HYRESSA

FP6 - Research Infrastructures - Accompanying Measure
Instrument: SSA

HYperspectral REmote Sensing in Europe – specific Support Actions

AM5 REPORT

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AM title:	SWOT and User Needs workshop			
AM leader:	**DLR**			
Status (F: Final, D: Draft, RD: Revised Draft):			F	
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Dissemination level (PU=public, RE=restricted, CO=confidential)				PU

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1. Introduction

1.1 Aim of the workshop

In order to meet the objectives of HYRESSA as described in the project proposal (HYRESSA, 2004), a SWOT and User Needs workshop (AM5) was organized. The aim of the workshop is the exploration of the Strength-Weakness-Opportunity-Threats (SWOT) and the user needs of hyperspectral remote sensing in Europe regarding

- operational services
- data quality
- accuracy aspects

of hyperspectral images now and in the future.

The results of the workshop will be used for the development of a technical questionnaire on user needs (QUN). Together with the results of the QUN (AM6) and the results of an exploratory workshop (AM7) the results of the workshop will provide a base for reviewing and refining existing protocols in compliance with standards (AM8), for the future collaboration plan (AM9) and for future proposals to build a user-driven Research Infrastructure of hyperspectral remote sensing facilities in Europe.

1.2 Outline of the report

In this report the results of the SWOT and User Needs workshop are presented. The following chapter will explain the methods used during the workshop. The results of the SWOT analysis are presented in chapter 3. The fourth chapter gives a summary and conclusion of the workshop.

2. Methods

2.1 SWOT analysis

SWOT analysis is a strategic planning tool which is used to evaluate the Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T) involved in a project. A SWOT analysis helps organizations to evaluate the external factors and internal situation facing a project. Strengths and weaknesses are internal aspects. This means that they are aspects of the project itself and can be influenced within the project. Opportunities and threats are external aspects. These are aspects of the environment influencing the project. These aspects cannot be changed, but can be anticipated on (Steiniger, 2003). The concept of internal and external aspects of SWOTs is presented in figure 1.

	Helpful to achieving the objective	Harmful to achieving the objective
Internal (attributes of the organization)	Strengths	Weaknesses
External (attributes of the environment)	Opportunities	Threats

Figure 1: SWOT concept (source: wikipedia.org/wiki/SWOT_analysis)

Before the SWOT analysis can be carried out, a project objective needs to be defined. The main objective (or top rank objective) of HYRESSA is to exploit the full potential of hyperspectral remote sensing in Europe. Answers to the question how to reach this objective are defined as lower rank objectives. In figure 2 this is schematically presented.

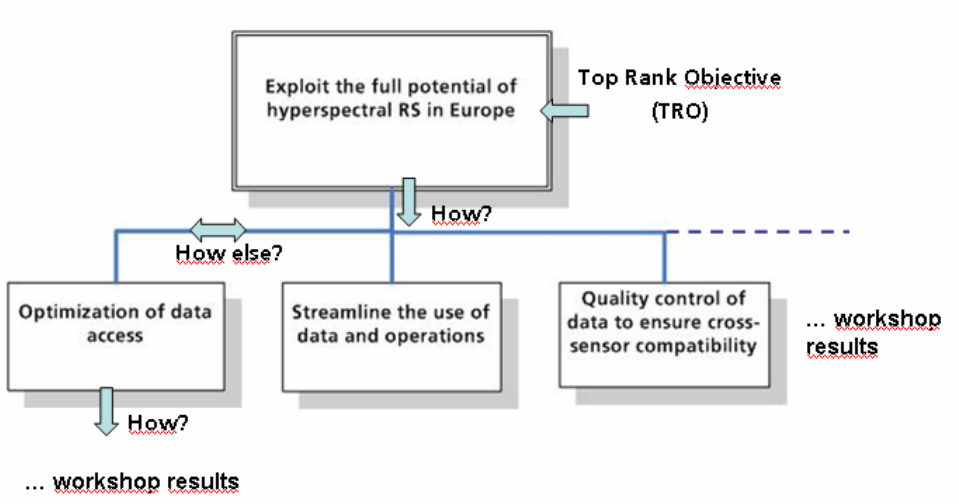

Figure 2: Top rank and some lower rank objectives of HYRESSA

From any rank, the objective in a lower rank should answer to the question "How?", and the objective in a higher rank to the question "Why?". The only exception is the top rank objective, where no "Why?" question can be posed. The discussions during the workshop will lead to further lower rank objectives (second rank, third rank, etc.).

The strengths, weaknesses, opportunities and threats of hyperspectral remote sensing are discussed in small splinter groups (<10 participants). More on the discussions can be found in section 2.2.3.

2.2 Workshop

The workshop was held on the 5th and 6th of July 2006 at DLR in Oberpfaffenhofen, Germany. The complete program can be found in Appendix I. In the following sections it is explained which participants have been invited, which topics have been addressed and how the discussions were organised.

2.2.1 Participants

Invitations to the workshop were sent to the identified experts of the hyperspectral remote sensing community with users and providers of hyperspectral remote sensing data from all over Europe. The selection was based on the database provided by AM4 of HYRESSA.

In total 30 participants were attending the workshop with 20 HYRESSA members. One third of the participants is a provider of hyperspectral data, two third are considered as users. The participants came from 15 different countries across Europe from universities, research institutes and commercial companies. The participants list can be found in Appendix II.

2.2.2 Topics

To make the discussions more focused and clear, four important aspects of hyperspectral remote sensing were defined prior to the workshop:

- Management of hyperspectral campaigns
- Hyperspectral sensors (calibration, operation, maintenance, etc.)
- Data processing
- Application of hyperspectral data.

