the core components of an SDI. These core components are; policy, access network, technical standards, people and data. The components can be placed in different categories based on the different nature of their interactions within the SDI framework. The first category includes the basis components people and data. SDI is whole about sharing data and cooperation between different people within and across different disciplines in spatial data communities. The second category are the technological components; policy, access network and technical standards. This second category is very dynamic due to the speed of technological developments and conciliation of rights, restrictions and responsibilities between people and data change. The second category signifies that an SDI involves more aspects than spatial data alone. Figure 1 displays the nature and relations between SDI components. Everybody who would like to access spatial data should enter the technical components.

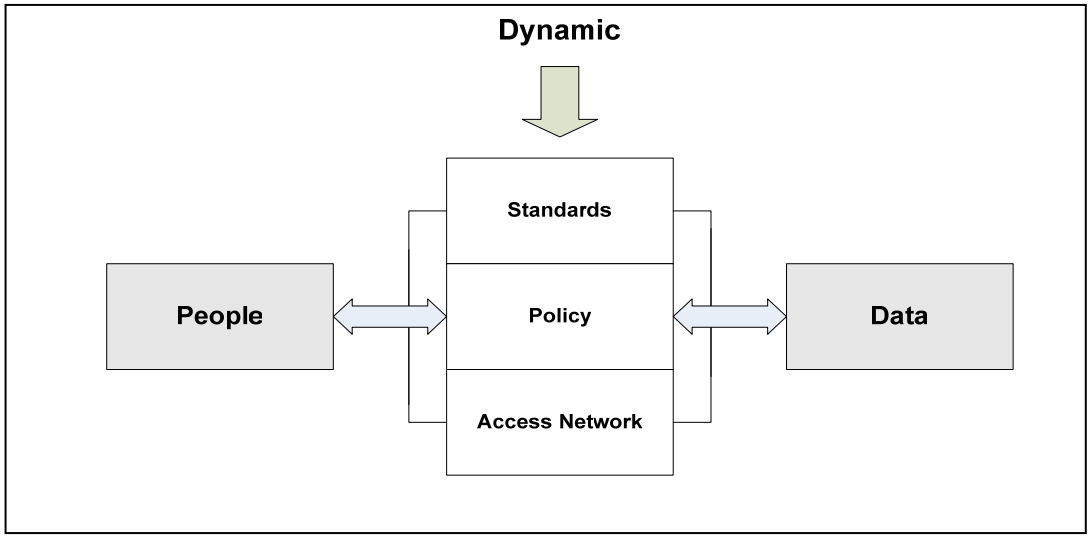


Fig. 1 Nature and relations between SDI components (Rajabifard, Williamson, 2002-A)

Fig. 1 provides a global view of the nature and relations between SDI components. These components are applicable to multiple SDI initiatives. It is tried to acquire detailed information about these core SDI components, focussed on making RS data accessible by using a web-based RS catalogue.

People
The stakeholders of a RS catalogue are not determined. The terms "RS catalogue" in combination with "stakeholders" are often mentioned in GI literature. However, a description of the exact stakeholders is each time absent. Therefore, the scope is broadened to gain some stakeholder information.
Focussing on a web-based system, Ginige and Murugesan (2001) state that the stakeholders are the system's main users, the organization that needs the system and those who fund the system.
According to Rajabifard & Williamson, (2004), the stakeholders of an SDI are the data providers, value-adders and data users. The exact value-adders are not described.

On a national SDI level, Nebert (2004) mentions that often governmental suppliers are key stakeholders. Subsequently, commercial entities are named as important providers of services, tools and sometimes data. In addition, end-users are named as stakeholders. Their involvement of an SDI depends on several factors including: the functionality of the infrastructure tools, the amount and quality of the content accessible, operating policies, infrastructure business model (will consumers be charged for access?), etc.

Data
Detailed information about which RS data is relevant to include in the RS catalogue is not found. According to Rajabifard (2002-B) Chan, et al (2001) Coleman & McLaughlin (1998) and Mclauglhin & Nichols (1992) an SDI encompasses fundamental datasets. The question is which datasets are fundamental to include in the RS catalogue.
Nedovic-Budica (2004) executed a study about the effectiveness of existing SDI developments and about outcomes of the related interactions between the local, state and national levels. Several case studies are used to evaluate existing SDI's focussed on local planning activities. An outcome of this study was that only some of the data themes available and accessible by SDI's are relevant to urban planning functions. Potential purposes to extract RS data out of the catalogue are unclear.

Standards
According to Groot & McLaughlin (2000), GIS designers and developers do not doubt about the usage of standards. In fact, the question is which standard should be used. Groot and McLaughlin (2000) state that choosing appropriate standards forms a challenge to make systems easier to manage and to improve the sharing of information. Many standards that are important for GI users exist. The availability of standards ranges from hardware- to operating system standards.
The focus of this research preliminary aims on a RS metadata standard, because metadata is seen as an important aspect of the RS catalogue. According to Nebert (2004) consistency in metadata content and style is recommended to ensure that comparisons can be made quickly by data users as to the suitability of from different sources. The FGDC states that geospatial standards facilitate data sharing and increase interoperability among automated geospatial information systems (Url 2, 9-11-2004)
Six standards dealing with geographical information are found on the internet;

- → The European Committee for Standardization (CEN) constructed the CEN 1998 (Url 3, 9-11-2004).
- → The NVN-ENV 12657 (version 3.0) standard, created in 2003, based on the CEN 98. This standard is a Dutch pre-norm used by the Dutch Ministry of Traffic and Water management (Heres et al, 2004).
- → The Federal Geographic Data Committee (FGDC) composed the 'Content for digital geospatial metadata' (American) standard, published in 1998 (Url 2, 9-11-2004).
- → The FGDC build another version the 'Content for digital geospatial metadata: extensions for RS data', published in 2002 (Url 2, 9-11-2004).
- → The International Organisation constructed the ISO 19115, available since 2003 (Url 4, 9-11-2004).
- → The ISO 19115-2, an extension for imagery and gridded data is under construction. This standard will be available in 2007 (Url 4,9-11-2004)

Nebert (2004) cites that, if possible, a supported international standard should be selected. Invent an own standard or make subtle changes in an international standard may result in costly problems. Standard metadata tools will be unusable and metadata will not be exchangeable by software.

Policy
According to Boer (2004), the Dutch cabinet made the decision on 28 November 2003 to make in six years twenty million Euro available for a programme proposal called "Space for Geo-Information". The aim of this project is to improve and innovate the geo-information facility in the Netherlands for a good and efficient management and powerful business. In this proposal, six themes are mentioned:

1. Determination of the preconditions for the development of an optimal GI infrastructure for social questions;
2. Further development of the national GI infrastructure;
3. Identification of authentic geo-registrations;
4. Improve accessibility of geo-datasets;
5. Provide strategic research and education, which is needed for these purposes;
6. Stimulate organizational- and product- innovations.

Mainly theme four, improve the accessibility of geo-datasets, is corresponds with this research. However, this research also contributes to themes 1 (process of analysing the demands regarding RS data accessibility), 2 (Core SDI concepts needed to make RS data accessible) and 5 (structured method to develop an RS catalogue).

Access Network
Using the Word Wide Web (WWW) as network to make RS data accessible is a good choice. Quite a few articles underline why the internet should be used to make data accessible.
According to Bajracharya et al (2004), the internet technology provides an efficient and effective way in obtaining, using and sharing both spatial and non-spatial information. Foster et al (2001) states that with internet technology it is possible to make data and information available inexpensively to both traditional users and new groups of users, including individual citizens.

Metadata
Metadata is not included in fig. 1. However, it is seen as an important SDI concept and therefore discussed in this paragraph.
According to Bernard (2004) the use of SDI concept 'metadata' is seen as a top priority in the creation of any SDI. This statement is based on GI literature of Crompvoets & Bregt (2003), FGDC (1997), McLaughin (1991) and Onsrud (1998). Metadata is a description of a dataset, which is referred as 'data about data' in GI literature (Gromley & McGlamery, 2002)(Williamson, 1999)(Dressler, 2002).
Many reasons are described in GI literature about why metadata should be used. According to Crompvoets (Url 5, 03-11-2004) the purpose of metadata is to enhance the management, search, exchange and use of spatial data. Focussing on the RS catalogue users, Woldai (2003), states that proper metadata answers questions regarding the content, quality, accessibility, and other characteristics of the geospatial data. Christianson (2003) cites that hundreds of different metadata elements exist for bibliographic cataloguing and related disciplines. In order to determine the required metadata the RS catalogue users have to be determined. Bank (2004) *fide* Hoogeweg (2004) cites that experts usually require more detailed metadata than the general public. The relation between geospatial data users and metadata is displayed in figure 2.

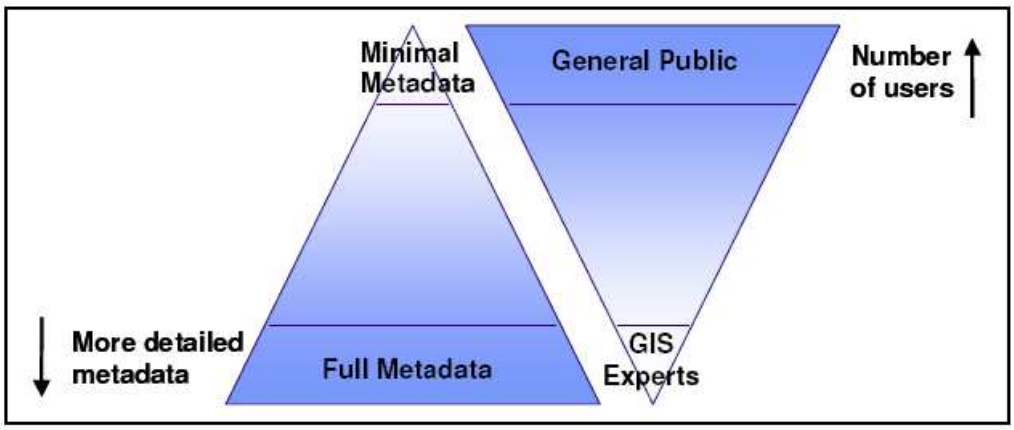


Fig. 2 Metadata completeness (Hoogeweg, 2004)

2.2 Similar projects

RS catalogues
Making RS data accessible using a web-based application is not new. Several articles (Moore & Oliver, 1999)(Lotz-Iwen, et al, 1998) verify that there are already RS catalogues available on the WWW. Usable literature about the process of constructing these RS-portals is not found.

NEONET
Within the Netherlands, the National Aerospace Laboratory (NLR) is working on a project to realise an infrastructure for geographical information derived from earth observation satellites. This network is called the Netherlands Earth Observation NETwork. NEONET is a metadata information system that assists users to locate software, datasets, services and more information resources related to earth observation satellites (Swol & Wisse, 2000). The main objective of the NEONET project is to provide a national infrastructure for the Dutch scientific and operational user community, which meets the long-term demand of the users in terms of data availability, data processing and data storage and which, as part of the international network, allows an active participation of Dutch user groups in international earth observation activities (Swol, 1996-A).
Swol et al (1996-B) describe the development steps of NEONET. The requirements from users and providers for a national data and information infrastructure are determined in three phases; a feasibility study, by using interviews and at a national user consultation. A set of 44 requirements is derived. These requirements are placed in five groups; data requirements, information requirements, service requirements, realisation requirements and user interest requirements. Each individual requirement is prioritized to indicate the necessity of a requirement that should be fulfilled. Based on the user requirements three basic building blocks are defined; data, information and services.
After the determination of the user requirements, the functions of NEONET are determined. This is done by transforming the requirements in functions. This process provided the following information:
→ Less functions than requirements;
→ One requirement can lead to more than one function;
→ Several requirements can point to the same function.

The individual functions are grouped into main functions. Four main functions are determined:
→ Finding information;
→ Retrieving / distribution of data;
→ Processing of data;
→ Making (processed) data available.
The establishment of the NEONET concept is defined as the next step in the development process of NEONET. This NEONET concept focuses on the environment of NEONET. This environment is defined as; the users, the Centre for Earth Observation and the 'outside world'. In the NEONET concept, the main role of NEONET is determined as providing an interface between users and providers of data and information. The interface is seen as an essential component of NEONET. Swol et al (1996, B) states that the quality of the interface determines for the bigger part how the users experience NEONET.
The final step that is described is the implementation proposal. This proposal presents the steps that have to be taken in order to realize NEONET. The implementation steps defined are:
→ Determine the objectives of the implementation phase;
→ Determine an implementation approach;
→ Determine the project management (project team);
→ Determine implementation activities;
→ Determine costs.

Although the NEONET's aims are much broader, this project has a big tangent plane with this research. Detailed information is gathered by an interview with R. Swol (appendix II)

2.3 ISDM for RS data catalogue development

Development strategies
Strategies to develop an RS catalogue are not found in GI literature. The term 'RS catalogue', is not much used. Terms as Geographical Information System (GIS) and Information System (IS) occur more frequently. Although these terms are global and cover a bigger domain than an RS catalogue, it is considered as the only option to acquire information about development processes.
A strategy to develop an IS or GIS is referred as a Information System Development Methodology. Avison and Fitzgerald (1988) define an ISDM as a recommended collection of philosophies, phases, procedures, rules, techniques, tools, documentation, management and training for developers of IS.
According to Modha et al (1990), it is unclear how many ISDM's exist. This statement is based on two articles. Olle et al (1988) mentions 64 well known ISDM's, whereas Levine (1985) names 800 ISDM's.

According to Taylor (2000), the use of strategies for the development of high quality IS in organisations is strongly recommended. This recommendation is based on a literature review executed by Taylor. Several resources out of different domains (standard textbooks, governments and regulatory bodies, etc) promote the use of an ISDM. Two motivations to use a IS strategy are described below.
Avgerou and Comford (1993), state that researchers promote the use of ISDM's for improved project management and control, better quality product, reduce maintenance costs of the completed system, standardization of the development process and opportunity for re-use of programs and code.
Avison and Fitzgerald (1995), describe that US and European governments require or strongly recommend the use of established development standards or methodologies for systems development in public an private sectors.

Although, it is clear that a strategy to develop an RS catalogue is important to use it does not automatically mean that the success of the RS catalogue is ensured. Bots et al (1990), states that a methodology is nothing more or less than a helpful tool by the development of an IS. The quality of the IS is principally determined by the quality of the designers.

Background ISDM's
Several articles provide information about different ISDM's (Davidson et al, 2002)(Klein & Hirschheim, 1991)(Beyon-Davies & Williams 2003). However, in almost each document these ISDM's are not elaborately described. Knowing that many ISDM's exist, the question is which ISDM is applicable for this research. In order to determine an appropriate ISDM, the book GIS organisations and people (Reeve & Petch, 1999) was very helpful.

Reeve and Petch (1999), describe that a change in the mainstream information system development has taken place. In the past computer professionals regarded the development of an IS as a technical project. However, due to problems that occurred while such an IS was implemented in an organisation this point of view is revised. Computer scientists became aware that human and organisational aspects play an important role in a successful development of an IS. The awareness that developing an IS is more than only a technical aspect resulted in a shift from techno-centric computing to socio-technical computing (fig 3).

TECHNO-CENTRIC COMPUTING	SOCIO-TECHNICAL COMPUTING
→ Focus on technology	→ People and technology
→ Technology push	→ Demand pull
→ Because it's possible	→ Because it's needed
→ Others are doing it	→ WE need it
→ Hierarchic	→ Democratic
→ Specified by technologists	→ Specified by users

Fig. 3 From techno-centric to socio-technical computing (Reeve & Petch, 1999)

Reeve and Petch (1999) describe several socio-technical ISDM's. These modern socio-technical approaches did not have a big impact on GIS yet. In this research this is seen as

a major bottleneck. Using a completely new approach provides to many uncertainty risks. After all, an ISDM will be used to acquire answers on the defined research questions. Testing a new approach is not an objective. Therefore, none of the modern socio-technical approaches will be used.

Usable ISDM
Reeve and Petch (1999) elaborately discuss a typical GIS development methodology. This methodology is called the Generic GIS Development Methodology. The Generic GIS Development Methodology includes stages and techniques, which are frequently mentioned in GI literature. This ISDM seems applicable to use. In this project is assumed that frequently used stages and techniques increase the success of this research. After all, these stages and techniques were not much used if they did not work properly.
A disadvantage of the generic GIS development methodology is its similarity with the Traditional Waterfall Approach. The Traditional Waterfall Approach is a much used methodology to implement an IS. The Traditional Waterfall approach is widely criticized in GIS literature.
According to Davidson et al (2002), the biggest problems with the waterfall approach arise because the subject matter experts are required to have perfect forethought. The functionality of a system cannot be easily revised. As a result, products may not satisfy the real needs.
The Centre for Technology in Government (Albany University, 1998) provides two critics regarding the stiff an inflexible procedure of the Traditional Waterfall Approach. The first critic is that projects scarcely follow the sequential flow that the approach proposes. The second critic is that in the beginning of a project often the requirements and goals are not quit clear. The approach does not deal very properly with this natural uncertainty.
Reeve and Petch (1999) focus upon three critics. The technical emphasis of the Traditional Waterfall Approach is described first. Users are not actively involved in the development process of an IS. Only in the early stages of the approach, the needs of the users are specified. After that, users are hardly involved in the development process. The insufficient user involvement can lead to building the wrong system, which is the second critic. The final critic is the neglect of 'human' issues. Implementing a IS into an organisation will have an impact on the employees. For instance, a IS can alter job contents and change operational procedures. In practise, human issues are accommodated at a certain stage of the approach without explicitly mentioning them. According to Reeve and Petch, it would be better if the methodology exhibited human issues. Showing that introducing a IS into an organisation is a socio-technical problem, in stead of a technical problem.

Although all critics, the Generic GIS Development Methodology is chosen to use as a foundation to develop a new RS ISDM. Adjustments in the approach will be made by considering the information (critics, socio-technical) gained. In the next chapter, the new RS ISDM is discussed.