On each of these four topics a discussion round in four splinter groups was held, as explained in the following paragraph. Each discussion topic was introduced with a short presentation held by an appointed HYRESSA member (expert on the corresponding topic). In addition to these presentations, also presentations on commercial hyperspectral services and future developments were given at the end of the workshop. All presentations can be found at the HYRESSA website www.hyressa.net/workshops.htm.

2.2.3 Discussions

During the workshop the SWOT analysis was carried out in discussions in small splinter groups. The discussions were initiated by a short presentation of about 15 minutes, introducing the topic and indicating some points of discussion. After this introduction the participants were divided into 4 groups to discuss the respective topic in splinter meetings for 45 minutes. Each group was supported by a facilitator. As facilitator four experts from the working field of hyperspectral remote sensing were selected: Prof. Klaus Itten (Remote Sensing Laboratories, University of Zurich), Prof. Michael Schaepman (Wageningen University), Prof. Paolo Gamba (University of Pavia) and Dr. Timothy Malthus (University of Edinburgh).
The role of the facilitator is the following:

- To stimulate the discussion
- To redirect the discussion if it gets stuck (endless discussion on methods or same topic)
- To summarise what is said if necessary
- To make sure that points are clear (specifying vague or broad terms)
- To make sure that all topics are addressed by giving suggestions or asking questions
- To make sure that all ideas and opinions are addressed by encouraging quiet participants and where necessary temper too enthusiastic ones
- Appoint a person who will take the minutes (secretary)

The secretary was charged with the task of making notes. The points were noted on a flip chart. In Appendix III pictures of the splinter group discussions are presented.

After discussion of the splinter groups, a concluding plenary session of 30 minutes was held. Here one of the four splinter groups presented their results. After this presentation the other groups had the possibility to add lacking points. All results of the discussion groups were collected to summarise them. Appendix IV contains the collection of SWOTs of all splinter groups divided into the four topics.

2.3 Weighting of SWOTs

After the workshop, the results were collected and ordered (Appendix IV). The Excel sheets with the strengths, weaknesses, opportunities and threats were sent to each workshop participant with the request to give a weighting for every SWOT. After receiving the weighted SWOTs the results were averaged and ranked according to their respective averaged weights. The aim of this weighting is to gain insight in which SWOTs are the most important. The weighting scale is from 1 (least important) to 10 (most important). The same weighting scale will be used for the questionnaire on user needs (QUN).

3. Results

In this chapter the three most important SWOTs of each topic will be presented as the main results of the discussions. The importance is based on the ranking (see 2.3). The complete list of SWOTs can be found in Appendix IV. The terms used in the SWOT analysis are defined in Appendix V (Glossary).

3.1 Management of hyperspectral campaigns

As first topic for discussion management of hyperspectral campaigns has been addressed. A brief introduction presented by DLR as a long-time data provider explained the main tasks of campaign management:

- Logistics of instrumentation (sensor and aircraft)
- Customer consulting
- Flight planning
- Scheduling of campaigns
- Coordination of campaign crew
- Cost estimation

The most important SWOTs of management of hyperspectral campaigns as a result of the first discussion are listed below.

Strengths	Weaknesses
1. Increased availability of airborne and ground instruments. 2. Increasing effectiveness and efficiency. 3. More than 10 years of data provision in Europe.	1. High costs for aircraft and mobilization in a scientific environment. 2. Restricted windows of opportunities for campaigns. 3. No operational hyperspectral satellites available.
Opportunities	**Threats**
1. Increase the education and training of end users and potential users. 2. Open up to semi-commercial (administration) end-users. 3. Manage the (end-) user's expectations.	1. Financers are not convinced (restricted future funding). 2. There is a lack of education. 3. Lack of transfer of knowledge

Table 1: SWOTs concerning the topic management of hyperspectral campaigns

Airborne hyperspectral remote sensing has been performed in Europe for more than 10 years already. Therefore, European providers have a lot of experience with campaign management. The most discussed point was the high cost for aircraft and mobilization. Scientific users can only afford campaigns, if they have third-party funding. This funding can only be assured, if financers are convinced of the technology. To achieve this, education and training has to be increased. Also the restrictions due to weather and aircraft and/or sensor availability are a big limitation when it comes to campaign planning. There is a demand for an overview of available instrumentation and planned campaigns in Europe (e.g. by creating a European hyperspectral remote sensing portal).

3.2 Hyperspectral sensors

A review of hyperspectral sensors with their calibration, validation and maintenance has been given in the introduction presentation for the second discussion topic by RSL. The calibration methodology has been explained on the basis of the future European hyperspectral sensor APEX.

The most important SWOTs of hyperspectral sensors as a result of the second discussion are listed below.

Strengths	Weaknesses
1. IS is developing from experimental to operational services. 2. Increased understanding of physical measurement. 3. There actually are calibrated and maintained sensors.	1. Sensor stability, repeatability and reproducibility is difficult. 2. Quality assurance often lacking. 3. Calibration information is lacking.
Opportunities	**Threats**
1. Define standards on traceability, calibration, terminology. 2. Provide documentation of calibration and maintenance data. 3. Define minimum calibration standards	1. Decision makers don't understand the importance of calibration and validation. 2. Lack of agreed standards. 3. Calibration costs higher than data acquisition costs.

Table 2: SWOTs concerning the topic hyperspectral sensors

Again, the long-time experience in hyperspectral remote sensing in Europe lead to the strengths of sensor maintenance and calibration. Following challenges were discussed as weaknesses, opportunities and threats:

- *meeting the accuracy requirements of the user community*
- *standard methodologies for calibration and validation*
- *check of sensor stability and quality*

When it comes to sensor calibration, the need for standards and quality assurance is highly demanded. Since there are quite a few hyperspectral sensors in use, inter calibration processes would help to show the quality difference between the sensors. All workshop participants emphasize on the importance of good quality of sensor calibration.

3.3 Data processing

INTA as a data provider with a lot of experience in data processing was introducing the third topic of hyperspectral remote sensing. Usual data processing tasks at provider side are:

- Radiometric calibration
- Geometric correction
- Atmospheric correction
- Evaluating product accuracy (quality control)

The most important SWOTs of data processing as a result of the third discussion are listed below.

Strengths	Weaknesses
1. Tools for geometric and atmospheric correction exist. 2. Detailed understanding of involved factors exists. 3. Geometric and atmospheric corrections combined.	1. No real capability to define the accuracy right now. 2. Validation processes are missing. 3. Lack of (agreed) standards.
Opportunities	**Threats**
1. Develop algorithms for thermal sensors. 2. Define standardized products which include data analysis. 3. Describe standards for data format, metadata description.	1. Hard to understand contribution of noise to the analysis. 2. Lack of precise DEM's. 3. Processing too slow for commercial oriented customers.

Table 3: SWOTs concerning the topic data processing

The discussion was again focusing on the lack of standards. It is hard to compare data, if there are no agreed standards which can be used for data processing. The generic tools for data processing are all accepted by the hyperspectral remote sensing community. Further developments can be including BRDF (Bidirectional Reflectance Distribution Function) effects and the thermal region of sensors. Analogue to the need to cluster the information about available sensors, spectral libraries should be centralized to provide a basis for data processing.

3.4 Application of hyperspectral remote sensing

The application of hyperspectral remote sensing was the last topic for discussion. The introduction to the topic was split into two application areas: Bio-science and geo-science. As a specialist for bio-science WU was giving the introduction to the first part. GFZ has a lot of expertise in using remote sensing data for geological applications, and therefore did the introduction to the geo-science part.

Bio-science applications

Bio-science applications originating from imaging spectrometer data products are in most cases indirectly derived and require the use of 'models' (e.g. radiances – PRI – LUE – DVM – Biodiversity). Directly derived bio-science applications from imaging spectrometer data are sparse (e.g. LUCC) or often site specific. Examples of bio-science products are:

- Biodiversity
- Ecosystem, habitat, species distribution
- Crop growth and yield estimation
- Plant stress (nitrogen, water)
- Fire (health, water stress, fuel type, activation energy)

Geo-science applications

The main application fields are:

- General geologic mapping (lithological/mineralogical – structural)
- Exploration geology (alteration mapping)
- Waste / abandoned mines
- Geohazards (sudden events – long term processes)

For geo-science applications the SWIR range (2.2 µm atm. window) has the highest importance. With hyperspectral remote sensing direct identification of minerals is possible.

The most important SWOTs of application of hyperspectral remote sensing as a result of the fourth discussion are listed below.

Strengths	Weaknesses
1. Some features can only be derived from hyperspectral data. 2. Spectral information can be used for almost everything. 3. IS is (semi-) operational for geo-applications.	1. Little understanding of the added value of IS data by potential users. 2. Knowledge is scattered. 3. Data is not efficiently used.
Opportunities	**Threats**
1. Perform temporal data takes. 2. Exploit full spectral coverage in a greater extent. 3. Intensify interdisciplinary collaboration	1. People are reluctant to switch from multi- to hyperspectral data. 2. Applied science is preferred, but basic science is needed first.

Table 4: SWOTs concerning the topic application of hyperspectral remote sensing

With the information gathered by hyperspectral remote sensing, a lot of application fields can be served. The main problem of the low use of hyperspectral remote sensing in comparison to multispectral remote sensing is the little understanding of the added value by potential users Again, education and training would help to overcome this problem. Especially the spectral understanding and the rather complicated models need to be clarified to potential users. The opportunity to intensify interdisciplinary collaboration can solve the weakness of scattered knowledge.

4. Summary

In general, the SWOT analysis has proven to be a good tool to clarify the user needs for hyperspectral remote sensing. The division into four topics made it a lot easier to name the specific SWOTs. Even though the workshop participants where discussing in four different splinter groups, a generally good consistency of the results could be identified. Within the discussion rounds, people sometimes found it difficult to categorise (strength, weakness, opportunity or threat?). The fact that in some cases weaknesses can also be formulated as opportunities was helping to decrease the number of collected SWOTs.

As conclusion of the four discussion rounds the main user needs could be extracted:

- standardisations especially for data processing and calibration
- more transparency on calibration processes, incl. quality measures
- European platform for hyperspectral remote sensing (e.g. sensor pool, combined research areas, information about campaigns, data pool, spectral libraries, ...)
- education and training in all kind of fields of hyperspectral remote sensing
- strengthen awareness of the additional value of hyperspectral remote sensing (to make funding easier)
- operational hyperspectral satellite system
- collaboration of SW developers to generate general tools for extracting information from hyperspectral data

References

- HYRESSA, 2004, Project proposal
- Steiniger, H, 2003, Die SWOT analyse, edditrex coop. (http://www.edditrex.de/scripts/consulting/swot_analyse.pdf#search=%22henny%20steiniger%20swot%20analyse%22 , 8/17/2006)

Website:

- http://en.wikipedia.org/wiki/SWOT_analysis (8/17/2006)

Appendix I – Workshop program

Wednesday July 5th

9.15 *Bus transfer Herrsching - DLR*

10:00 Welcome
– Andreas Müller (DLR)
10:15 Introduction HYRESSA
– Ils Reusen (VITO)
10:30 Introduction workshop objectives and program
– Stefanie Holzwarth (DLR)
11:00 Evaluation of user-orientated attractiveness of imaging spectroscopy
– Jens Nieke (RSL)