3 Methodology

Because other models did not fulfil the requirements postulated in this research, a new approach is constructed. Although the construction of a new approach is not an objective, it is necessary to find an answer on the previous defined research questions (§1.2) on a structured way. The new developed approach is called the Alternative Waterfall Approach 2005.

Background
The Alternative Waterfall Approach 2005 is based on the generic GIS development methodology. In this project it is assumed that by using the generic GIS development methodology as basis, the foundation of the Alternative Waterfall Approach 2005 is reliable. The generic GIS development methodology supplies the skeleton of the Alternative Waterfall Approach 2005. The skeleton provides an easy understandable overview of the operation of the approach. In addition, many stages and techniques of the generic GIS development methodology are included in the Alternative Waterfall Approach 2005.

Operation Alternative Waterfall Approach 2005
The Alternative Waterfall Approach 2005 is a highly structured model composed out of seven stages (fig. 4, page 29). The bold text represents the name of a stage. Each stage includes one or more activities to execute. These activities are assigned with a capital to enhance the structure of this report. The activities are described per stage. Each stage is assigned with an own paragraph, starting with §3.1.
The beginning stage of this approach is situated at the top of the waterfall. After finishing one stage, the 'water stream' towards the next stage (sizeable arrows downwards) should be followed. This is the common route defined by the Generic GIS Development Methodology. The connection (thin black line) between the 'maintenance and review' and 'information inquiry' stage displays that the RS catalogue should be revised continuously. Reeve and Petch (1999) describe that a IS is never stable. Requirements change over time. The operation of the remaining coloured lines is explained at the innovating aspect paragraph.

Innovating aspects
The Alternative Waterfall Approach 2005 includes three innovating aspects. The following innovating aspects are applied:
1. A transformation from a generic ISDM to a specific RS ISDM;
2. Including a participation stage;
3. Including aspects that make the Alternative Waterfall Approach 2005 more flexible.

The underlying text explains why these innovating aspects are applied.

Transformation from a generic approach to a specific approach
The foundation of the Alternative Waterfall Approach 2005 is a generic ISDM. Adjustments are made to transform this generic approach too a specific RS ISDM. RS sensing specific subjects (e.g. evaluation RS-portals) are implemented in the stages of the approach. This transformation resulted in an approach to determine the SDI concepts needed to implement a RS catalogue into the CGI framework.

Participation stage
A participation stage is included in the Alternative Waterfall Approach 2005 to decrease the technical emphasis of the model. The participation stage provides a participation possibility to the stakeholders in the development process of the RS catalogue. Involving people in the development process is important to increase the success of the RS catalogue (socio-technical, §2.3)
The implementation of a participation stage affects the model structure. Normally, early in the generic GIS development approach, there is tried to establish an internal case for a IS (user needs, cost-benefit analysis, risk). The Alternative Waterfall Approach 2005 does not provide the possibility to carry out these studies. This is caused by the participation stage. For instance, a cost estimation cannot be made. First, the participation results (demands)

should be analysed in order to choose SDI concepts. A cost estimation (part of feasibility study) can be carried out in the middle of the approach. Because of this, the feasibility study is moved from the beginning to the middle of the approach. The method used to create a participation possibility is explained in §3.3.

Aspects that make the approach more flexible
The third innovating aspect is included to make the Alternative Waterfall Approach 2005 more flexible. The inflexibility of the Traditional Waterfall model is [in addition to the technical emphasis] a main critic. The four coloured lines are implemented to improve the flexibility. These lines are sub divided in two categories. The first category is composed out of the blue, green, purple and red lines. These lines provide the possibility to go back to a previous stage and execute an activity for a second time. This results in the opportunity to gain extra information needed or to refine earlier acquired information.
The second category includes the dotted grey, light green and yellow lines. These lines are a result of implementing the blue and purple lines. After entering a stage for a second time, it is assumed in this project that it is not always necessary to follow the default route (sizeable arrows). The two dotted lines provide the possibility to take a shortcut route. Both lines are dotted to decrease misunderstanding. The dotted lines may only be followed after a certain stage is entered for a second time or more.

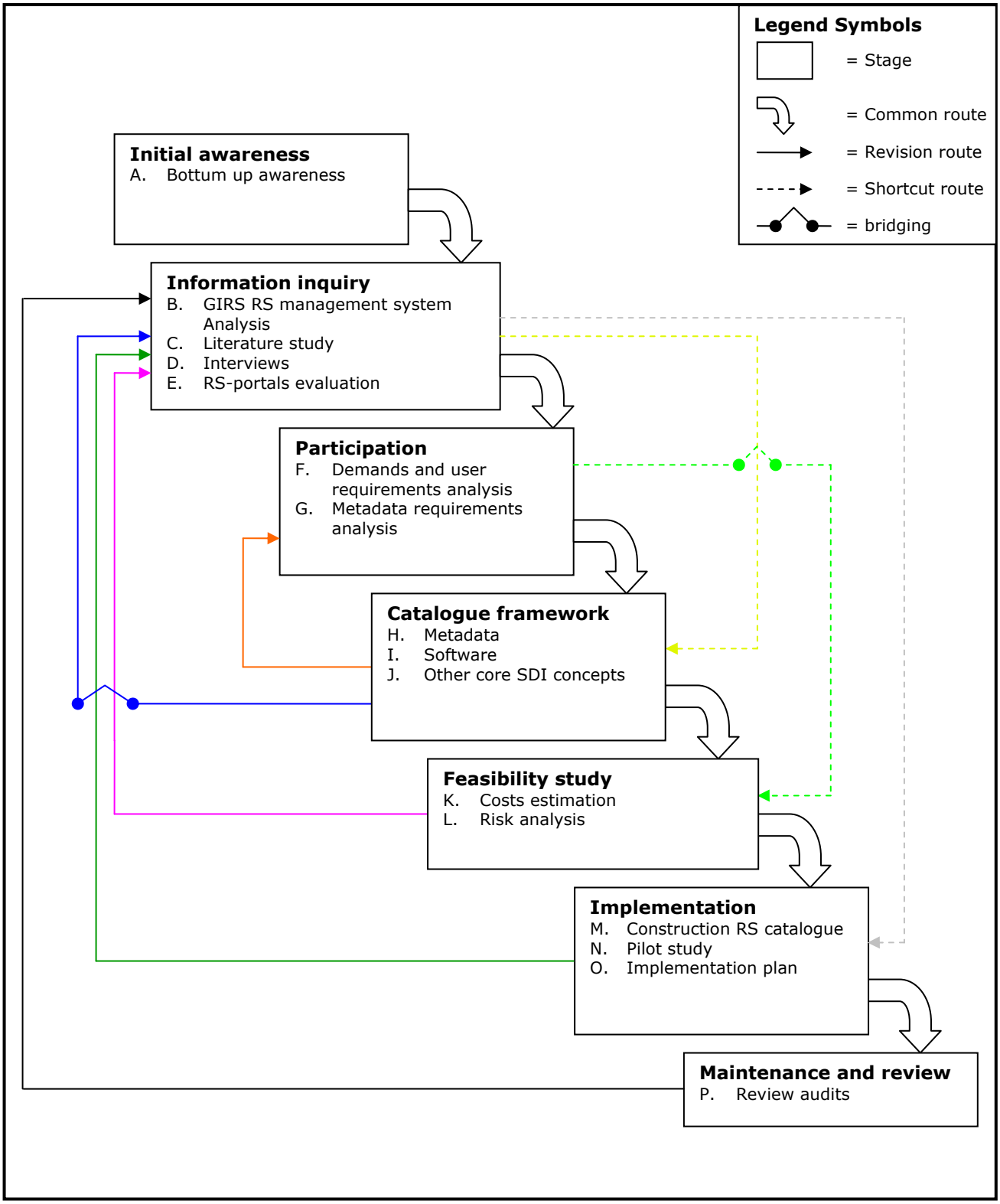


Fig. 4 Alternative Waterfall Approach 2005

3.1 Initial awareness

A. Bottom up awareness

The first stage of the Alternative Waterfall Approach 2005 shows the acknowledgement of the problem (initial awareness) regarding the system used to manage the GIRS RS collection. Several CGI employees are not satisfied with the system, as stated in the introduction. The frustrations that arise from working with the system cause the initial awareness of the problem. The dissatisfaction caused by the system to manage the GIRS RS collection results in the awareness that it is time for a new system. Initial awareness arising from frustrations about the way people are currently doing their job is referred as bottom-up awareness (Reeve, 1999).

According to Aronoff (1989), a number of problem areas could arouse frustrations with existing manual methods regarding Geographic Information Systems (GIS):

1. Spatial information may be poorly maintained, so that maps and property lists are seriously outdated and questions cannot be reliably answered without rummaging through stacks of paper records (Gossette, Ferguson and Dueker, 1990).
2. Spatial data are not stored in standard formats, so that the accuracy of mapped data varies across a city's area; several departments collect and manage the same spatial data;
3. Data are not shared between departments because of concerns about confidentially and or legal restrictions. Because possession of information convey's power, data transfer may be inhibited because of internal political considerations.
4. The 'CFTM' (Can't Find the Map) factor, may mean that delays caused by manual retrieval and processing of spatial data become intolerable;
5. New requirements emerge within the organisation, which traditional methods of handling spatial data cannot fulfil.

3.2 Information inquiry

The second stage is devoted towards gaining information from inside and outside the CGI. The external situation is scanned in order to find relevant information about for instance similar projects. Information about failures and successes are valuable information to learn from.

The CGI is scanned to gain an impression of the internal problems regarding RS data accessibility. An indication of these internal problems provides the possibility to find a solution in order to make the GIRS RS collection accessible.

In order to scan the internal and external situation the information inquiry stage is subdivided in different phases:

B. GIRS RS management system analysis

The GIRS RS management system is analysed in order to determine the bottleneck(s) that cause the frustrations of the manager that operates the system. By exploring these irritations carefully, an overview of the bottlenecks that stagnate the accessibility of the GIRS RS collection is gained. In addition, the analysis provided the possibility to get familiar with the GIRS RS management system. This analysis of the GIRS RS management system is fulfilled by executing the following activities:

Analysing metadata list

The metadata list plays a key role in the current system to manage the GIRS RS collection. The list provides information about the current methodology used to store RS data. By analysing (reading) the metadata list, insight in the method used to store RS data is collected.

The metadata list also provides an overview of the content of the GIRS RS collection. The content is analysed by arranging available metadata in a spreadsheet. Subsequently, visualisation tools (diagrams) are used to construct transparent overviews about the content of the GIRS RS collection.

By analysing the above mentioned subjects information is gained about the scientific and economical value.

Meeting with former GIRS RS system manager
A meeting with the former manager (H. Schok) provided historical information about the GIRS RS system. This information was helpful in order to clarify the bottlenecks determined by the GIRS RS system analysis. In addition, the former manager answered questions that arise from the GIRS RS system analysis.

C. Literature study
A literature study is executed by consulting acknowledged on-line libraries for academic literature retrieval, WWW search engines and the WU library. The aim of the literature study was to acquire usable information.

D. Interviews
Interviews are carried out to acquire information from inside and outside the CGI. Interviews were preferred above other information extraction tools, because a personal approach often results in extra information. The literature study provided some candidates for external interviews. Internal candidates are selected on basis of their work relationship with RS data. The selection of a RS data user/supplier, Geo-information manager (Geodesk) and the current manager of the GIRS RS collection supplied information from different focus points about the RS data accessibility in the CGI.
In this research it was assumed that interviewing people with different focus points resulted in different information.

E. RS-portals evaluation
Available RS-portals present on the WWW conceal precious information. Much used aspects to construct a RS-portal are determined by evaluating several portals. The inventory of these RS-portals is performed by involving CGI employees.
The RS-portals are evaluated by using each time the same criteria which ensures a systematically, qualitative good method. The criteria list constructed on the basis of expert knowledge, objectivity, measurability and management. The individual RS-portal evaluation results are set next to each other in a matrix. Subsequently, frequently used aspects are determined.

3.3 Participation

The participation stage displays the stakeholders involvement in the RS catalogue development process. Two activities are carried out in this stage. The first activity is executed to acquire information from mainly the RS catalogue users. The second activity is carried out to refine the results of the first activity in order to make a clear overview of the metadata requirements.

F. Demands and user requirements analysis
The RS catalogue users are not determined in a previous stage. Assumption able is that the CGI employees who work with RS data are potential users of the RS catalogue. After all, the development of the catalogue aims primarily on the CGI organisation. People from different groups within the CGI are asked to participate. In this project is assumed that extracting information from different groups (managers, executers WU, etc.) results in more detailed overviews about user needs.
A questionnaire is used to analyse the demands and user requirements regarding SDI concepts. A questionnaire provided the possibility to acquire information from a large group of CGI employees in a relatively short period. In addition, it was assumed that the cooperation level of the CGI employees would be higher by using a questionnaire instead of an interview. Filling in a questionnaire only takes several minutes. Another reason to use a questionnaire was that the answers are measurable. Visualisation tools (diagrams, grid charts) are used to organize the answers. Transparent overviews moderate the process of making valid conclusions.
According to Isselt (1994), the realization of a good questionnaire is a difficult job. Therefore the questionnaire is tested before the actual hand over. Two persons are asked to test (fill in) the questionnaire. Badly formulated questions are corrected before the questionnaire is handed over to the CGI participants.
In addition to the demands and user requirements analysis, the questionnaire is used to determine the stakeholders. An analysis of the metadata needs was not possible in this

phase. The exact RS catalogue users were not determined, which are needed to verify the required metadata (fig.2)
The questions that are included in the questionnaire are formulated on the basis of information acquired from previous stages.
After finishing the demands and user needs analysis, the second stage is entered.

G. Metadata requirements analysis
The metadata requirements are determined by a second questionnaire. A questionnaire is again preferred above other techniques to increase the cooperation level of participants. The people who filled in the questionnaire are selected on the basis of the main target audience of the RS catalogue determined by demands and user requirement analysis (F). The metadata requirement questionnaire provides a list of metadata elements composed by using expert knowledge. The people who filled in this questionnaire were asked to cross out or add metadata to establish a metadata list, which satisfies their demands. The individual results of the metadata requirement questionnaire are compared. Subsequently, an arbitrary method is used to determine the required metadata that satisfies the main RS catalogue users.

3.4 Catalogue framework

The fourth stage is reserved to determine the core SDI concepts needed to realise a RS catalogue framework. The core SDI concepts are determined by using the information gained at previous stages.

H. Metadata
The demands and requirements regarding the metadata are summed. Subsequently is analysed which options occur to satisfy the demands of the stakeholders. The policy makers (stakeholders) have to make a choice which option is preferred.

I. Software
According to the information gained in the previous stages a criteria list is composed in order to select appropriate software to build a RS-catalogue. The evaluated software is based on information gained by the literature study and CGI employees. Information about the software is gained by focussing on the websites of software providers, using the software, consult people who work with the software and Email contact with software providers.

J. Other core SDI concepts
According to the information gained in the previous stages, several other core SDI concepts are determined. These other core SDI concepts are determined by the information gained in previous stages.

3.5 Feasibility study

The fifth stage is the feasibility study. This stage is not executed due to a lack of time. Two activities were planned to determine the feasibility.

K. Cost estimation
Although only the core SDI concepts are determined, a rough costs estimation was planned. The purple line in the Alternative Waterfall Approach 2005 offers the possibility to acquire information from other IS costs estimations.

L. Risk analysis
The second activity planned in the feasibility stage is carrying out a risk analysis. By identifying risk sources, it can be tried to 'manage' or reduce them. In this project is assumed that the potential risks can be remarked during previous stages.

3.6 Implementation

The sixth stage is also not executed due to a lack of time.

M. Construction RS catalogue
Before the RS catalogue can be implemented in the CGI framework, the RS catalogue has to be constructed. The demands regarding the RS catalogue are clear when the implementation stage is entered. In addition, the concepts needed to construct the RS catalogue are determined in previous stages.

N. Pilot study
A pilot study offers the opportunity to test the operation of the RS catalogue. The aim was to ask several CGI employees to test the RS catalogue. According to their findings, errors or shortcoming regarding the RS catalogue could have been adjusted.

O. Implementation plan
Before implementing the RS catalogue, it was intended to make an implementation plan. The dark green line of fig 4, provides the possibility to go back to the information inquiry stage. It is assumed that a GI literature consultancy provides detailed information about which steps have to be taken to implement a web-based RS catalogue in the CGI framework. After the establishment of the implementation plan, the implementation steps determined should have been executed.

3.7 Maintenance and review

The final stage is also not executed.

P. Review audits
An audit provides the possibility to compare the results gained during executing the Alternative Waterfall Approach 2005 with the actual outcome; the RS catalogue. This could have provided interesting information about the usability of the Alternative Waterfall Approach 2005. It was planned to execute the audit by asking CGI employees to make use of the RS catalogue. Remarks could have been send to my Email address.

4 Results & discussions

4.1 Initial awareness

A. Bottom up awareness

The manager of the GIRS RS collection is not the only person within the CGI who is aware of the current problem. F. Rip, staff member of Geodesk, is familiar with the GIRS RS collection existence (§4.2, section D) Although F. Rip is not trusted with the content of the GIRS RS collection; he knows that there is a problem with making the collection accessible.

In the contrary, much CGI employees are not aware of the bad accessibility of the GIRS RS collection (§4.3, section F.). This is caused due to the fact that many CGI employees do not know that there is a GIRS RS collection available. The lack of familiarity with the GIRS RS collection is a result of the bad accessibility. This knowledge grounds the dissatisfaction of the CGI regarding the current RS data management system.

All problem areas that are mentioned by Aronoff (§3.1) have a share in the frustrations that arise by several CGI employees about the current system used to manage the GIRS RS collection. This can be stated by taking results of the information inquiry- and participation stager in consideration.