11:15 *coffee break*

11.30 Presentation 1: Management of hyperspectral campaigns
– Stefanie Holzwarth (DLR)
11:45 Discussion 1 (4 splinter groups): Management
12:45 Conclusion 1: group 1

13:15 *lunch break*

14:15 Presentation 2: Sensor (calibration, operation, maintenance, etc.)
– Jens Nieke (RSL)
14:30 Discussion 2 (4 splinter groups): Sensor
15:30 Conclusion 2: group 2

16:15 *Bus transfer DLR - Herrsching*

18:00 "Mühlfeldbräu" – brewery tour and dinner
21:00 Semi-final World Cup…

Thursday July 6th

9:00 *Bus transfer Herrsching - DLR*

9:30 Results of previous day and introduction to second day of workshop
9:45 Presentation 3: Data processing
– Eduardo de Miguel (INTA)
10:00 Discussion 3: Data processing

11:00 *coffee break*

11:15 Conclusion 3: group 3
11:45 Presentation 4: Application of hyperspectral data
Geo-science: Charly Kaufmann (GFZ)
Bio-science: Michael Schaepman (WU)
12:05 Discussion 4: Application
13:05 Conclusion 4: group 4

13:30 *lunch break*
14:30 *tour through calibration lab*

15:00 Presentation 5: Future developments
– Andreas Müller (DLR)
15:30 Presentation 6: Commercial hyperspectral services
– Eyal Ben Dor (Bar-Kal)
16:00 Summary
– Stefanie Holzwarth (DLR)
16:15 Closure
– Ils Reusen (VITO)

16:30 *Bus transfer DLR - Herrsching*

Appendix II – List of participants

name	organisation	country
Ivar Baarstad baarstad@neo.no	Norsk Elektro Optikk A/S	Norway
Martin Bachman martin.bachman@dlr.de	DLR	Germany
Eyal Ben-Dor bendor@post.tau.ac.il	Bar-Kal	Israel
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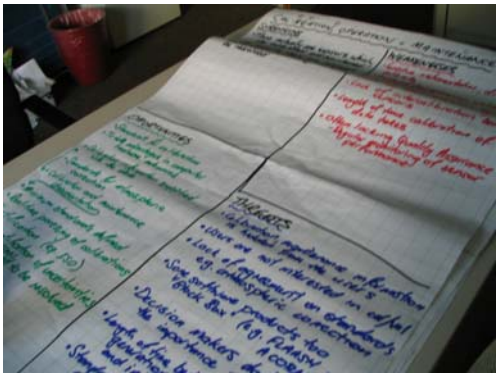
Birgit Suhr birgit.suhr@dlr.de	DLR	Germany
Harald van der Werff vdwerff@itc.nl	ITC	Netherlands
Lucia Yanez lucia.yanez@wur.nl	DLR/WU	Germany
Bogdan Zagajewski bogdan@uw.edu.pl	University of Warsaw	Poland

Appendix III – Pictures of splinter group discussions


a.


b.


c.

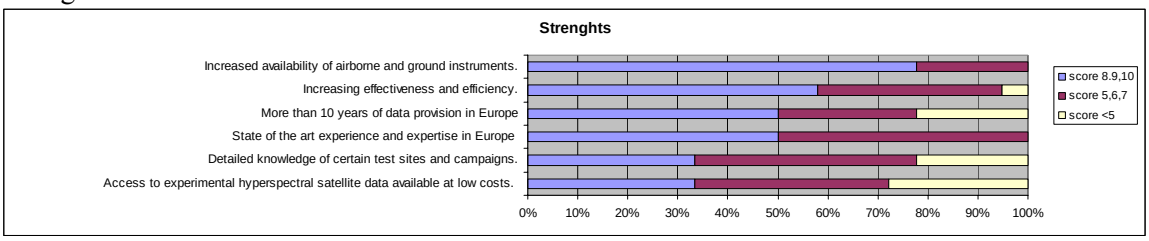

d.

a,b,c: discussion in splinter groups
d: result of splinter group discussion

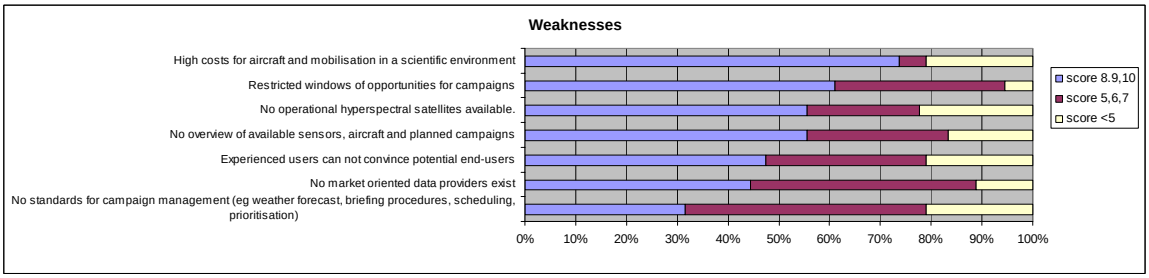
Appendix IV – SWOT Analysis

Management of hyperspectral campaigns

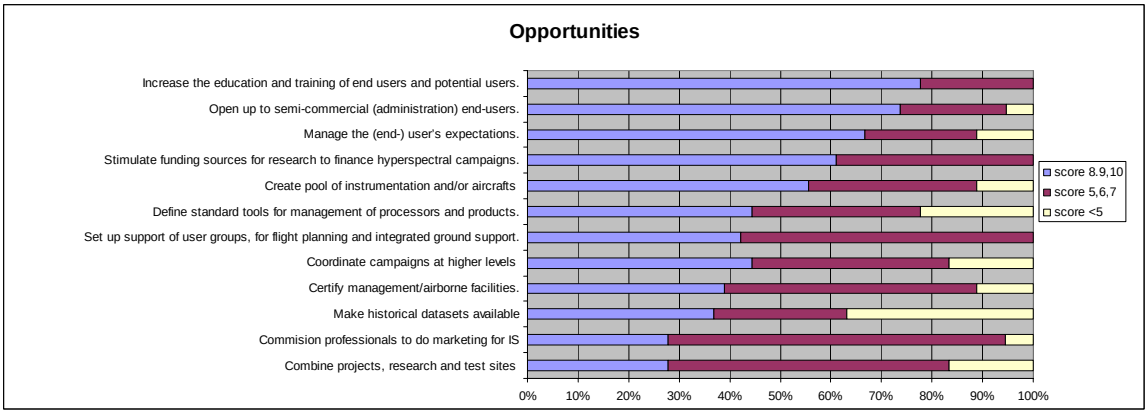
Strengths



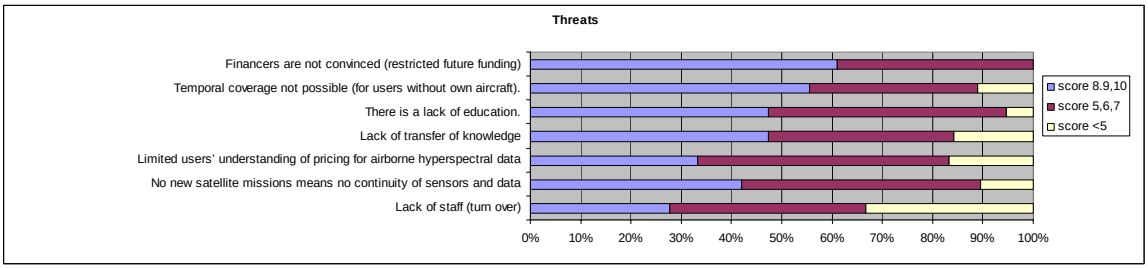
Weaknesses



Opportunities