4.2 Information inquiry

B. GIRS RS management system analysis

The complete analysis report of the GIRS RS management system is included in appendix I.

In the introduction chapter, the method used to manage the GIRS RS collection is partially described. In addition, two metadata templates are used to construct metadata. The recorder type of an image (analogue or digital) decides which template is applicable. The former manager of the GIRS RS collection and some of his colleagues constructed these templates around 1990. By exploring (reading) these two metadata templates and their usage in the metadata list, many negative findings concerning the metadata became visible.
The purposes of metadata as described in §2.1, are not completely covered by the two metadata templates used. This is caused by two main reasons:
First, vital metadata elements are not included, resulting in missing information (e.g.; user restrictions).
Second, the negative findings regarding the quality of filled in metadata:

→ Unclear filled in metadata;
→ Redundancy of filled in metadata (use of non-distinguishable metadata items);
→ Presentation of non-punctual information;
→ No uniform description of metadata items;
→ Providing out of date information;
→ Gaps in the metadata.

The content of the GIRS RS collection is determined via a statistical analysis making use of the metadata list. Resulting in the following information:

→ 220 RS images are described originating from a variety of recorders (fig 5.), and suppliers (fig 6.).
→ The oldest RS image is dating from 07-06-1972, the youngest RS images is added on 26-07-2001 (GIRS RS collection is not up to date).
→ The size of the observed areas differs from a road towards a whole country.

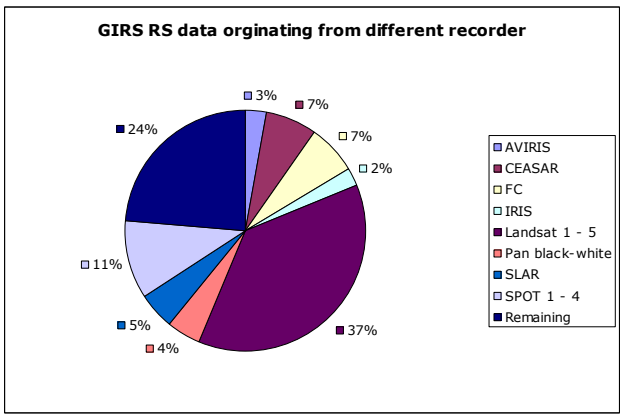


Fig. 5 GIRS RS data originating from different recorders

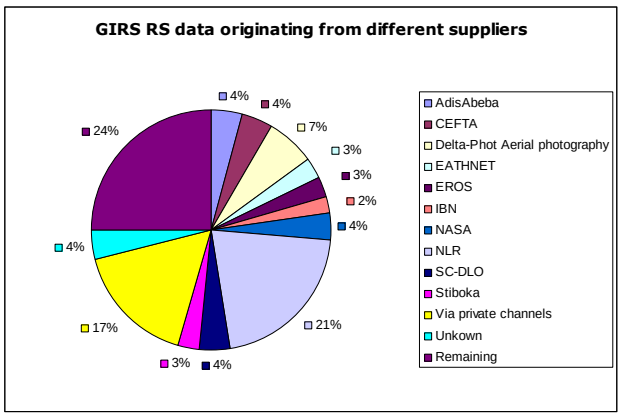


Fig. 6 GIRS RS data originating from different suppliers

The GIRS RS collection comprises a high diversity of RS images (heterogeneous collection), compared by some arbitrary RS-portals on the WWW (ARSMIS, EUROMAP and Euroimage).

The scientific and economical value of the GIRS RS collection is not determined. The incomplete metadata and heterogeneity of the GIRS RS collection does not provide the opportunity to determine the actual value.
Although, the scientific and economical value are not determined by a grounded method, an impression is gained about the value of the GIRS RS datasets. The GIRS RS collection contains datasets that are usable for Msc. Geo-information students. For instance, many RS data of Wageningen (the Netherlands) and surrounding municipalities is included. Spatial datasets of Wageningen and surrounding are valuable, because numerous student projects are carried out in this area, whereby these datasets are worthwhile to use.

Discussion
A lack of information regarding the research and economical value results in an uncertainty factor for the feasibility of the catalogue. If the GIRS RS collection research value is low, RS users will neglect the catalogue. It is questionable if it is wise to spend money and efforts on the development of a catalogue whereby the value of the data included is assumed to be valuable.

C. Literature study

The results of the literature review are mainly used to construct the theoretical framework (chapter 2) of this report.

D. interviews

The results mentioned in this paragraph are gained via interviews with people displayed in table 1. The complete interviews are included in appendix II.

Table 1 Overview interviewed people

Name:	Function:	Organisation:	Focus point:
F. Rip	Executer Geodesk	WU	Specialist GI management
H. Bartholomeus	Educator	WU / GIRS chair	Manager GIRS collection / RS data user-expert
H. Kramer	Researcher	Alterra	Research
F. van der Wel	GIS researcher / SDI	KNMI	Research
R. van Swol	Senior scientist Geomatica / SDI	NLR	NEONET

The accessibility of RS data is a subject that interests many people at this moment. The realization of NEONET expresses the presence of request for RS data on a national scale. On organizational scale, the Royal Dutch Meteorological Institute (KNMI) is –as well as the CGI- struggling with making RS data accessible. Due to governmental changes, the KNMI should make some 'basic' RS data accessible for interested parties.

The increasing quantity of RS data is pressurizing the policies of organisations to make use of metadata. The quantity of metadata elements determines the costs and time needed for the production of metadata. The metadata of geospatial data is often created manually. People look up to fill in large quantities of metadata. This is caused by a lack of time and filling in metadata is seen as a boring activity.
According to Van der Well, there is another reason to use metadata. Information about datasets is mostly available in the heads of employees. Employees come and leave the KNMI, thus valuable information for searching the archive flows out of the KNMI. The usage of metadata in combination with a good metadata search engine prevents this problem.

Kramer and Barholomeus were asked how to deal with bad metadata (§4.2, section B) accessible. Both agree that throwing away bad metadata is not an option. Sometimes this information can be useful. Bartholomeus suggests using a quality flag to inform a potential user about the bad metadata. In case essential metadata components are not filled in, another solution has to be found. For instance, a reference to the manager of data collection.

The management of the GIRS RS collection is not in hands of Geodesk. Remarkable and confusing, because Geodesk is the focal point for collection, management and supply of GI within the CGI (Url 1, 26/01/2005). F. Rip is aware of the existence of the GIRS RS collection. However, the metadata list is unfamiliar.
The manager of the GIRS RS collection and F.Rip indicate that Geodesk should be the central manager of the GIRS RS collection. The transfer of the GIRS RS collection did not take place due to one main reason:
→ The lack of initiative of both parties to cooperate in the establishment of a good solution, which improves the accessibility of the GIRS RS collection.

A variety of reasons caused this lack of initiative:
→ Geodesk has no expertise / acquaintance with RS data;
→ Geodesk does not advertise actively;
→ Many RS data is not interesting for commercial aims (due to small coverage);
→ No clear overview of the GIRS RS collection content is available;
→ Bureaucracy of Geodesk to retrieve data;
→ RS users have there 'own channels' to satisfy there RS data needs;
→ RS data copyrights blocks data sharing possibilities;
→ No good RS data policy (+ supervision);
→ Uncommonly someone asks Geodesk for RS data.

According to Swol, standards are indispensable for establishing a web-based application. Especially when several stakeholders are involved. Without standards, it is impossible to develop new software applicable for a variety of companies. Often there are thoughts that standards are the key to success. Standards are very important but form no bottleneck for the success of a data infrastructure, because standards can be made, cooperation by companies not.

Out of the user requirement study of NEONET, remarkable quantities of requirements were analysed. After prioritizing the requirements the conclusions was drawn that only a few are relevant. Swol mentions that it is important to consider that requirements are time depending.

Other learning's from the NEONET project are:
→ The cooperation to share RS data with others determines the success of national data infrastructure.
→ Not only the realisation of an infrastructure costs money, the maintenance is also expensive. For the maintenance of an SDI, a long-term money flow must be available to keep everything up to date.
→ The maintenance costs are often underestimated.
→ From the idea of NEONET towards the realisation of NEONET is a very slow process.
→ Who pays for the infrastructure?
→ The requirement analysis for NEONET resulted in many demands. Ranking these demands on priority status decreased the amount of requirements. It could be stated that only a few requirements were relevant.

Remaining information gained via the interviews:
→ Many RS data is stored in the GIRS RS collection, but probably there is more RS data scattered through the CGI. The amount of RS data is not determined via interviews.
→ Information about which RS images to include in the RS catalogue is depending on the relevance of an image. However, determining the relevance is person-restrained. Geodesk could not provide a structured method to determine the relevance for GI.
→ Incomplete metadata should not be thrown away. An indicator should provide information about the completeness or metadata quality of a RS image.

Discussion
Interviewing people with a different function or focus point was assumed to result in much information. Afterwards can be stated that much information is gained. A disadvantage is that the answers gained are barely comparable. This is caused by adjusting the interview questions towards a specific focus point. Questionable is the method used to select candidates for an interview. Selecting people with the same focus point would have resulted in answers that can be compared. When answers can be compared more valid conclusions can be drawn, but more interviews are required to gain information from different focus pionts.

E. RS-portals evaluation
The complete report (and matrix) is included in appendix III.

Twenty-seven RS-portals are evaluated in the period 22-11-2004 - 20-12-2004. The CGI employees provided around fifth-teen RS-portal addresses, which they visit on a regular basis. This amount of RS-portals is added with some arbitrary RS-portals found on the WWW. In this project it is assumed that an amount between the 25 and 30 portals is needed to make a grounded statement about much used aspects in RS-portals.
Table 2 presents an overview of criteria present in RS-portals. The criteria list is based on expert knowledge, objectivity, measurability and management. Each criteria is provided with a percentage (column 1). This percentage provides information about the presence of criteria in the evaluated RS-portals. The bold percentages display criteria that are present in 70% or more of the evaluated RS-portals. This percentage (threshold) is arbitrarily chosen in order to determine criteria which are much present in RS-portals. The criteria are subdivided in five groups in order to realize a transparent overview.

Table 2 Criteria present in RS-portals in terms of percentage

	Criteria	Criteria present in RS-Portals in terms of percentage
Accessiblity	Clear URL description	**74%**
	Clear vision / objective	**81%**
	Overview related links / additional sites	59%
	Website in English	**96%**
	Website in non-english language	0%
	Multilanguage	4%
Metadata	Metadata RS image	**89%**
	Description metadata	11%
	View service images	**78%**
	Print facility metadata	22%
	Metadata language english	**81%**
	Metadata item: acquisition date of image	**85%**
	Metadata item: publication date of image	19%
Search possibilities	Browse facility	15%
	Browse facility intermediate results (after first search)	**70%**
	Search on map (request box)	52%
	Search on predefined boundaries (e.g. admin. Borders)	15%
	Search on coordinates	**70%**
	Search on platform	**78%**
	Search on acquisition technique	4%
	Search on sensor	22%
	Search on acquisition date	**70%**
	Search on type of image file (JPEG, Grid etc)	4%
	Search on keywords	48%
	Search on subject (themes)	37%
	Search on combination of search possibilities	67%
	After searching refine search possibility	63%
Functions	Function buttons english	**96%**
	Function buttons non-english	0%
	Function buttons multi-language	4%
	Use hyperlinks	**78%**
	Direct download	**70%**
	E-commerce (payment)	52%
Support	Contact web-master / system administrator	**85%**
	Get in contact with the producer of the image	0%
	Copyright (licence) information	**93%**
	Registration	48%
	How to do …catalogue (help-option)	56%
	Helpdesk contact	44%

In addition to table 2, more information is gained by the RS-portal evaluation.

The availability of RS-portals on the web prove that it is technical possible to establish a web-based RS catalogue to make RS data accessible.

RS-portals make use of web references to increase the awareness the portal existence. Web references are links provided by a website to guide a website-visitor to another (related) website. These links act as web advertisement and form a useful tool to increase the awareness of a RS-portal. Information about the usage of web references by RS-portals is checked by executing a popularity check (Url 6, 15-03-2005). This website offers the possibility to determine the amount of web references that are found by search machines Google, Altavista and Hotbot. For each RS-portal, the opening page is used to determine the amount of web references.
The matrix in the appendix III provides an overview of the results of the popularity check. It does not automatically signify that the portal with the biggest amount of web references

becomes the best website evaluated. Other factors like the value of RS data included (monopoly position) and marketing strategy influence this popularity check. The popularity check underpins that many (96%) RS-portals use web references.

The process of evaluating RS-portals learned that the openings page of a website is important. Information about the vision and objective in the and RS data included (spatial extend, quantity of datasets, platform) saves lots of time in search for a particular image. Also information about the included RS-data is valuable. The openings page should provide information that allows users to quickly determine if the RS-portal is usable or not.
By evaluating the RS-portals the experience is gained that a quick determination of the usability of a RS-portal increases the user-friendliness.

Metadata that is presented by RS-portals differs greatly in its appearance. This is caused by a variety of reasons:
→ RS-portals provide different compositions of metadata elements to describe a dataset;
→ Metadata elements that cover the same domain (e.g spatial extend) appear in a variety of formats (e.g.; geographic location, NW corner, Upper left, Path/Row);
→ Often metadata is not included in a standard, but in background information.

RS-portals do not provide much technical (development) information. RS-portal providers were asked by Email about technical information. The response was low, resulting in a lack of information to create a transparent overview. Out of the scarcely responded Emails, the following information could be extracted:
→ RS-portals are constructed using a mix of software programs;
→ Several people mentioned that their RS-portal was custom made by a specialized company.

All twenty-seven RS-portals differed in their appearance. This is caused by a variety of factors like, RS data included, RS-portal disciplines and usage of different search tools. Even RS-portals in the same domain (government, commercial,…) differ in their appearance. The information gained by this evaluation provided information about appearance of a suitable RS-portal according to the researcher's opinion. A description of this suitable RS-portal in included in appendix III.

Discussion
Some of the criteria used to evaluate are quite general. For instance, the criteria 'description metadata' can be interpreted in different ways. A description of the metadata is the amount of metadata sets available in a RS-portal. Another description of metadata is the spatial extend that the metadata included in the RS-portal covers. Using criteria that are a bit vague affects the quality of the evaluation. However, it allows to evaluate RS-portals more quickly.
Information about criteria present in RS-portals is provided on a evaluation of twenty seven RS-portals. Questionable is if an evaluation of hundred RS-portals would have resulted in different outcomes.

4.3 Participation

F. Demands and user requirements analysis

Twenty-three people filled in the demands and user requirements questionnaire. These people were provided with information about the aims of this questionnaire. The people who responded are split up in five groups, based on the function and organization. These groups are:

→ Executers Alterra,;
→ Executers WU GIS chair;
→ Executers WU GIRS chair;
→ Managers (Geodesk, GIS chair, GIRS chair);
→ Executers Geodesk.

Figure 7 provides an overview of the quantity of people who filled in this questionnaire per group. In this project is assumed that an acceptable amount of people per group cooperated, to make valid statements.

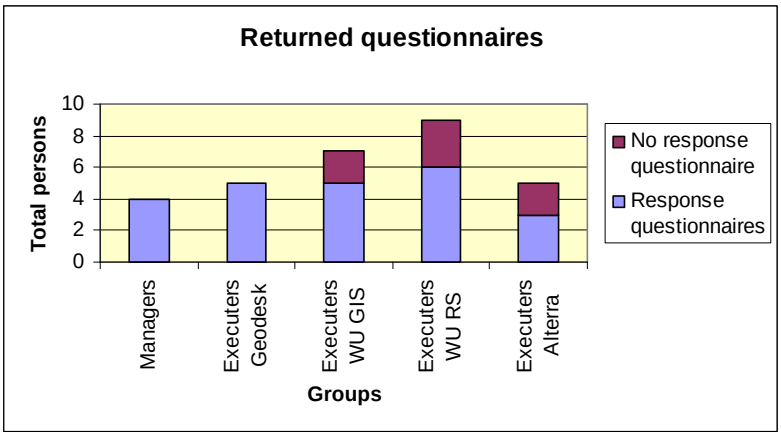


Fig. 7 Returned questionnaires

The awareness of the presence of the GIRS RS collection is low (fig 7). Even within the executers WU GIRS group, which 'supervises' the collection, there exist people who are not familiar with the GIRS RS collection.

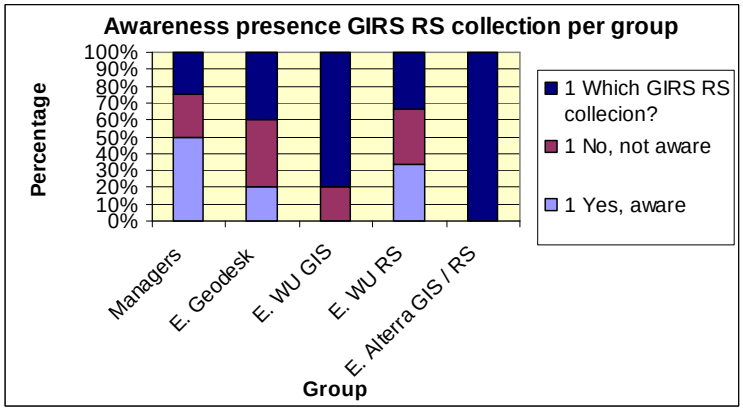


Fig. 8 Awareness presence GIRS RS collection per group

Somewhere between the 300 – 500 RS images are scattered through the CGI. This statement is based on the people who have their own 'private' RS data collection. These images are stored on fourteen different places (hard drives, CD-ROMs, etc). Metadata is sporadically used to describe these images (fig. 8). It is not clear if the RS data in private collection is unique. It could be that certain RS data is also stored in another private collections.