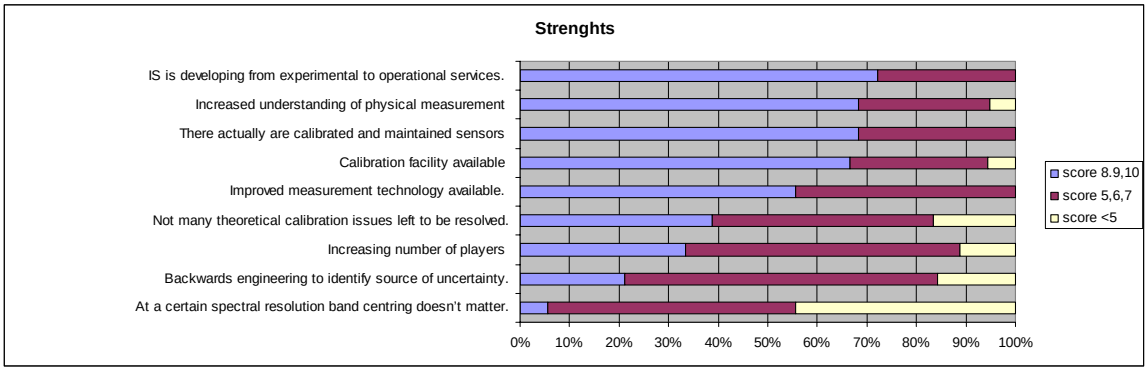


Threats

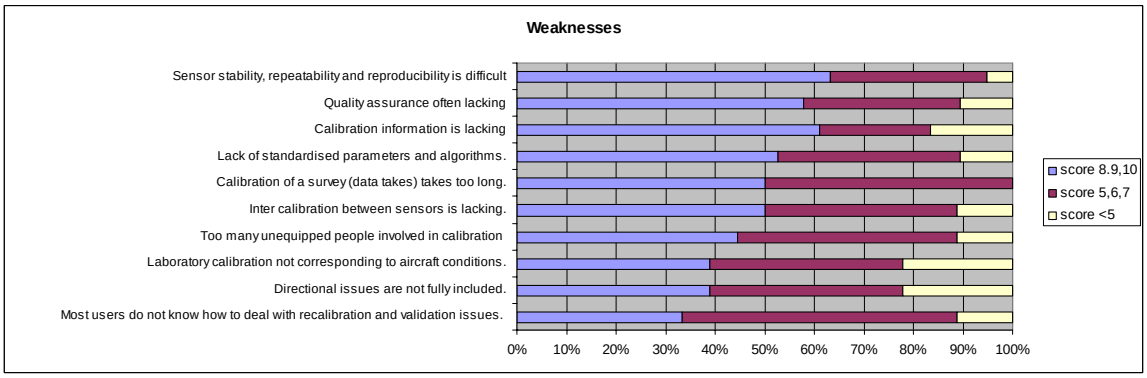


Hyperspectral sensors

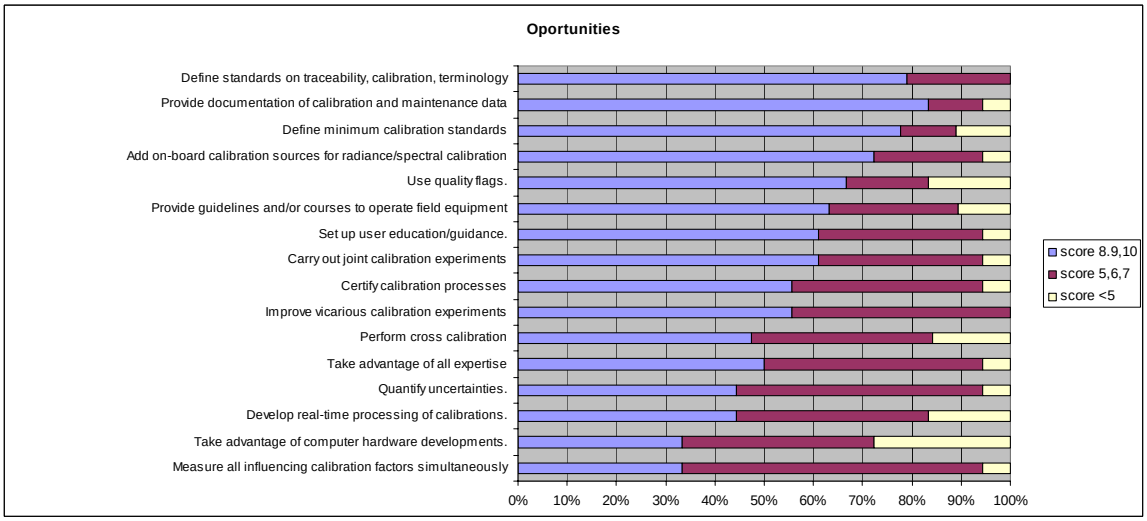
Strengths



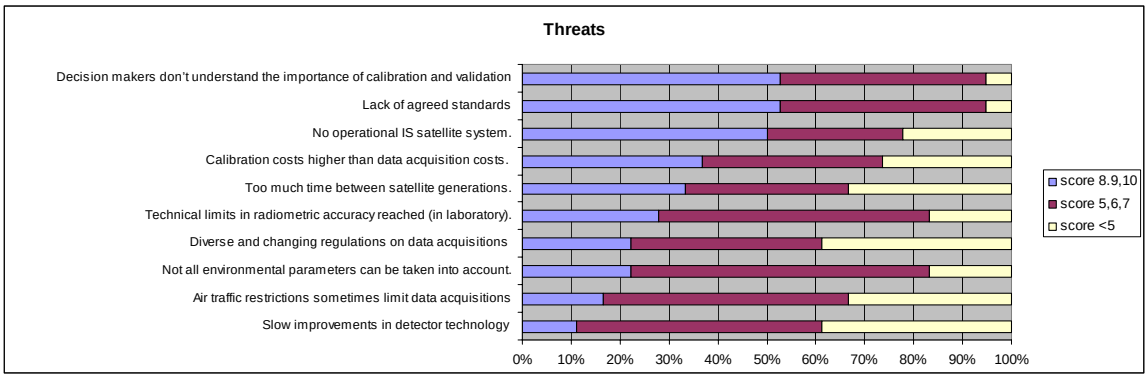
Weaknesses



Opportunities

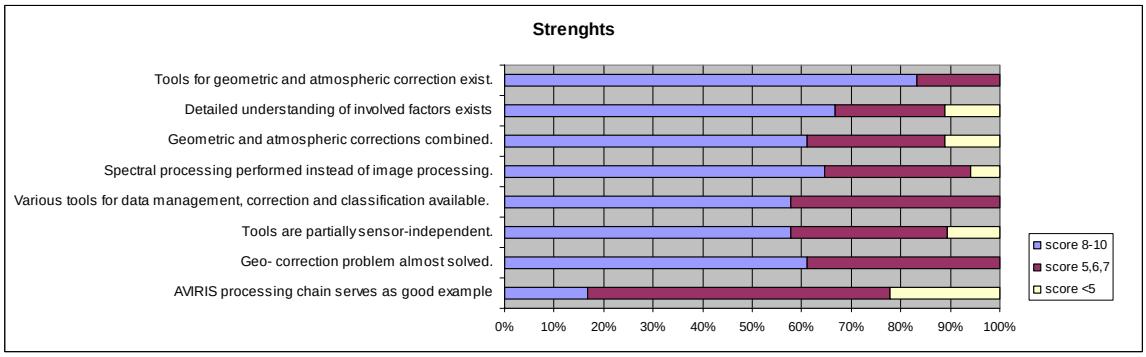


Threats