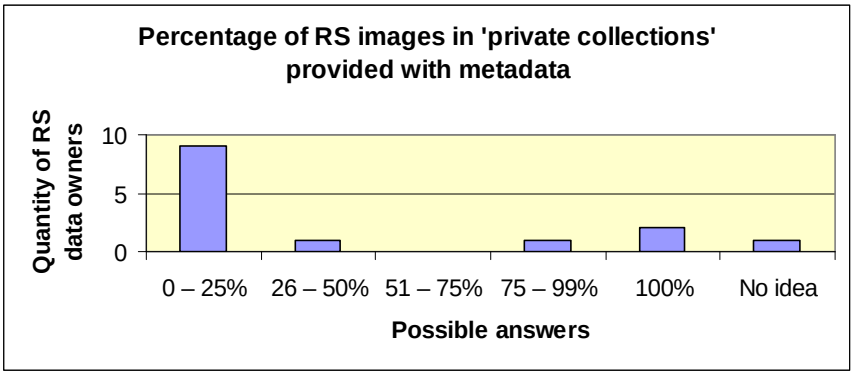


Fig. 9 Percentage of RS images in a 'private collections' provided with metadata

The usefulness of the RS data that is stored in these 'private' collections could not be determined via the questionnaire. The thoughts regarding the usefulness heavily run apart in three extremes; average until non-useful, 100% useful and no idea. Extreme thoughts about the usefulness occur in each group.

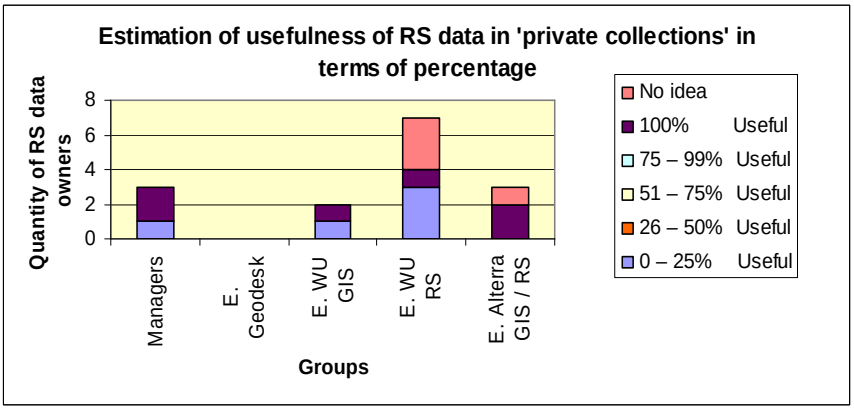


Fig. 10 Estimation of the Usefulness of RS data scattered through the CGI

The people who filled in this questionnaire were asked about their demands regarding the description of RS data. The current metadata templates used to describe the GIRS RS collection (§4.2, section B & appendix I) were showed. The question was if these templates are useful to describe RS data. Most of the people answered; no. Instead of the GIRS templates, an international standard should be used, focussing on the choice with the highest score.

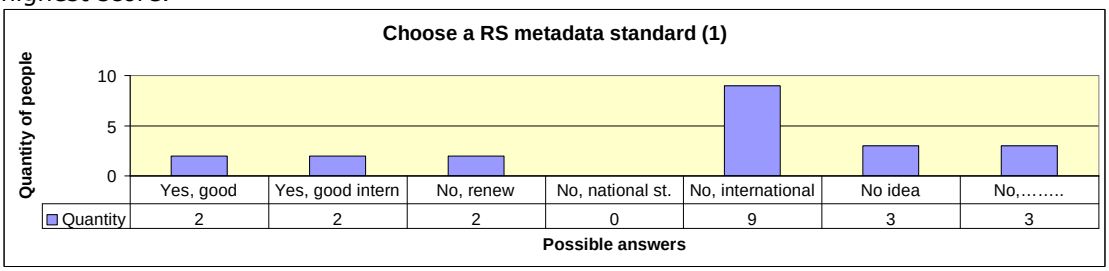


Fig. 11 Choose a RS metadata standard (1)

Figure 12 exhibits that the greater part of the most important groups, managers (policy RS data management), Executers Geodesk (central manager GI) and the executers WU RS (RS data supply / experts) demand an international standard (fig. 11). This knowledge is decisive to make use of an international standard.

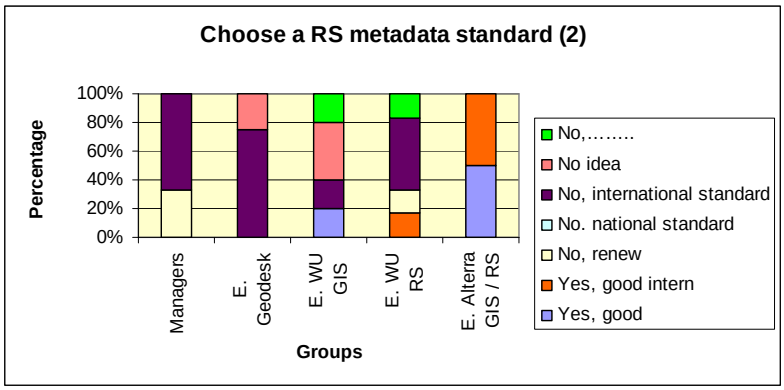


Fig. 12 Choose a RS metadata standard (2)

In addition, on the demands regarding the description of RS data, the demands regarding the quantity of metadata elements to fill in is gained. Most of the RS data owners are willing to describe a quantity between 11 – 30 metadata elements. However, many RS data owners are only willing to fill in 10 metadata elements or less. One CGI employee would like to fill in more than 50 metadata elements if sufficient time and money is provided by the management.

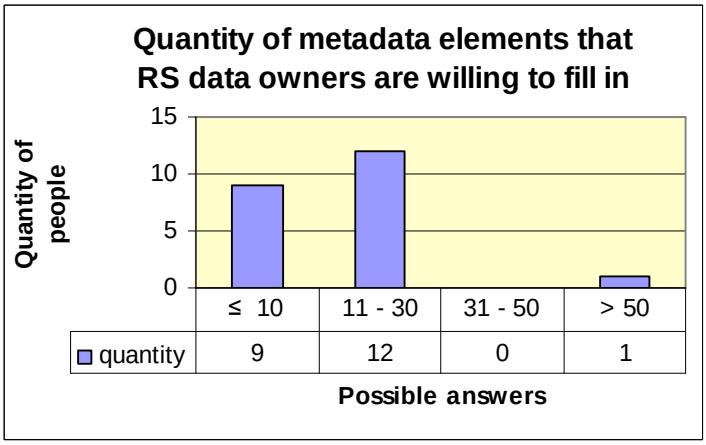


Fig. 13 Choose a RS metadata standard (2)

Geodesk is, almost uniformly, assigned as responsible that should manage the RS data within the CGI (fig 14). Many motivations regarding why Geodesk should manage the RS data were supplied. One motivation summarized them all: 'Geodesk has got the infrastructure (software, orgware and humanware)' (F. Rip). The lack of specific knowledge regarding RS data within the Geodesk (§4.2, section D) is probably causing the reserved attitude of some WU RS members.

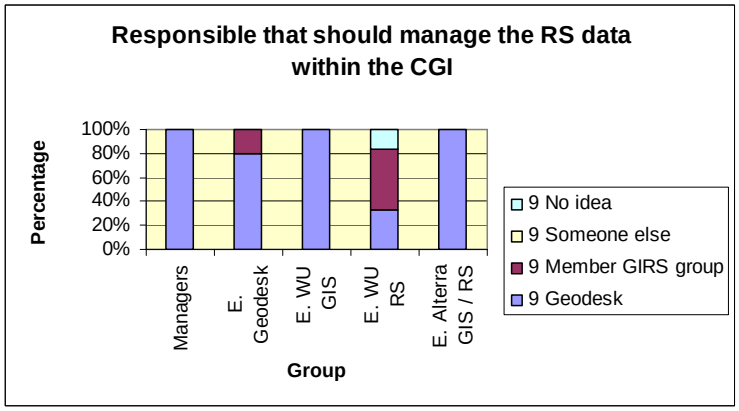


Fig. 14 Responsible RS database management

The purposes to extract RS data out of the RS catalogue are displayed in figure 15. This overview shows that RS data is valuable for multi-purposes. The user purposes 'specific RS projects' and 'monitoring projects' are dominant.

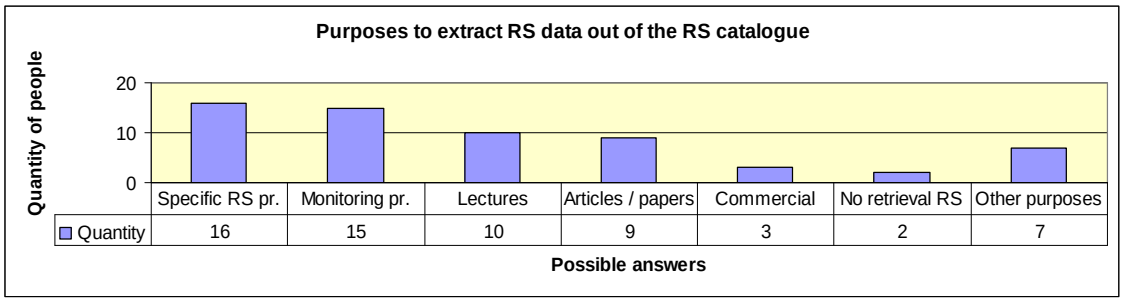


Fig. 15 Purposes to extract RS data out of the RS catalogue

The employees of the CGI and students are seen as the biggest RS catalogue user groups (fig. 16). However, the diagram shows that the thoughts regarding this subject differ. This diverge of thoughts can be the result of a lack of information supply to the people who filled in this questionnaire. No information about e.g.; the functions of the catalogue (download), content of the GIRS RS collection or RS data restrictions), etc, were supplied. In addition the multi-purpose usage of RS data play a role in this issue.

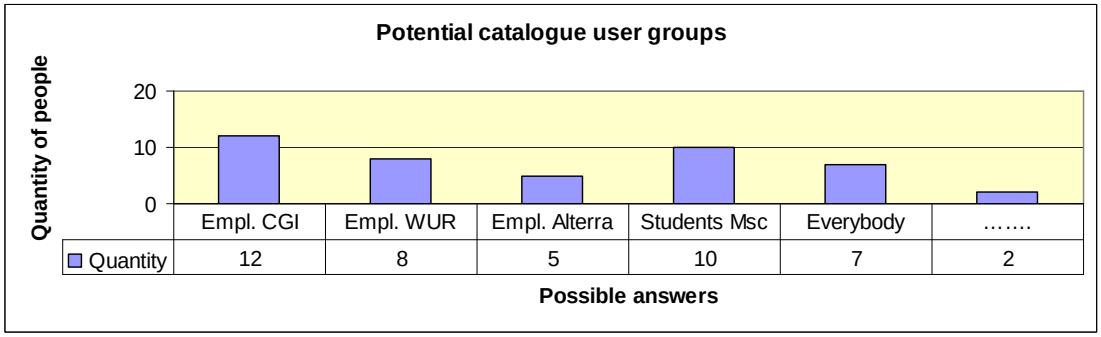


Fig. 16 Potential RS catalogue user groups

The emphasis of the RS catalogue has to be on the requirement group's 'metadata' and 'search possibilities'. Both groups are assigned with significant higher points using three interpretation methods. The results are acquired by asking the people who cooperated, to prioritize the five requirement groups used in the RS-portal evaluation (table 2) by assigning priority points. These points had to be assigned on the basis of the importance of a group (1=low, 5 = high).
Figure 17 provides an overview of the results of the first interpretation method. This method is based on counting the total score of priority points per group. The groups 'metadata' and 'search possibilities' are assigned as most important groups.
The second interpretation method is based on the priority behaviour of individual persons. This behaviour is exhibited by the line structures in fig. 18. Each line represents the priority assignment behaviour of one person. The individual line structures are categorized per group (management, E. Geodesk, E. WU GIS, etc) by assigning the same line colour. This results in a possibility to compare the priority assignment behaviour within a group. Resulting in the knowledge that within a group different opinions are present. The overall view in line structures illustrate a narrowing at the groups 'metadata' and 'search possibilities'. Except one person, everybody provided these groups with a high importance value. The priority behaviour figure also illustrates the different thoughts regarding the groups 'accessibility', 'functions' and 'support'. This conclusion can be made by focusing on the relatively big range in line structures regarding these groups. A clear overview regarding the exact hierarchy of requirement groups is not provided by this interpretation method. The third interpretation method (fig 19) visualizes the priority choices in terms of percentages. For each group several percentages are determined. These percentages display how many people (in percentage) assigned a group with priority point 5,4,3,2 and 1. The groups 'metadata' and 'search possibilities' are assigned with the largest quantity of priority points 5 and 4. Meaning, that these groups are determined as the most important groups.

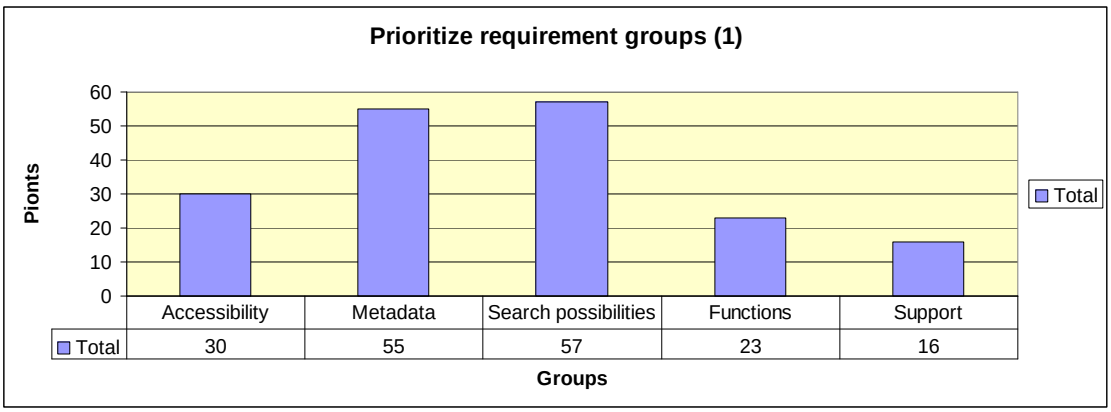


Fig. 17 Prioritize requirement groups (1)

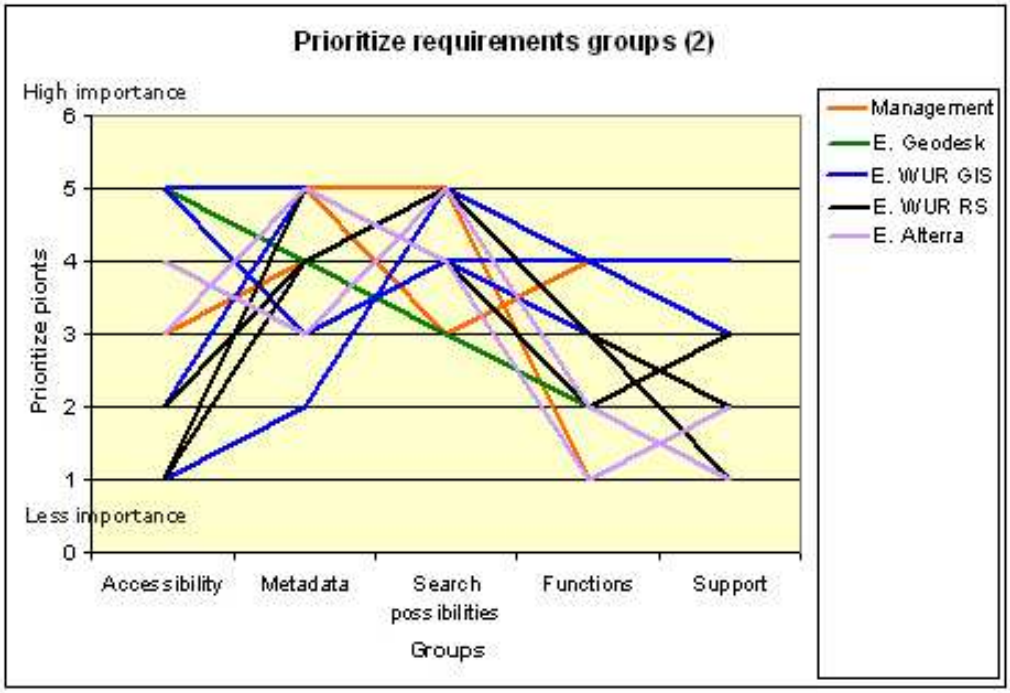


Fig. 18 Prioritize requirement groups (2)

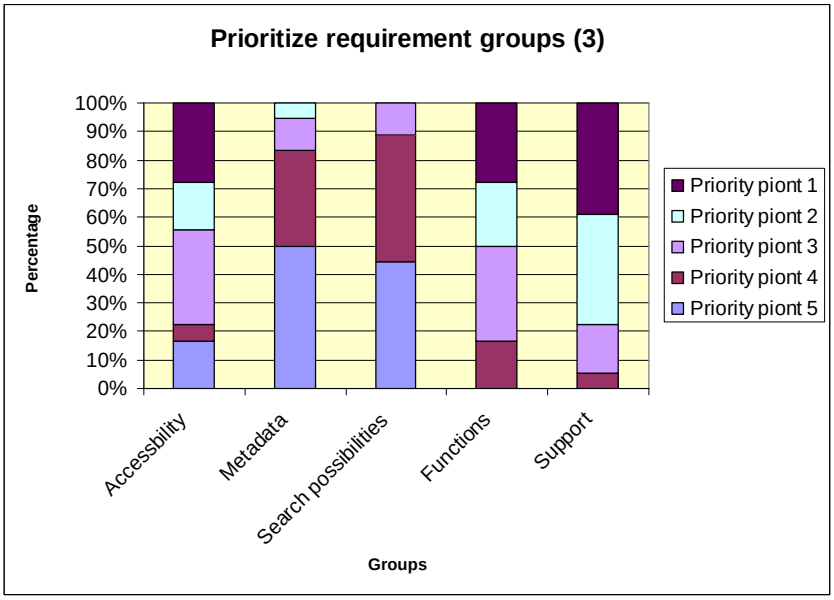


Fig. 19 Prioritize requirement groups (3)

The basis aspects of the RS catalogue are determined by constructing a list of aspects that are present in the evaluated RS-portals (§4.2, section D). The people who filled in this questionnaire were asked which aspects are crucial, less crucial or not interesting. The answers are interpreted by two arbitrary methods.
The first method is focused on the requirements on individual person level. The results are displayed in table 3.
The numbers in the columns crucial aspect, less crucial aspect and not interesting aspect represents the quantity of times chosen. The following **arbitrary** order methodology is used to determine the final 'value' of each individual aspect:

→ A number in a column that distinguishes itself with at least 3 points from the numbers in the two other columns of the same criteria aspect is dominant.
→ An aspect receives the importance value (crucial, less crucial or not interesting) depending on the column where the dominant number is situated.
→ The aspects that do not contain a dominant number are assigned as a less crucial aspect.

Table 3 Prioritized requirements on individual level

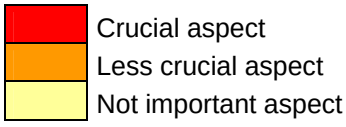
Requirements GIRS RS catalogue	Crucial aspect	Less crucial aspect	Not interesting aspect	Importance value
Metadata RS image	18	2	0	Crucial
Search on coordinates	18	2	0	Crucial
Search on acquisition date	17	3	1	Crucial
Search on map (request box)	17	3	1	Crucial
Browse facility	16	5	0	Crucial
View service images	16	4	0	Crucial
Metadata item: Acquisition date of image	16	3	1	Crucial
Description metadata	15	5	0	Crucial
Website in English	14	5	1	Crucial
Search on sensor	13	6	2	Crucial
View service (webmapping)	13	6	2	Crucial
Search on combination of search possibilities	13	5	2	Crucial
Use of international RS metadata standard	12	8	0	Crucial
Copyright (licence) information	12	8	1	Crucial
Browse facility intermediate results (after first search)	12	8	1	Crucial
Direct download	10	7	3	Crucial
Search on platform	10	6	4	Crucial
Search on keywords	10	5	3	Crucial
Search on predefined boundaries (e.g.; admin. borders)	10	10	1	Less crucial
How to do …catalogue (help-option)	10	9	1	Less crucial
Last update information	9	10	1	Less crucial
Spatial extent RS-portal (world, Europe, Wageningen)	9	8	2	Less crucial
After search refine search possibility	8	9	2	Less crucial
Search on subject (themes)	7	8	4	Less crucial
Print facility metadata	6	13	1	Less crucial
Helpdesk contact	7	11	2	Less crucial
Metadata item: Publication date of image	7	8	4	Less crucial
Link to other RS-portals	5	13	3	Less crucial
Contact web-master / system administrator	5	11	4	Less crucial
Search on acquisition technique	5	10	4	Less crucial
Data suppliers information	4	12	4	Less crucial
Registration	4	9	5	Less crucial
Clear URL description	6	8	4	Less crucial
Provide clear vision / objective GIRS RS catalogue	6	8	4	Less crucial
Get in contact with the producer of the image	2	12	7	Less crucial
GIRS RS-portal advertisment on WUR sites	2	12	7	Less crucial
Provide clear domain type (educational, government)	1	10	8	Less crucial
Search on type of image file (IMG, geoTIFF, etc)	3	9	9	Less crucial
Visitors statistics	2	6	13	Not important
E-commerce (payment)	0	5	14	Not important

The second arbitrary method focuses on the requirements on group level. These results are displayed in fig. 20.
The colours in the columns represent a value of importance per aspect (legend). The following arbitrary order methodology is used to determine the value of importance:

- The answers of each individual person are categorized in the group of origin (managers, Alltera, WU GIRS, …).
- The answers are transformed to numbers:
  - \+ = 1
  - +/- = 2
  - \- = 3
- Per aspect the individual values (1= crucial, 2= less crucial 3= Not interesting aspect) are summed.
- The average value per aspect, per group is calculated.
- The averages ending on ,5 are rounded of down.
- A colour representing the average value is assigned to the aspect corresponding with a particular group.

		Managers	E. Geodesk	E. WU GIS	E. WU RS	E. Alterra GIS / RS
Accessibility	Clear URL description					
	Provide clear domain type (educational, government)					
	Provide clear vision / objective GIRS RS catalogue					
	Link to other RS-portals					
	Website in English					
Metadata	Metadata RS image					
	Desciption metadata					
	Spatial extend RS-portal (World..Europe..)					
	View services images					
	Use of international RS metadata standard					
	Metadata item: Acquisition data of image					
	Metadata item: Publication date of image					
	Print facility metadata					
	last update information					
Search possibilities	Browse facility					
	Browse facility intermediate results (after first search)					
	Search on map (request box)					
	Search on predefined boundaries (e.g. admin. borders)					
	Search on coordinates					
	Search on platform					
	Search on sensor					
	Search on acquisition technique					
	Search on acquisition date					
	Search on type of image file (IMG, geoTIFF, etc)					
	Search on keywords					
	Search on subject (themes)					
	Search on combination of search possibilities					
	After search refine search possibility					
Functions	Direct download					
	View service (webmapping)					
	E-commerce (payment)					
Support	Contact web-master / system administrator					
	Get in contact with the producer of the image					
	Copyright (licence) information					
	Registration					
	How to do ...catalogue (help-option)					
	Helpdesk contact					
	Data suppliers information					
	GIRS RS-portal advertisment on WUR sites					
	Visitors statistics					

Fig. 20 Prioritized requirements on group level



By comparing table 3 and fig. 20, a list of basis aspects is determined. The list is composed out of requirements that are determined by the following arbitrarily chosen demands:
→ The requirement must be assigned with the label: crucial aspect in table 3;
→ At least three groups should have assigned this requirement with the label: crucial aspect in fig 20.
These demands exclude requirements assigned as crucial aspect by the quantity of people of one group (table 3).

The following basis requirements are determined:
→ Website in English;
→ Metadata RS image;
→ Description metadata;
→ View service images;
→ Metadata item: acquisition date of image;
→ Browse facility;
→ Search on map facility;
→ Search on coordinates facility;
→ Search on acquisition date facility;
→ Search on sensor facility;
→ Search on combination of search possibilities facility;
→ View Service (web mapping) facility.

These basis requirements are determined by making use of strict demands. Excluding aspects that are questionable to include in the RS catalogue.
The basis requirements originate for the biggest part out of the 'metadata' and 'search possibility´ groups. This corresponds with the outcomes of figures 17, 18 and 19.
A visible comparison of the above mentioned basis requirements with the outcomes of the RS-portal evaluation (§4.2, section E) is made. This comparison shows that the basis requirements for the greater part correspond with the criteria which are often (≥70%) present in RS-portals. A possible clarification for this outcome is that the people who filled in this questionnaire are familiar with the much present aspects in RS-portals and automatically assign these much used aspects as crucial aspect.

The quantities of people that would like to cooperate in the development process and / or would like to stay informed are relatively high (fig. 21). Also the cooperation level of the RS data owners (fig. 22) is relatively high. However, there are some factors determined that influence the motivation to hand over RS data:
→ Time needed to construct metadata;
→ Costs;
→ Restrictions in RS data use.

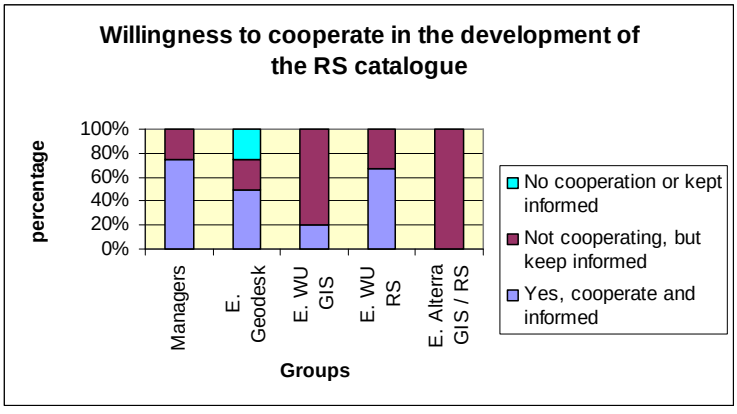


Fig. 21 Willingness to cooperate in the development of the RS catalogue

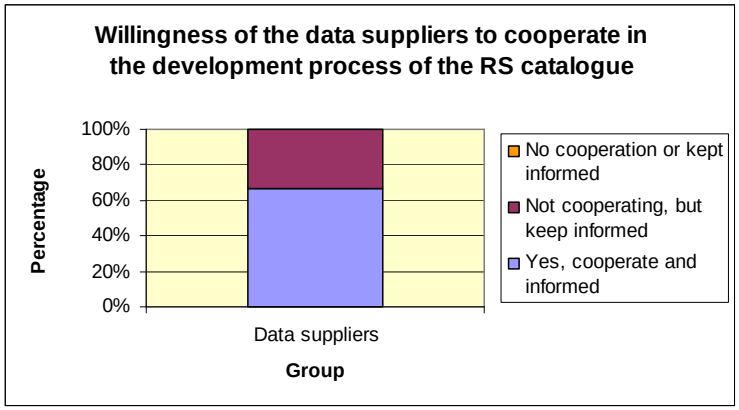


Fig. 22 Willingness data suppliers to cooperate in development process of the catalogue

Discussion
Before the demands and requirements questionnaire was spread, two persons tested the questionnaire. Their remarks were considered and if needed corrected. In spite of this questionnaire test, some CGI employees provided remarks about some questions during the final hand out. A few remarks dealt with unclear problem definition, unclear terms or unclear assignment. Notable is that the remarked unclear aspects were not a problem for other people that filled in the questionnaire. It is questionable if a more extended pilot of the questionnaire would have resulted in a questionnaire that is understandable for all participants.

The people who filled in the demands and requirements questionnaire were barely supplied with detailed information gained in previous stages of the methodology. This affects the results of the questionnaire. For instance, it is determined that everybody should have access to the RS catalogue. The awareness figure (7) shows that the biggest part of interrogated people were not familiar with the GIRS RS collection. This result is thus barely grounded, but based on the global opinion of the interrogated people. Questionable is, if the interrogated people should be provided with detailed information gained in previous stages. A detailed information supply would have lead towards more grounded results. From the other hand, it is questionable if people will fill in the questionnaire. Reading a report before filling in the questionnaire will not stimulate people to cooperate.

The demands and requirements questionnaire provides information about who the potential users of the RS catalogue are. In addition to the CGI employees who filled in the demands and requirements questionnaire, GI-students, Employees Alterra, etc. are also potential users. Their demands and requirements are not determined. Therefore, it should be considered if the demand and requirement analysis should be executed for a second time focussing on the complete group of RS catalogue users. It could be that the demands between different users groups differ.

The questionnaire provides a participation possibility to the stakeholders. This participation possibility is anyhow a bit steered. The people who filled in this questionnaire were asked to fill in questions. Often they had to choose one of the already defined answers (multiple choice). Questionable is if a more 'open' approach would have resulted in different results.

Summary
The desirability for a RS catalogue is relatively high. The relatively high cooperation level indicates a basis to accept the challenge of making RS data accessible within the CGI using a RS catalogue.

Many diagrams show that individuals within one group or separate groups do not share the same thoughts regarding a variety of subjects. Therefore, many choices are made on a compromise bases resulting in solutions that do not satisfy each user completely.

Still many requirements regarding RS data accessibility are not clear;

→ Metadata elements that satisfy the catalogue users ;
→ Technical aspect RS catalogue;
→ Useful datasets to included in the catalogue;
→ Style of the interfaces;
→ Software to build the RS catalogue prototype;

G. Metadata requirements analysis

Six RS experts cooperated to determine the required metadata. These people are selected because they are involved by specific RS- and RS monitoring projects. These projects are determined as the main purposes to extract RS data from the RS catalogue (fig.15). However, also other purposes are determined. Assumed is that these other purposes require less specific RS metadata (fig. 2). For example, the purpose of using a RS image in a paper to improve the layout requires less specific metadata. Expected is that the basic or pertinent metadata (e.g.; coordinates, acquisition date) satisfies the metadata requirements for the less RS specific purposes of the RS catalogue.

The experts are asked to cooperate by filling in a questionnaire. The questionnaire presents a list of metadata elements. This list is composed using expert knowledge. The questionnaire includes only one question: Which metadata elements should be included in a GIRS RS template that satisfy the user needs regarding the determination of fitness for use, whereby the amount of elements to fill in should be minimal?
This question is composed by taken two aspects in consideration:

→ RS data owners are willing to describe a quantity between 11 – 30 metadata elements;

→ The metadata elements required to satisfy the demands of the RS catalogue users.

The assignment of the participant was to cross the metadata, which was non-valuable. Valuable metadata that was not included in the questionnaire list, could be mentioned on the questionnaire form.

The outcome of the questionnaire is showed in table 4. The bold text displays the category name of the underlying metadata. The italic texts display metadata examples that can be filled in. The character in column 1 provides information if the metadata element is mandatory (M) or optional (O) to know. These graduations are applied to gain more detail in the metadata requirements.
The 'values' are assigned by the following arbitrary method:
5 ≥ experts determined a metadata element as valuable, than mandatory (M).
3 or 4 experts determined a metadata element as valuable, than optional (O).
2 ≤ experts determined a metadata element as valuable, than the metadata element is excluded.

Table 4 Required metadata elements

Image information	**1**
Acquisition date of dataset:	M
Acquisition time of dataset:	M
Keywords:	M
Platform:	M
Sensor:	M
Band number(s):	M
Spectral resolution per band:	O
Spatial resolution per band:	O
Spatial resolution unit:	O
Image name(s):	M
Data format(s):	O
Data type(s):	O
Band combinations preview: *true / false / 453*	M
Spatial location	
Projection:	M
Datum:	M
Spheroid:	M
Upper left corner:	M
Upper right corner:	M
Lower left corner:	M
Lower right corner:	M

Process level	
Radiometric processing level: *Raw DN / Top of atmosphere reflectance (TOA) / Ground reflectance / sigma / gamma / …?*	M
Geometric processing level: *not corrected / geocoded / orthorectified*	M
Specific information	
Look angle: *Nadir...-180 - +180*	M
Aerial photographs	
Flying height platform:	M
Platform zenith angle:	M
Flight parameters:	O
Rotations: *tilt, pitch, roll,…*	O
Meteorological information	
Weather conditions: *sunny, rainy, hazy*	M
Clouds cover percentage:	M
Visibility in km:	O
Sun azimuth:	O
Sun elevation:	O
Actual earth-sun distance:	O
-Distance unit:	O
Ground level temperature:	O
Associated data	
Access constraints: *copyright Alterra*	M
Scientific papers reference:	M
Associated files name(s): *field measurements, flight parameters document*	O
-File format(s):	O
Original RS data supplier	
Organization name:	M
Email:	O
Website URL:	O
Data supplier from within CGI	
Project number:	M
Project name:	M
Contact person name:	M
Phone:	O
Email:	O

Metadata related towards cataloguing purposes are excluded from the list. This is because the answers of the six experts were not acceptable to process. Three experts remarked that metadata for cataloguing purposes should be extracted from managers/ organizations who have affinity with cataloguing purposes. Geodesk, who is assigned as the central manager of the GIRS RS collection has that experience.

Two remarks were made about the following metadata elements:
→ Spectral resolution per band;
→ Spatial resolution per band;
→ Spatial resolution unit;
These metadata elements are related towards the sensor type and thus known. A disadvantage is that non-experts have to extract this information from other resources. One expert suggests to make standards for sensors.

Discussion
Remarkable is that many metadata elements in table 4 are actually metadata entities. Metadata entities provide only superficial information, in stead of details. Focusing on the geometric processing level metadata entity, the method used to apply the geometric correction is not documented. The geometric correction method provides information about the quality of the correction. For example, the amount of Ground Control Points (GCP's) used in a random geometric correction method influence the quality of the correction heavily. Using metadata entities in stead of metadata elements influences the metadata quality negatively.
The usage of metadata entities has also advantages. Focussing on the geometric processing level example it is difficult and laborious to describe / standardize the process levels used. In a RS data production / commercial environment this is easier, caused by a repeatedly used method on tedious collection of RS data (learning RS-portal evaluation, §4.2, section E). This results in a description of the process level, which can be used several times. The GIRS RS collection is a heterogeneous data collection (§3.2, section B). Probably, many RS images are produced using different process level methods (lack of metadata). Describing the process level per individual image is time- and cost consuming. If metadata entities should be used to describe the GIRS RS data is questionable. A lack of detailed metadata could block further usage of RS data.

Five people cooperated in the process of determining the required metadata. Questionable is if this group is represent able for all RS experts.

If a personal approach was preferred above using a questionnaire, would the metadata requirement analysis bring in other results?

4.4 Catalogue framework

Several core SDI concepts are determined by executing the stages of the Alternative Waterfall Model 2005.

H. Metadata standard

The demands regarding the metadata determined in previous stages are:
→ RS data owners are willing to describe a quantity between 11 – 30 metadata elements;
→ RS catalogue users demand an international standard;
→ Table 4 determines which metadata is required.

The quantity of metadata elements determined in table 4 does not satisfy the demands of the RS data owners. 47 Metadata elements are needed to satisfy the metadata needs for specific RS and monitoring projects. A possibility to approach this demand of the RS owners is to neglect the 19 metadata elements that are assigned as 'optional' in table 4. A quantity of 28 mandatory elements remains. In this case, the demand of the RS data owners is satisfied. However, the result of this option is unacceptable. The metadata assigned as 'optional' is remarked by 3 or 4 of an total of 6 experts as valuable. This means that 50% (3/6 x 100%) or more of the main target of catalogue users needs the optional metadata. This percentage is too high to neglect.