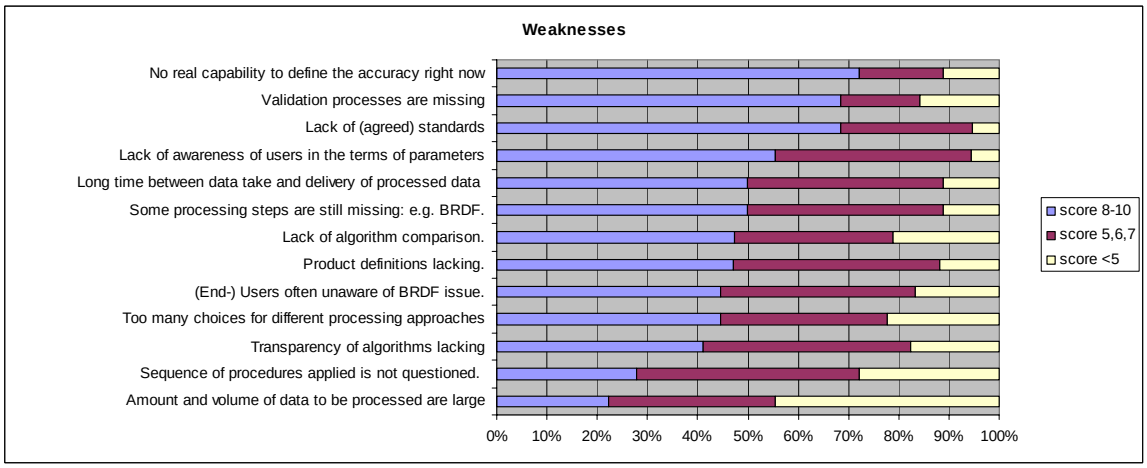


Data processing

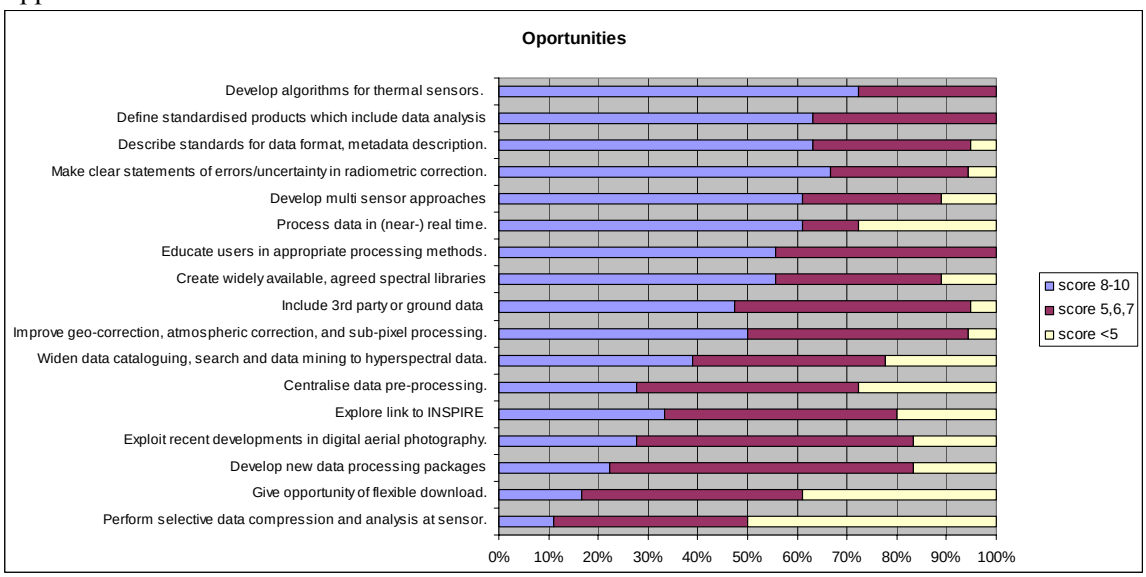
Strengths



Weaknesses



Opportunities



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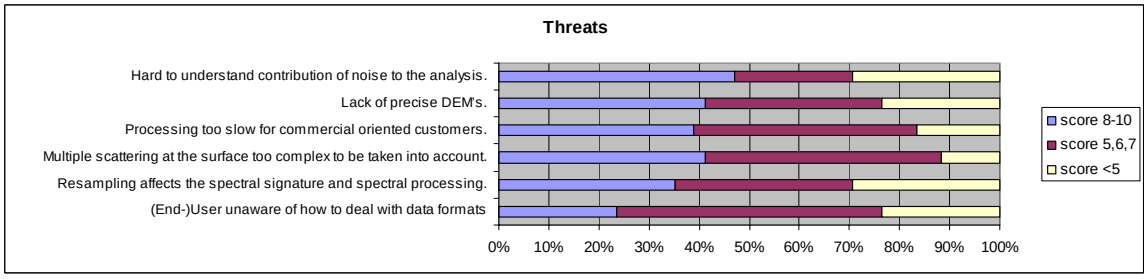
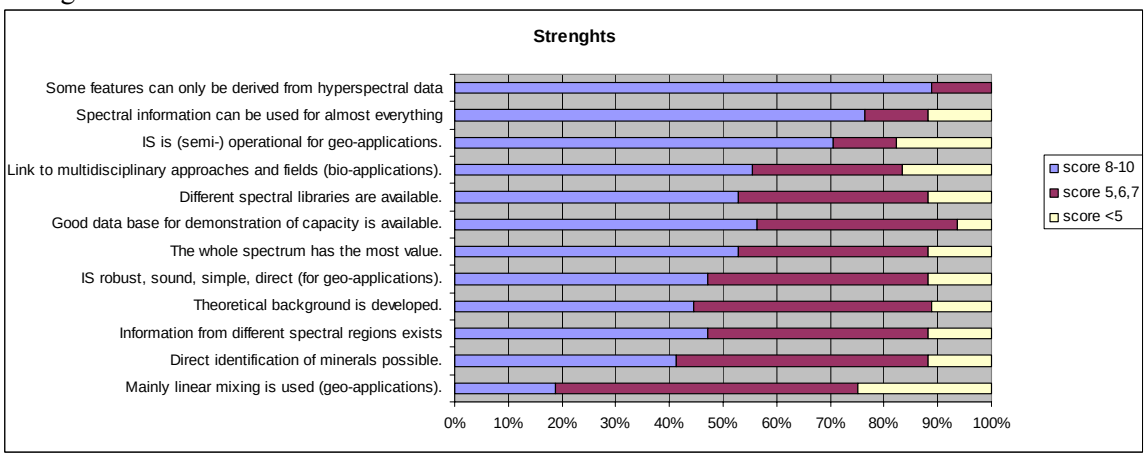
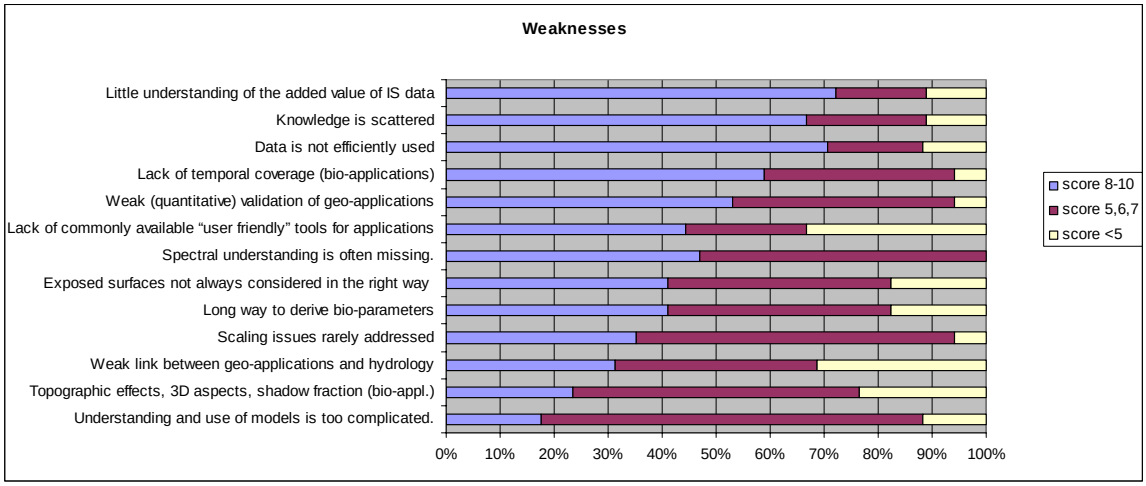