The ISO 19115 is the only international standard to describe geographic data. This standard provides over 400 metadata elements. A select number of metadata elements is applicable to describe RS data.
The ISO assigned a subset of the total amount of metadata as core metadata. This core metadata is mandatory to use / describe. Within a predefined boundary provided by ISO, the subset of core metadata can be extended for a specific user community.
A manual comparison of the core ISO metadata with the metadata elements provided in table 4, results in the knowledge that a big part of the core ISO metadata is not needed. In addition, the results of the metadata requirement analysis display metadata that is not included in the ISO 19115 (e.g.; visibility in km).

It is clear that the demand of the RS data owners cannot be fulfilled. Two demands remain. In order to meet these demands three options occur;

→ Create a RS template of the metadata elements displayed in table 4;
→ Neglect the required metadata of table 4 and only use the ISO 19115;
→ Create an intermediate solution. Transform the required metadata of table 4 to an ISO 19115 style and add this list with metadata elements that are required but not described by ISO 19115.

The managers of Geodesk and GIRS chair are assigned to make this choice. Geodesk is assigned as responsible for RS data magement. The GIRS manager has many expertise regarding RS data.

Discussion
Focusing on the GI literature review (§2.1) about standards a acknowledge standard should be used. The choice of using the ISO 19115 contributes to standardization. However, using this international standard does not satisfy the metadata requirements completely. In addition, many metadata elements should be filled in that are not needed. The choice to create an RS metadata template does not contribute to the standardization of metadata descriptions. However, the biggest group of the RS catalogue users will be satisfied with the available metadata. By using a template, the reasons why a metadata standard should be used will be neglected (§2.1). In addition to the theory about standards, A Willemen of Geodesk mentioned (personal communication) that GI projects often demand dataset descriptions according to a supported standard.
The choice to create an intermediate solution seems a good alternative to satisfy the demands of an international standard and required metadata. However, this intermediate solution will lead towards a large quantity of metadata elements to fill in.
Taken these three options into consideration, the question is which choice is the best. A discussion can lead to other options.

I. Software

According to the information gained in the previous stages a criteria list is composed in order to select appropriate software. The software chosen to evaluate is based on information gained by the literature research and CGI employees.
The software is evaluated focussing on the possibilities (criteria) that the software offers.

Table 5 Software comparison based the presence of criteria

	Notepad list	**MS Access**	**Carbon tools**	**GIS portal toolkit**
View service images	Not present	Present	Present	Present
Flexible metadata standard usage	Present	Present	Present	Present *
Browse facility	Present	Present	Present	Present
Efficient search on map	Not present	Not present	Not present	Present
Efficient search on coordinates	Not present	Not present	Not present	Present
Efficient search on acquisition date	Not present	Present	Not present	Present
Efficient search on sensor	Not present	Present	Present	Present
Efficient search on combination of search possibilities	Not present	Present	Not present	Present
View service (web mapping)	Not present	Not present	Not present	Present
Description metadata (metadata of metadata)	Present	Present	Not present	Present
Accessible for a variety of users	Not present	Not present	Present	Present
The software should serve multi-purposes	Not present	Present	Not present	Present

*The GIS portal toolkit uses the ISO 19115 for storing metadata. According to G. Hoogeweg (ESRI) it is possible to implements specific metadata elements and make them part of the metadata.

According to table 5 the GIS Portal Toolkit is assigned as the most suitable software. The GIS portal toolkit package includes each basis requirement (§4.3, section E).

The GIS Portal Toolkit is a product of ESRI. According to the website of ESRI (URL 8, 05-03-2005) this is a cost-effective way to create a portal in a small instant of time. ESRI defines a GIS portal as a single point of access to spatial information, regardless of the location, format, or structure of the data source.

The complete GIS portal toolkit and supporting servers (ArcISDM and ArcSDE) are available in the CGI. In addition, software originating from ESRI is much used within the CGI. The Arc catalogue and ArcGIS are good examples.

The toolkit unites with the futuristic plans of Geodesk (lunch meeting CGI, 22-11-2004). The GIS portal offers a good opportunity to offer vector and raster GI via the WWW.

An elaborate description of the GIS Portal Toolkit is provided at the ESRI website (Url 8, 11-04-2005). In addition, several (real existing) portals build with the GIS Portal Toolkit can be explored.

Disadvantages
In the contrary of information provided by ESRI, it takes a while before the GIS portal is running. Lots of time and energy must be invested before the portal satisfies the organizational demands (P. lentjes).

Discussion
The GIS Portal Toolkit provides the possibility to create a website that satisfies the demands of the RS catalogue users. Nevertheless, it is questionable if it is wise to use this modern software. Investing money in the development and implementation while the research and economical value of the data included (GIRS RS collection) is not determined is a big risk.

J. Other core SDI concepts

People
The stakeholders and their relation with the RS catalogue are:
→ RS catalogue users (everybody…students, CGI, WUR, other interested parties);
→ Manager of the GIRS RS catalogue (Dr Bartholomeus (GIRS RS collection transfer to central manager));
→ Data suppliers (GIRS chair members);
→ Central manager of GIRS RS collection (Geodesk);
→ The managers of Geodesk and GIRS, GIS chair (policy, funding RS catalogue);
→ Web-application manager (the researcher that builds the prototype);
→ ESRI (supplier of the GIS portal toolkit, ArcISM & ArcSDE);
→ ICT CGI (provides access to computer facilities / network within the CGI);

Discussion
As showed above, many people are involved in implementing a RS catalogue into the CGI framework. Questionable is if all stakeholders are determined.

Datasets
The GIRS RS collection.

Discussion
This research is principally aimed on the GIRS RS collection. However, there exist also other RS data collections within the WUR (Dr. ir. J. Clevers, CGI, personal communication). Questionable is if the GIRS RS collection should be made accessible in combination with other RS collections.

Network
The internet is preferred above the intranet of the WUR, because the internet provides access to everybody.

4.5 Evaluation Alternative Waterfall Approach 2005

Although the Alternative Waterfall Approach 2005 is not completely executed, the operation until the stage 'catalogue framework' can be evaluated.

Operation approach evaluation
The Alternative Waterfall Approach 2005 provides a model, which is highly structured. After finishing a stage, the next stage have to executed. In practise, the operation of the approach is less structured. Several times, two or more activities were carried out simultaneously. This comment corresponds with the critic of the centre of Technology in Government (§2.3)
A big disadvantage of the Alternative Waterfall Approach 2005 is that it is not clearly defined when the next stage should be accessed. It is possible to enter the next stage after executing all the activities mentioned in the model. However, the quality of the results (e.g. completeness) gained is also decisive in taking the decision to go to the next level.

Innovating aspects evaluation
To accomplish the transformation from a general ISDM to a RS ISDM several specific activities are included in the Alternative Waterfall 2005 stages. Afterwards it can be stated that it would be better if more generic names were assigned to these activities. For example the participation stage includes the activities; 'demand analysis' and 'metadata analysis'. If participation is needed for a third time, which activity should be executed? The assignment of a more generic term, like participation possibility, provides the possibility to execute the stage several times. This improves the flexibility of the Alternative Waterfall Approach 2005.

The participation stage resulted in valuable information needed to construct a RS catalogue according to the demands of the RS catalogue users. In addition to the RS catalogue users demands, other stakeholders play also an important role in the development of a RS catalogue. Their demands are scarcely analysed. This is the outcome of the emphasis of the participation stage, which is principally oriented on the RS catalogue users instead of all stakeholders.

The coloured lines that are implemented in the Alternative Waterfall Approach 2005 worked properly. These lines really make the approach dynamic. However, the Alternative Waterfall Approach was not flexible enough regarding the initial awareness stage. The results of the initial awareness stage are partially acquired in other stages (information inquiry- and participation stage). There is no connection from the information inquiry- and participation stage to the initial awareness stage. To determine the real process of implementing a RS catalogue, these connections have to be realized. By implementing these connections, a possibility is made to determine the initial awareness on basis of several employees instead of one.

Discussion
Involving people in the development process of the RS catalogue is determined as a very important aspect in this research. An aspect about involving people in the development process that is not discussed is the level of involvement (intensive vs. extensive). Provides a questionnaire sufficient opportunity for stakeholders to clarify their demands? Is a personal approach a qualitative better method to ensure good results? Aspects as cooperation, costs, and time play also a role in determining a proper participation method.

Another discussion point is if all stakeholders should participate in the development process.

After a partial evaluation of the Alternative Waterfall Approach 2005 it has become clear there are several aspects that should be improved. When these aspects are improved it is questionable if the Alternative Waterfall Approach 2005 is useful for other organizations to improve their RS data accessibility.

5 Conclusions & recommendations

5.1 Conclusions

Although the Alternative Waterfall approach is not completely executed, much information to answer the research questions is acquired.

1. What are the demands to access Remote Sensing data using Spatial Data Infrastructure (SDI) concepts applied within CGI?

One central, easy accessible for everybody, web-based facility that provides efficient and effective discovery, evaluation and use of available RS data.

2. What are the demands of the stakeholders towards the RS data accessibility?

The demands that are determined are:
→ Easy access to the RS catalogue;
→ Awareness of the existence of the available RS data;
→ The process of making RS data accessible may not take to much efforts and time;
→ Low costs;
→ Clear policy.

3. Which core SDI concepts are recommended to make RS data accessible and fit the stakeholders demands?

The core SDI concepts that are recommended to make RS data accessible are based on the stakeholders demands. Four SDI concepts are determined:

→ Access network: World Wide Web;
→ Software: GIS Portal Toolkit;
→ Data: GIRS RS data collection;
→ Metadata: (table 4 / ISO 19115 / Intermediate solution)

4. What are the demands with regard to RS data for making this data accessible via a web-based application?

The demands regarding RS data for making this data accessible via a web-based application are:
→ Proper metadata of RS images;
→ Description metadata;
→ Useful RS data.

5. What are the user requirements towards the description of the RS data and usability of the system?

The determined user requirements towards the description of the RS data are twofold:
→ Usage of international metadata standard;
→ Metadata elements determined in table 4.

The determined user requirements towards the usability of the system are similar with the demands regarding RS data accessibility. The RS catalogue should provide effective and efficient use of RS data. In order to establish this demand, the basis requirements (§4.3) have to be included in the RS catalogue.

6. What are the implementation steps of a web-based RS catalogue?

This question cannot be answered, because the implementation stage of the Alternative Waterfall Approach 2005 is not executed.

Additional conclusions
Not all demands concerning RS data accessibility are determined. Many stakeholders are determined (§4.4, section J), but not all demands are analysed. This is caused by Alternative Waterfall Approach 2005, which is principally focussed on the demands of the users.

The research results determine that the current system used to make the GIRS RS data collection accessible does not meet the demands of the RS data users. In addition, the relatively high cooperation level of CGI employees indicates a basis to accept the challenge of making RS data accessible. Briefly, it is time for a change concerning RS data accessibility within the CGI. This information should act a signal to the Geodesk and GIRS chair managers.

Analysing the demands and requirements of the stakeholders regarding RS data accessibility is a slow process. All stakeholders opinions have to be analysed to make considerable choices. Analysing all these opinions carefully require lots of time.

Not all demands and requirements of each individual stakeholder can be fulfilled. Many diagrams exhibit that the opinions of stakeholders regarding a variety of subjects differ.

The usefulness of the constructed Alternative Waterfall Approach 2005 is not determined. In order to determine the usefulness, the complete approach has to be executed and revised. The remarks of the stakeholders regarding the RS catalogue supply information about the usefulness of the approach.

The results gained by this research deliver a basis to continue with the process of making RS data accessible. However, much more information has to be acquired to realize a RS catalogue. This research focuses on the core SDI concepts, but non-core SDI concepts are also needed.

The implementation of RS catalogue in the CGI framework will have a big impact on the RS data management within the CGI. The catalogue will close a cycle of RS data management within the CGI (collect, store, offer and use RS data).

5.2 Recommendations

A recommendation is to execute the Alternative Waterfall Approach 2005 completely. After executing the whole approach, an evaluation can take place to determine the model's usefulness. After the realization of the RS catalogue, it can be checked if the catalogue meets the demands of the participated stakeholders. This information is vital to determine the further use of the Alternative Waterfall Approach 2005.

This research is whole about making RS data accessible. As stated in §1.1, more RS data collections are available within the WUR. Recommended is to make an inventory of these collections. Probably these collections include valuable RS datasets that could be included in the RS catalogue.

The success of the RS catalogue partially depends on the data included. Which specific RS data is useful for the RS catalogue users is not determined. More information about the usefulness is necessary to determine the relevance of datasets that should be included in the RS catalogue.

The metadata of the GIRS RS collection have to be adjusted towards the demands of the RS catalogue users. Several questions pop up:
→ Is it possible to adjust the metadata of the GIRS RS collection to the demands of the RS catalogue users?
→ What is a cost efficient way to do this?

Geodesk is assigned as responsible for the GIRS RS data collection. The transfer of this RS data from the current manager (H. Bartholomeus) towards Geodesk is complex. Therefore, the following question should be answered:

→ What is a proper strategy to implement the GIRS RS collection in to the Geodesk framework?
→ How can Geodesk deal with the lack of knowledge about RS data?

A main bottleneck in making RS data accessible are the user restrictions (copyrights). Juridical issues are neglected by this research, but play a very important role regarding sharing data. It is recommended to gain more information about the user restrictions. Some interesting questions are:
→ Which RS data does not have user restrictions?
→ Are RS images bought by a CGI employee, also usable for Alterra and WU employees?

Epilogue

While I wrote this epilogue, I realized that this was the last time that I looked back on my personal objectives as a student. After nine years of studying, the end of my college years is in sight. It where nine beautiful years, which I will not forget! But before I am going to hand over this report to the examination board, I have to finish this epilogue by evaluating my personal objectives.

That my knowledge about aspects that deal with the management of spatial data is increased does not need –after reading this report- a further explanation. Although the course of the research differed a bit with the expectations (building a RS catalogue), I am glad that I choose this subject.
During this research I tried to improve my verbal communication skills. Several times, I personally approached a CGI employee instead of sending an Email. This personal approach was regularly caused by the pressure to quickly acquire results. I experienced that I could not make myself always completely clear. However, during the research my verbal communication skills improved a bit. I realize that my verbal communication skills problem cannot be solved at once. Improving my verbal communication skills is a long-term objective.

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URL 6 : www.linkpopularity.com
URL 7 : www.esri.com
URL 6 : www.geoleaders.com/news/carbontools2.html

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AIRS data support	http://daac.gsfc.nasa.gov/atmodyn/airs/
ARSMIS	http://aadc-maps.aad.gov.au/aadc/aramis/search_remote.cfm
ASDC	http://eosweb.larc.nasa.gov/
Carterra	http://carterraonline.spaceimaging.com/
CCRS	http://ceocat.ccrs.nrcan.gc.ca/
CRISP	http://www.crisp.nus.edu.sg/crisp_cat.html
Earth Explorer	http://edcsns17.cr.usgs.gov/EarthExplorer/
EOEW	http://earth1.esrin.esa.it/ew/
EOSC	http://scrscbs.kacst.edu.sa/
EOSDG	http://edcimswww.cr.usgs.gov/pub/imswelcome/
Euroimage (L)	http://www.eurimage.com/
Euroimage (Q)	http://www.eurimage.com/
Euromap	http://www.euromap.de/site/index.html
GLOVIS	http://glovis.usgs.gov/
Landsat.org	http://landsat.org/
MDQ	http://www.macres.gov.my/macres3/data_query.htm
MODIS LBBI	http://landqa2.nascom.nasa.gov/cgi-bin/browse/browse.cgi
NAPL	http://airphotos.nrcan.gc.ca/prod_e.php
NSIDC	http://nsidc.org/daac/
Orbimage	http://www.orbimage.com/
PO.DAAC	http://podaac.jpl.nasa.gov/index.html
SIRIUS	http://sirius.spotimage.fr/anglais/welcome.htm
Terraserver	http://www.terraserver.com/
Terraserver-USA	http://terraserver.microsoft.com/
TRFIC	http://trfic.jpl.nasa.gov/
VRSD	http://rsd.gsfc.nasa.gov/rsd/

Acronyms

CEN	European Committee for Standardization
CGI	Centre for Geo-information
FGDC	Federal Geographic Data Committee
FTP	File Transfer Protocol
GCP	Ground Control Point
GI	Geo-information
GIRS	Geo-information Science with special emphasis no Remote Sensing
GIS	Geographic Information System
ID	Identification
IS	Information System
ISDM	Information System Development Methodology
ISO	International Organisation for standardization
KNMI	Royal Dutch Meteorological Institute
MB	Mega Byte
NEONET	Netherlands Earth Observation NETwork
NLR	National Aerospace Laboratory
RS	Remote Sensing
RSMS	Remote Sensing Metadata Standard
SDI	Spatial Data Infrastructure
TOA	Top Of Atmosphere reflection
URL	Uniform Resource Locature
WU	Wageningen University
WUR	Wageningen University and Research Centre
WWW	World Wide Web

Appendix

Appendix I: Analysis GIRS RS management system
Appendix II: Interviews
Appendix III: Evaluation RS-portals

Appendix I (1 of 3)

Analyses GIRS RS management system

Appendix I includes:
A: Report of the meeting with the former manager of the GIRS RS collection, H. Schok;
B: Report of the findings during the GIRS RS collection analysis.

A: Meeting H. Schok

Around 1990 H. Schok started with conceptualize a metadata list for the RS images possessed by Wageningen University. The motive for this project was the growing amount of RS data that had to be maintained. In those days all the RS images were stored on tapes. The corresponding metadata was stored in DOS files or on hard copies. The RS tapes were stored in a bookcase. Due to the amount of tapes the bookcase was chockfull. To keep the RS collection manageable, H Schok made the decision to create a useful metadata list.
Because a lack of money to organize the RS data a –keep it simple- constructing methodology was used. Therefore, the metadata list is build up out of plain text. Building a database or web-application did not fit in the –keep it simple- methodology. Together with some former colleagues, H. Schok determined the essential metadata components that were needed for a good description of the RS data. These metadata components formed the bases for organizing the RS data collection.
Filling in the metadata was a time consuming and difficult job, according to H. Schok. Often the producer of a RS image provided lots of information, but it was not always clear what the information meant. Also shortages of information did occur. In spite of pressing efforts, some metadata components could not be filled in. Nevertheless this RS data was admitted into the metadata list, because there were no other management solutions. H. Schok managed the RS data and the metadata list. Every time there showed up new RS data, he updated the list.
The content of the box was, more or less familiar within the head of H. Schok. The list functioned as an external memory which was useful for him to look things up.
At the moment of the raise of Geodesk, there was no discussion about handing over the RS data, based on three reasons:

→ the collected RS imagery was only applicable for a small group within the CGI;
→ the frequency of people that knocked on the door of H. Schok for the retrieval of RS images was very low;
→ Geodesk did not have the expertise to manage RS data.

B: Analysis GIRS collection

metadata
Two metadata standards are used for describing the whole RS collection. One standard for digital acquired data and one standard for aerial photography. (see fig. 1.1 and 1.2).

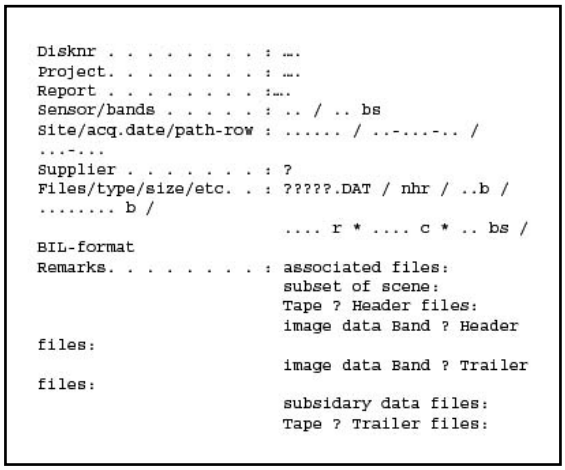


Figure 1.1 Standard for digital acquired data

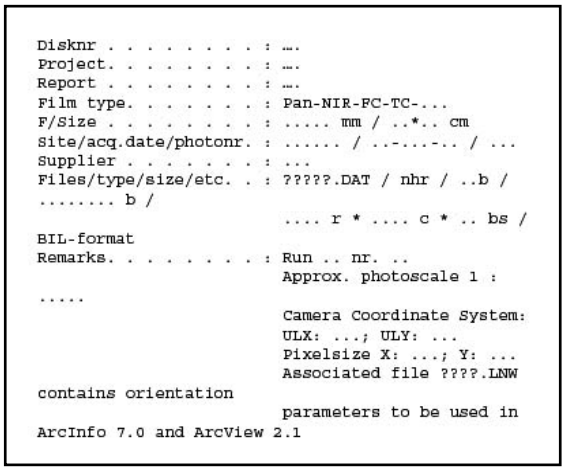


Figure 1.2 Standard for aerial photography

The metadata items 'files/types/size/etc', provide a lot of information, but it is not always clear what they mean. According to S. Schok, producers of RS data provided unclear information. To exclude the risk of throwing away valuable information all the collected information is stored as a precaution on the metadata list.

Furthermore, there is a lot of the same information on the metadata list caused by the usage of non-disguisable metadata items. One project often includes more than one RS-image. This results in a frequently occurrence of the same a project name on the metadata list, better referred as redundancy.

The metadata item 'location / area determination' is not very punctual. Often descriptions occur, like 'east Netherlands' or 'middle of Spain'. These kinds of descriptions are non-precise. Supplementary is the critic regarding the overall view of filled in metadata. Often there is no rectilinear way visible for filling in metadata items. A clear example is the description of the acquisition day of images (11-09-2001 / 11-09-'01 / 11-sept-'01). Remarkable are the quantity of non-filled in metadata items. Also out of data references toward employees, which do not work anymore for the CGI are provided.

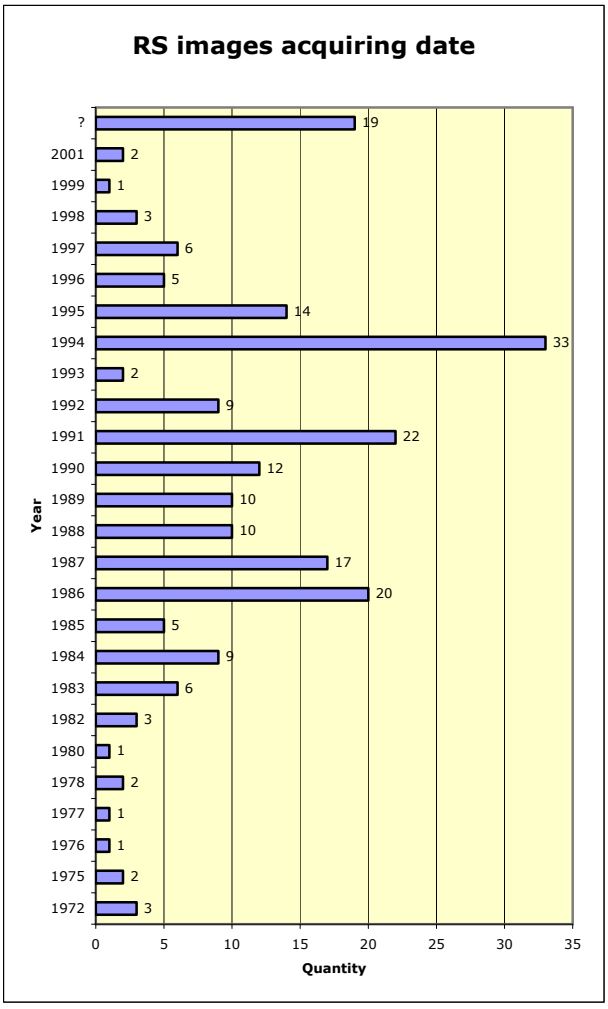
RS images
Some RS images are investigated via a random check. The only remarkable fact is that some RS images are stored twice in different format on a CD-ROM. This is caused by the conversion of the analogue aerial photographs to a digital format via scanning. Due to the technology of that time, the output of the scan (.TIF format) could not be important in the RS analysis software used. Therefore, a second conversion had to be made, to change the format to a .IMG file, which was compatible with the software package used in those days. Both formats were stored on a CD-ROM, to exclude the risk of throwing valuable RS data away.

Content of the GIRS RS collection
The images present in the GIRS RS collection are obtained by a variety of recorders (fig. 5). A distinction between data acquiring techniques within one recorder type is not made. For example, a CAESAR down- & forward-looking recorder and CAESAR down-looking recorder are assigned towards generic term CEASAR. This is done to keep the pie chart transparent.
The RS techniques that have an occurrence frequency of less than five on the metadata list are enumerated and registered under the category name 'remaining'. The Landsat 1 – 5

and SPOT 1 – 4 are generic terms for respectively Landsat 1, Landsat 2, etc. and SPOT 1, SPOT 2, etc.
The biggest share in the RS collection of the CGI is devoted towards the Landsat 1 – 5.

Figure 6 displays the various suppliers of images present in the RS collection. In the legend of figure 6 the label 'private channels' occurs. This is the collective noun for RS images collected via private channels. The legend item 'unknown' represents the RS images whereby no suppliers name could be brought to the light. The legend item 'remaining' represents all the supplier names that does not show up more that five times on the metadata list.

The underlying figure displays the quantity of RS images present in the RS collection, acquired in a certain year. The y-axis shows a non-chronological era. At the top of the y-axis, a question mark is reflected. This question mark represents the quantity of times that no information about the acquiring date is provided.



RS images acquiring date present in GIRS RS collection

There are twelve RS images whereby no complete acquisition date is supplied. These RS images miss an exact acquisition day, but the month and year are known. Although there non-completeness, these twelve RS images are included in the year of acquiring.

Appendix II (1 of 11)

Interviews

Interview with: Frans Rip
Function: Coordinator GIS-facilities
Organisation: CGI - Geodesk
Date: 07-09-2004

1. Does Geodesk manage Remote Sensing images?

No

2. Why not, RS imagery is also geo-information?

Geodeks does not manage any RS imagery caused due to three main reasons:
→ RS imagery is not handed over towards Geodesk;
→ Geodesk has no acquaintance with RS imagery;
→ Users of RS imagery have there own 'channels' to meet there demand for RS data.

3. Do you know that there is a cardboard box with RS images on CD-ROM, stored on the bookshelf of one of the CGI employees?

Yes

4. Do you know that there is a digital list (plain text) with the metadata of the RS images of that particular box?

No,…….is there?

5. How does Geodesk collect there Geo-information? Plausible is that new produced of collected geographical information is handed over towards the Geodesk.

After finishing up a project it is not an automatically continuation to hand over the acquired or produced geo-information to Geodesk. Geodesk has the intention (try to improve) that the data flow is a closed chain, but experience has shown that this is not the case. Geodesk can not enforce employees of Wageningen University or Alterra to hand over geo-information.

6. Why does employees of Alterra and Wageningen University do not hand over geo-information?

The main reason is that there is no extra money reserved in the project cost estimation for storing geo-data. Filling in a time-consuming metadata standard costs money. Also the motivation to fill in a metadata standard is often very low.

7. Must people always pay money to make use of the Geodesk storing facilities?

We try to find a balance between the wish of the people that use Geodesk as a 'shopping window' and the wish of Geodesk itself: try to serve the users as much as possible.
If Geodesk makes an agreement with a producer, about the usage of a certain dataset or something, than we speak of a performance commitment. When there is a performance commitment Geodesk will ask a financial compensation for the executed activities to the producer..
Before such a performance commitment is realised, there could be a phase whereby the dataset is already in the 'shopping window', but Geodesk does not use it. In this case Geodesk can not ask a financial compensation. In this case Geodesk does not take maintenance responsibilities. At the moment there are interested persons for this dataset, Geodesk makes a reference to the producer, so that the producer is entrused with the activities. Maybe you can also talk with Theo van der Heijden, he is often involved by such cases.

8. What are the demands towards the geo-information that is handed over to Geodesk?

For commercial aims the data must be relevant, so that the geo-information can be placed into the 'shopping window' on the internet.

9. How is this relevance determined?

The employee of Geodesk that gathered new geo-information must determine the relevance.

10. Is there a standard for determining the relevance?

No, the relevance of the geo-information is determined by the insight of that particular employee of Geodesk. Demands for determining the relevance of geo-information could be:
→ The cover of a recognizable;
→ Landcovering or bigger;
→ Recent information;
→ Historical information;
→ Etc.

11. Did you ever experience that a (potential) costumer asked for RS data?

Uncommonly someone asks for RS data. But when someone asks it is always for very specific data, like a particular area, particular sensor, etc.

12. Who must manage the RS collection of the CGI in the future?

The management of RS imagery is pleasant if a good overview is provided. Managing RS imagery is in line with the strategy of Geodesk.

Appendix II (3 of 11)

Interview with:	Dhr. R. van Swol
Function:	Senior Scientist Geomatica, Data infrastructures
Organisation:	NLR
Date:	09-09-2004

1. What means a Dutch infrastructure for the dissemination of earth observation data?

The network is for Dutch companies, organisations, institutes, etc. It is not only for RS data that is linked to the boundaries of the Netherlands. Also RS data from foreign counties, collected by Dutch companies, organisations, etc, could be provided via NEONET.

2. Are there any restrictions for participants of NEONET?

No, no restrictions

3. In the Remote Sensing world a lot of terms are being used. How did you dealt with that during conversations?

By the realisation of an earth observation data infrastructure a lot of people are involved. For the development of a data infrastructure a lot of agreements must be made. Good agreements must be the outcome of fruitful discussions. During a discussion every participant must know what he or she is talking about. Therefore it is very important to give clear definitions of terms used in projects. A bad classical case is the ditch and a channel discussion. Without good a terminology you can not make good agreements!
An adequate example of the NEONET project was the difference between an original image directly from the sensor and an image that is adjusted. Both items can be called RS images, but there is a small difference. For a RS user such a difference can cause huge mistakes, during an interpretation of an image for example.

4. Has there bin an inventory of the demands of the stakeholders (requirements analysis)?

Yes, we did. More about this in written in a report, which I will give to you at the end of the interview.

5. Were there certain things that attract your attention during this inventory?

During a requirement inventory it is remarkable that there are a lot of demands. By ranking these demands on there priority status, conclusions can be drawn that only a few requirements are relevant. Also requirements are time depending. Keep that in the back of your mind!

6. In the article, called NEONET (12-09-2000) is written that NEONET makes use of a metadata standard for describing the data. Can you tell something more about this standard?

At the moment the development of NEONET started, there were no metadata standards. Therefore a metadata standard had to be designed. Out of a subset of standards related to geo-information and some adding's a new standard was designed. The standard is called the CEO metadata standard.
Often there are thoughts that standards are the key to success. Standards are indispensable for establishing a web-based application, especially when several stakeholders are involved. Without standards, it is impossible to develop new software applicable for a variety of companies. Standards are very important but form no bottleneck for the success of a data infrastructure, because standards can be made, cooperation by companies not.

7. What is cooperation of RS users/producers towards filling in metadata?

Filling in metadata is a psychological aspect, because it is boring. This psychological aspect causes problems towards the cooperation of RS producers/researchers. Therefore people must be obliged to fill in there metadata. The idea of metadata is good, but if the quality of the metadata is low the metadata becomes worthless. Also costs determine the cooperation of filling in metadata. A long metadata standard will cost organizations a lot of many. Certainly at the moment when large RS collections are available.

8. Is the NEONET project a success?

After the implementation of NEONET on the WWW the enrolment of RS organizations was low. Without grow in the participation of RS organizations no national infrastructure could be established. After all, a data infrastructure arises from supply and demand. Generally the same reason was brought up by RS organizations that did not want to cooperate in the NEONET project. 'There is no data available on NEONET', pronounced by the employees of RS organizations that did not want to cooperate. The reaction of me was a question: 'Which data did you supply for NEONET?' The answer is guessable. Therefore, the cooperation of the stakeholders determines the success of the data infrastructure. From this point of view NEONET was not very successful. Maybe also bad marketing has a small influence, but this is a really small aspect. On the other hand, from a technical point of view, NEONET was a success.

9. NEONET is proves that the technology can meet the demand of creating a SDI network. What is the next step?

Combining the different kinds of data, making overlay's like RS data with topological data, or other combinations in just a couple of seconds.

10. Is there any documentation available about NEONET which I can use?

Yes,
→ The NEONET project, executive summary;
→ The NEONET project, part1: Requirements, concepts and implementation plan;
→ Design and implementation of the NEONET core facilities.

Other documentation:
→ Groot, r. En J. Mc Laughin, Geospatial data infrastructure concepts, cases and good practice.

11. Finally, do you have some tips to keep in mind during my research?

→ Not only the realisation of an infrastructure costs money, the maintenance is also expensive. For the maintenance of a data infrastructure a long/term money flow must be available to keep everything up to date. Compare it with the management of a website. The maintenance costs are often underestimated.
→ Old images you can buy almost for nothing. I do not know what the content of the RS collection is, but maybe it is not valuable to establish a web-application for the CGI.
→ From the idea of NEONET towards the realisation of NEONET is a very slow process.
→ Who pays for the infrastructure?

Appendix II (5 of 11)

Interview with: dhr. F. van der Wel
Function: GIS researcher, specialisation SDI.
Organisation: Royal Dutch Meteorological Institute
Date: 16-09-2004

1. Is the dataflow a standardised process?

You can subdivide the dataflow in two main streams, namely the operational and the research data flow.
1. The operational dataflow is standardized; this dataflow is like a production process.
2. The research dataflow is absolutely not standardized.

There must be stated that the KNMI is the dutch crossing (knooppunt) for a international network. The operational dataflow has a typical coding for data and data transmissions via the GTS network. Since there is a raise in the participants of the meteorology market, there is a conflict with the codes. The codes are not usable for everyone. Also there are some changes in progress due to governmental policies. In the future the KNMI should provide some basis data for free or for min. costs to all users. This basis data must be easy accessible for everybody. Therefore the KNMI is several years busy with SDI issues. This results in internet application next to the GTS network. Internet provides more possibilities.

2. Are employees of the KNMI enforced to fill in metadata?

The KNMI employees do not work much with metadata. Metadata is produced during an automatically process.

3. Why does the KNMI archive RS data?

Good question,…the KNMI has a lot of paper archives. The metadata is mostly available in the heads of the employees. For example, at the moment when a researcher wants a RS image of a heavy thunderstorm. He or she has to think: when was there a big thunderstorm? The outcome of this question provides the point of departure for searching the archive. Employees come and leave the KNMI, thus valid information for searching the archive flows out of the KNMI. If there is no methodology to search on a structure way in the archive …… If you cannot find the RS data, why should you archive it? Data becomes interesting / valuable if you have metadata. Therefore the process of consciousness-raising is very important. Via metadata the 'fitness for use' can be determined.

4. Is every RS image within the KNMI stored?

In the past a lot of data was not archived after the usage of the image. Later on this changed. After acquiring RS data, the data is stored in a database, called Omnivoor. Omnivoors eat everything, this corresponds with the database (heterogenous data). After one year, this data is going to an archive. This has consequences for the accessibility of the data. The archive is difficult to access (robot-steered) in comparison with Omnivoor. I must mention that Omnivoor is not super operational at the moment, because Omnivoor is quit new.

5. Do you think it is valuable from an economical point of view to invest attention towards the metadata problematics?

Certainly, investing attention is important. Now it is the time to invest money, but in the end a win / win situation will be created.
The increasing quantity RS data is pressurizing the policies of organizations to make use of metadata. If you do not make use of metadata, you will drown. I once had a closet full of old remote sensing tapes, a sort of inheritance of my precursor. At the moment I tried to archive them it resulted in a failure. The machine that was renewed and the tapes could not be used anymore. This was a big clean up in my closed.