Application of hyperspectral remote sensing

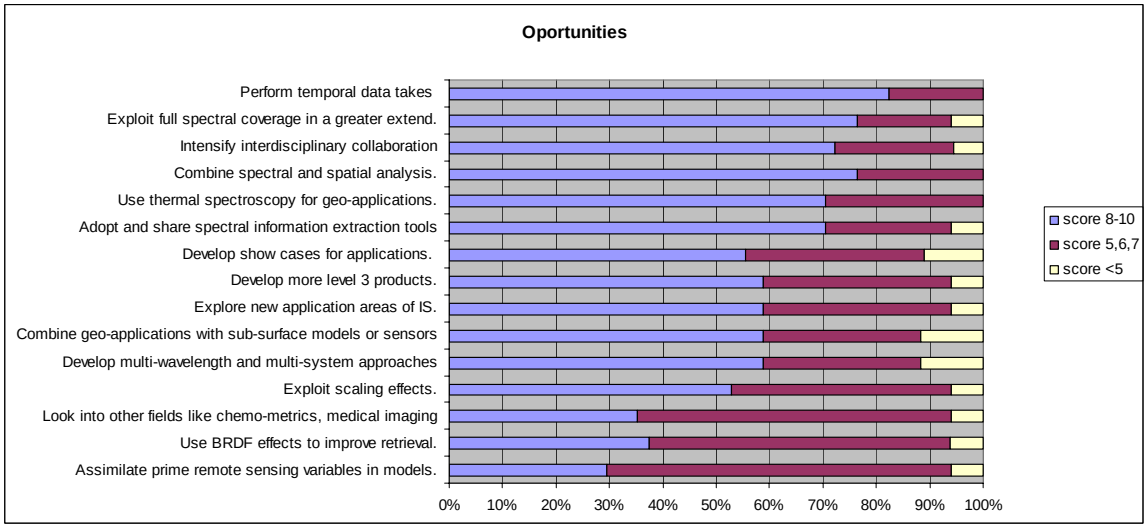
Strengths



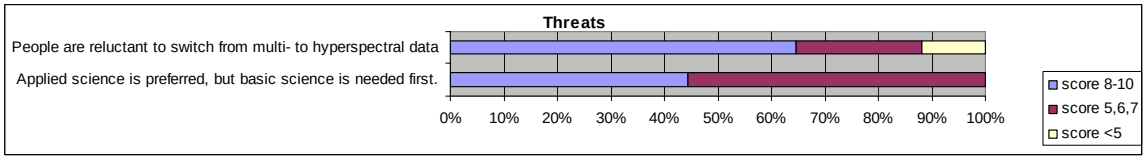
Weaknesses



Opportunities



Threats



Appendix V – Glossary

campaign	realization of several surveys within a given time period (e.g. HyEurope)
data processing	the radiometric, atmospheric and geometric correction of sensor data
data provider	any institution offering access to hyperspectral data required over area of interest determined by a user
end-user	anyone interpreting thematic information extracted from hyperspectral data
experienced	anyone in the above fields has more than 10 years of experience or holds a record of more than 10 projects in the respective field
experimental services	access to hyperspectral instruments and/or data for experimental purposes (e.g. Development of methods)
instrument operator	any institution offering access to hyperspectral instruments operated over area of interest determined by a user or a data provider
IS	Imaging Spectroscopy
operational services	access to hyperspectral instruments and/or data for operational purposes (e.g. Monitoring applications for governments)
product	thematic information extracted from hyperspectral data, ready to interpret (also called Level 3 product).
survey	data acquisition over area of interest determined by a user or a data provider
SW developer	anyone providing tools for extracting information from hyperspectral data or/and to alter data in order to facilitate thematic information extraction
temporal coverage	regular data acquisition during a longer period of time (e.g. A survey each year during 10 or more years)
user	anyone generating products (→ products)
value-adder	anyone altering data in order to facilitate thematic information extraction (e.g. calibration, geo-coding, atmospheric correction)