6. Can you mention an example of economical advantage?

At the moment RS data is made accessible, you can monitor the quantity of hits, downloads, etc. This information could be a very valuable information source, at the moment a request for a subsidy / more money is deposited by the employer.
On the other hand this could also be negative, in case nobody makes use of the application for the retrieval of remote sensing images. Also the efficiency could be detemined.

7. Did u ever heard from the FGDC metadata standards?

Yes, that standard is compulsory to apply at the moment a description of governmental data must been made. Probably in the future the same will occur for the Netherlands / Europe.

8. Which advantage(s) is/are provided by the ISO 19115 in comparison with the actual metadata?

The current metadata is automatically processed.

9. In the reply Email you send me, you wrote that the KNMI wants to switch over to the ISO 19115 standard. Why?

Due to the acknowlegment of the ISO 19115. Elaborated in

10. What do you think of the NEONET project?

It is a success qua technology.

Appendix II (7 of 11)

Interview:	Harm Bartholomeus
Function:	Remote sensing support and education
Organisation:	CGI
Date:	17-09-2004

1. You offered this thesis, because you realized it was time to do something about the accessibility of the RS collection of the CGI. Did you discussed this with your RS collegues?

No, not really.

2. Why not? Now you do not no if the right culture exists within the CGI for developing a data infrastructure for RS data.

During coffee breaks we discussed a little about this subject. It is correct that I do not know if the right culture is present for a RS imagery data infrastructure.

3. Was it not better to do first a feasibility study?

Actually, yes.

4. Why is the cardboard box with RS data moved to your closed?

Sir. H. Schok was retiring.

5. In what year this moving take place?

2001 – 2002

6. The last adding of a RS Image to the RS collection of the CGI was in 2001, according to my statistical analyze. Are there no RS images gathered in the last couple of years?

Yes, there are RS images collected. These images are probably stored by the persons that collected the RS data.

7. Why are those images not added to the RS imagery metadata list?

I did not try actively to get these RS images in my possession and nobody pushed me. There also was no motivation to do this, because nobody had questions applicable towards the RS collection.

8. You also collected RS data yourself I assume. Did you put it on the metadata list?

No, except the motivation aspect there is another issue, namely the format of the metadata. It is unhandy and therefore uninteresting to invest time in organizing RS data via this methodology.

9. Why does nobody ask questions about the RS collection?

People are not aware that there is RS data available. Also it hard to find a specific RS image. It is easier to order a RS image of 50 Euro, than invest money to search for a image in the own collection. Ordering is much cheaper.

10. Do you think there is any interest for RS data within the CGI?

Yes, especially for student projects. I know by head that there is interesting RS data available about Alora in Spain. This could be combined with a elevation models which stands in the closed of Sir. J. Stuiver.

11. Why are these elevation models not been delivered to Geodesk?

These elevation models are not applicable for Geodesk, because it is not valuable from a economical point of view.

12. Why do RS users within de CGI do not deliver RS data to you?

It has nothing to do with money. It has more to do with the absence of a good database system for RS data. Therefore the RS users within the CGI will rather keep the RS data in there own archive. There also exists a culture that people only supply information if they have some (data in this case) RD data in return. A win / win situation.

13. Why do people do not deliver there geo-information to Geodesk?

Geodesk does not advertise very actively. They do not approach people. Never an Email or something. Probably this has something to do with the interests. Geodesk is focused on the commercial market.
Also the bureaucracy of Geodesk is annoying. Usually you have to fill in quit some papers before they receive a dataset. If you go directly to the producer you do not have this problem and you save time, although it is illegal.

14. Do you think the mentality of the RS group must change?

No, it has nothing to do with the mentality of the RS group. I think time is a more important issue. The time for filling in metadata components must not be to long. Probably more than 10 metadata components are to much. An idea could be the automatically processed metadata via Erdas Imagine.

15. Do you think that the dataflow must be a closed chain? (collected / produce RS data→ use RS data→ storage RS data?

It would be nice. Especially at the moment, every individual RS participant of the RS group could store his RS data on a server.

16. Do you think this is feasible?

By big projects that are commercial is it already been realized (Geodesk). Probably for research objectives this is also possible. Depending on different factors like, the time for filling in metadata. The policy of the government should have been this way, but it is not so in practice.

17. Who should maintain the RS collection?

Geodesk.

18. Did you never have a discussion with Geodesk for the management of the RS collection?

Yes indeed, we had a small discussion about it. This was in the tendency towards: 'we have to do something' the response was 'OK do something'.

19. Who should maintain the web-application?

The CGI is prejudiced with the possibilities to store there own data. Other departments do not have those facilities. Sir A. Bergsma is responsible for the maintenance of these facilities, but every chair has his own contact person who manages the web-applications.

20. What should be done with the RS images with a badly filled in metadata or fully missing metadata standard?

Implement a sort of quality flag. Something like: watch out missing metadata! The potential user of such an image can determine for himself of this image is good enough to use. Plausibly is that the potential user is a RS expert.

Throwing away data must be avoided, because sometimes the RS is in spite of missing metadata still usable. For a classification purposes a image does not need a atmospheric correction for example.
At the moment essential metadata components are not filled in, it becomes a difficult story.
A big clean up is a hard methodology. It is better to mention on the web-application that this particular image is available on CD-ROM, with a reference to the manager of the box.

21. Do you think it is handy to realize a flow diagram to determine the relevancy (either it would be stored in the web-application database) of a dataset?

A flow diagram is handy.

22. A flow diagram is a structured methodology, that can be used by everybody with a small knowledge of RS images. Maybe you can via flow diagram place the work to determine the relevancy on the desk of a student or something. That would be a cost saving decision, or not?

Yes, sounds nice.

23. Should you use the ISO standard 19115?

When it is possible, sure. But the standard must meet the demands of the CGI.

Interview: Henk kramer
Function: Remote sensing and GIS specialist
Organisation: Alterra
Date: 17-09-2004

1. In your reply Email you wrote that you have maintained a archive for satellite images. Is this the same RS collection that is standing on the closet of Sir. H. Barholomeus?

No, this archive is possessed by Alterra, not Wageningen University.

2. Who manages this satellite collection?

Geodesk

3. Can you tell me who is the contact person for this collection?

Annet willemen.

4. Has Geodesk an management system for the maintenance of the collection?

She uses a excel sheet.

5. Which metadata is used to organize those images?

This depends a little on the sensor, but the metadata is more or less the same.

6. Which metadata components are used?

Filename, date, track (global location), frame, land, CD nr., Description.

7. What do you think of the quality of the metadata?

The metadata is for our usage sufficient. If you look from a theoretical point of view it is unsatisfactory.

8. Is all the data stored that is acquired by RS specialist on Alterra side?

No and yes. The original data is stored and named on the excel list by Geodesk. The products are not stored a central place but on a local computer / project backup. The processes how to create a product is stored. The reason for not storing products on a central place is because the interests field is very small.

9. There are no exceptions made in the storing policy with regard to products?

Well there are exceptions, like products for commercial purposes, like the European Land use map.

10. Do you think that there is RS data that wanders through Alterra?

Yes, certainly. This is mainly RS data that could only be used in one project, because of the copyright.

11. Why do people do not hand in RS data towards Geodesk?

People have there own channels. Often copyrights do not allowed the usage for other projects.

12. I can conclude that the dataflow within Alterra is not a closed chain?

Yes

13. Do you think this has to change?

It could be better, but I do not think that you can oblige people to hand over there RS data with corresponding metadata. This is probably hard to realize in practice.

14. How is the RS data collected by Alterra?

RS users / producers order there own RS data for a specific project.

15. Is it not better to order via a central point? Maybe you can get RS data cheaper.

For an inventory of the RS dataflow it is better to order via a central point. You do not get RS images cheaper if you order more in one time, because Alterra does not order big amounts of RS images.

16. What do you think of the feasibility of this (thesis) research?

It is interesting. The application is feasible, but to keep it up to date is questionable.
It could be quit handy for student purposes. I also want to no who is paying for the web-application and the maintenance. If that is arranged, than it could be an success.

17. Do you think that the RS images could bring up some money?

No, I don't think so. I did not determined a big demand for the RS images during the years, but maybe this could change at the moment a web-based application is made. An other disadvantage is the copyright policy. Therefore you are not allowed to use or -from an economical point of view- sell the RS images.

18. What should you do with RS data that has a incomplete metadata description?

I would not throw it away, but keep it stored on CD-ROM. I also should not include the incomplete metadata in the web-application. You can make a link which can provide an Email address to the manager of the RS collection. You never know where a RS image could be useful for.

19. Are there distinctions made in the metadata description with regard to the different RS data levels (one image, serie images, etc)?

Yes, because you do not fill in 10 times the same sensor, acquisition date, etc. if it is one aerial photography series made in one flight by an airplane.

Appendix III (1 of 5)

Evaluation RS-portals

Appendix C includes:

A: Matrix RS-portal results
B: Method;
C: Accessibility RS-portals;
D: Search possibilities;
E: Metadata;
F: Support;
G: Technical aspects;
H: The perfect catalogue.

B Accessibility RS-portals

The presence of many portals proves that the technical establishment of a RS catalogue is attainable. Nevertheless, to make a portal easy accessible I noticed that there is more than only a technical aspect.
The language used to build-up interfaces determines the accessibility of a RS-portal. According to the criteria list twenty six RS-portals provide information in English. Only one RS portal offers the users to choose between the English or French language (SIRUIS portal).
Focusing on the language used to provide the website-buttons with a name, the same language relation (26 English, 1 Multilanguage) is present. Also the indicator 'metadata language English', shows that the usage of the English language is dominant.

In addition, Uniform Resource Locators (URL's) contributes towards the accessibility of RS-portals. For example a URL like, www.landsat.org is easy to memorize and clear. The URL represents a domain of an organization and the website provides information about Landsat. According to indicator 'clear URL', seven evaluated RS-portals do not have a clear URL.
Some strange findings about URL's of evaluated portals came to the light. The CARTERRA catalogue is accessible via two different URL's. A valid explanation is hard to provide. Two URL's can contribute to a better accessibility of the catalogue, but it is also confusing.
Another strange finding focuses on two RS-portals, both named GLOVIS. Although the catalogue name is identical, the content of the catalogue differs as well as the two URL's.

The awareness of a RS-portal's existence influence the accessibility heavily. Links, provided on other (related) websites stimulate the accessibility of a RS-portal. These links, better referred as web-references, act as web advertisement and form a useful tool to increase the awareness of a RS-portal.
The criteria list underpins that many RS-portals use web references (indicator 'related links / additional sites'). Via a popularity check (http://www.linkpopularity.com) information is gained, about the accessibility of the evaluated RS portals via web-references. The top three is composed out of the total linkages provided by the search engines Altavista, Google and Hotbot and looks like this:

1. Terraserver-USA (114945)
2. Terraserver (33252)
3. Orbimage (4057)

A RS-portal situated in the top three does not signify that the portal automatically becomes the best RS catalogue evaluated. The popularity check more depends on the quantity of particular RS data providers (monopoly position), marketing strategy, etc.
The URL heavily influences the popularity. The URL of the MODIS LBGI homepage (http://landqa2.nascom.nasa.gov) provides zero Altavista web-references. While the MODIS LBGI catalogue openings site URL (http://landqa2.nascom.nasa.gov/cgi-bin/browse/browse.cgi) supplies fifteen Altavista web-references. For each RS catalogue the openings page is used to determine the popularity.

Some RS-portals are merely a small segment of e.g.;;an organizations website. Due to the huge presentation of information on the first interface (homepage) an entry of the RS catalogue was sometimes hard to find (e.g.;; Euromap portal). Browsing intensively through such a website led towards the openings page of the RS catalogue. It can be stated that a stand-alone website -which is not part of another website- stimulates the data retrieval process by saving time. Most of the evaluated websites are stand-alone portals.

C Metadata

The indicator 'description metadata' shows that only three RS catalogues supply specific information about the content of the database.
This is remarkable, because metadata about the quantity of datasets (full or empty?) or spatial extent is vital information e.g.;; to determine the usability of the RS-portal.
Sometimes metadata about the content of the database is provided in the background. This information is not included in the indicator 'description metadata', because the information given is not detailed enough. For example, in the background is mentioned that the catalogue contains Landsat data of the whole world. Search results in the database show that there are whole countries were no Landsat data is available.

In the RS data retrieval process metadata provides the information to determine the fitness for use of a certain image. Noticeable is that provided metadata of the evaluated catalogues differs greatly in its appearance. No structured line is visible concerning vital metadata items. Probably this is caused due to the variety of evaluated RS catalogue disciplines. However, this result verifies that international, acknowledged RS data standards did not have a big impact on RS-portals yet.

The openings webpage of the portal provides often the first vital information about the usability. A clear vision and objective (added with spatial extend) of the portal save lots of time in search for a particular image. A clear vision and objective is provided by 81% of the evaluated portals. In addition, many RS-portals provide quantities of metadata without using a standard. Metadata about the e.g.;; production, process levels and sensors are placed on an arbitrary places in the website. This kind of metadata presentation is only provided by product portals or portals that provide RS data of a limited quantity of sensors.
Acknowledged RS metadata standards did not have a big impact on RS-portals yet. Each portal provides a different composition of metadata elements to describe a dataset. Even metadata elements that cover the same domain appear in a variety of formats. Some metadata elements covering the domain 'spatial extend' with corresponding RS-portals are provided in the underlying table.

Table Comparison of metadata definitions

ARSMIS	Earth Explorer	EOSC	Euroimage
Geographic location	NW corner NE corner SW corner SE corner	Path Row	Upper left Upper right Lower right Lower left

D Search possibilities
The RS-portal evaluation list shows that a variety of search functions is used. On the evaluation list, twelve search possibilities are enumerated. The most popular search possibility is based on platform information. Many RS-portals provide only data of one platform, which is a valid enlightenment for the most popular search possibility. If RS-portals provide data of several platforms, often choosing a platform is the first step that must be made. Subsequently an interface pops up with a search strategy developed for this particular platform, which differs from the other platform interface (e.g.;; http://www.eurimage.com/).
Search on acquiring date and search on area share the second place in popular search possibilities.
Sometimes non-included, alternative search possibilities occurred. Alternative search possibilities are only used for highly specialized RS disciplines and did not occur frequently. Therefore, no further attention towards these alternative search possibilities is required.

E Support
Half of the evaluated RS-portals show that the indicator 'how to do catalogue' is present. The indicator 'helpdesk contact' displays almost the same numbers. Remarkable is the appearance that often both indicators are present or absent in a RS-portal. Apparently, the constructers / stakeholders of evaluated RS-portals determined that if the help-aspect forms a crucial element in the RS-portal, both indicators should be included.
The indicator 'Contact web-master / system administrator' is popular in the contrary of the indicator 'Get in contact producer Image'. The web-master is the central manager as well as oracle. Providing Email addresses of producers of RS-images on a RS-portal is not popular, because the producers could form individual oracles. This is not advantageous for the RS data management.

F Technical aspects

The technical aspects of a RS-portal are incidental provided via the RS-portal itself. By establishing contact with the RS-portal providers using Email is tried to make an overview of frequently used software / hardware. The response was low, resulting in a lack of information to create a transparent overview. Out of the scarce responded Email the following information could be extracted:

→ RS-portals are constructed using a mix of software programs;
→ Several Emails mentioned that their RS-portal was custom made by a specialized companies.

G The most suitable RS catalogue

After evaluating twenty seven RS-portals concerning a variety of disciplines, the vision of a suitalbe RS catalogue comes slowly to the light. Focusing on a multi-discipline RS-portal, my opinion regarding a suitable catalogue is described in this paragraph.
The suitalbe RS catalogue must act as a useful tool to provide the users -within a small amount of time and minimum efforts- the RS data needed, whereby the possibility of determining the fitness for use is essential. The interfaces of the catalogue must be transparent and in a chronological order to stimulate the user friendliness of the application.
The openings interface (homepage) must assign information about the background of the RS catalogue. The background information is supposed to supply information about the objective of the catalogue, the founder of the catalogue and information about the RS data included.
Subsequently, detailed information about the spatial extent of the RS data included must be visible in a blink of an eye. Depending on the amount of RS data sources a good solution for displaying this information has to be found. The EOSC-portal forms a good example concerning the presentation of spatial extent information.
The background information and spatial extent determine the usability of the RS-portal. Presume the portal is usable, the user can continue with his RS data retrieval process by querying the database.
The search strategy heavily depends on the content of the database and the expertise of the user. Therefore a detailed description of the search-interfaces is impossible to provide. I only can provide information about a pleasant search-interface strategy, composed out of the information gained during the evaluation of the RS-portals.
Searching a database by selecting an Area of Interest (AOI) on a map is very pleasant, because marking an AOI via a request box is to execute. Especially, when the user already knows that there is RS data available, thanks to the spatial extend information in the beginning of the catalogue. The results of the query -based on the AOI- must be listed, whereupon the list can be browsed. In case the results list is very long, there must be an opportunity to refine the query with e.g.;;the acquisition date.
Each RS image in the RS catalogue should be provided with a fully filled in international standard to approach international demands concerning RS metadata. To prevent the user for a metadata overflow per RS image, it could be a good idea to first provide a metadata interface with some core metadata. Followed by, a possibility to look at the fully filled in metadata standard.
The presence of viewing and download services are also important, because I immediately want to look and if useful, download the RS image. If problems occur e.g.;; during the download process, an Email of a helpdesk must be available to solve the problem.
Assumption able is that in the beginning of the RS catalogue a research concludes that the RS catalogue is not useful for his purposes. Providing linkages to other RS catalogues could be helpful.
In addition, the presence of an export button for RS-images to a web mapping site would be nice. The web mapping site should make it possible to make overlays with different kind of Geo-information (aerial photographs, topographical data, etc).