INNOVATION CLUSTER ACCELERATING REMOTE SENSING

D 1.1.4.

Midterm report on demand sectors

(agriculture, nature, water & infrastructure)

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"Developing a network of regulatory bodies, government, and RS sector associations regarding regulation and legislation"

ICAReS

Common challenges

Within the 2 Seas area the three major sectors (agriculture, nature and water) constantly face important challenges which require innovation to help tackle them. Greater use and development of remote sensing (RS) and data processing methods will help provide this innovation, and both will create and support new solutions to face these challenges. Moreover, it will greatly improve the efficiency of these sectors.

However, there are obstacles in the way when looking at remote sensing. For example, there is a lack of knowledge and awareness of the possibilities remote sensing can bring; there is a lack of suitable testing and demonstration locations for companies to further innovations; and the policy on legislation and the use of drones for remote sensing is unclear.

From this the following challenges need to be addressed: the aggregation of sector demands, communication with RS companies and knowledge institutions, creation and advertisement of sites for demonstrating new remote sensing applications, harmonisation of legislation and regulations and finally the formation of a durable cluster to work together on these issues.

Overall Objective

The overall object of the ICAReS project is:

To develop a cross-border innovation cluster and create the necessary conditions for innovation in the field of remote-sensing and advanced data-communication and -processing, based on the needs of the priority sectors: nature, agriculture and water & infrastructure.

A durable cluster will result in some key benefits. There will be cross-border collaboration within the sectors allowing the demands to be aggregated and jointly tackled. The

innovation of remote sensing products and services will accelerate. This will allow business operations to improve through the increased use of remote sensing. Finally, the cluster will bring clarification of different national legislations and a joint lobby for better regulations to create business opportunities.

Summary Work package 1

An important framework condition for innovation is the optimisation of the innovation chain of remote sensing. In work package 1 (WP1) the relevant stakeholders within the 2Seas area will be identified and contacted by the project partners. The stakeholders are considered to be

- personnel within the innovation chain and demanding sectors,
- end users of remote-sensing technology,
- suppliers of technology and knowledge institutions,
- product and services SMEs,
- branch organisations,
- and relevant government bodies.

Cross border networks of end-users will be enlarged or established to aggregate and formulate their demands regarding the desired use of RS applications. This will be stimulated and promoted by masterclasses and demonstration days. Also, RS branch organisations and the relevant government bodies in regulation and legislation will be brought together to identify and discuss the opportunities and obstacles of using RS applications in practice. WP1 will establish networks of knowledge (academia) and technology suppliers (SME) to formulate innovation and knowledge needs (e.g. data processing, lightweight materials, sensors, energy packs) to be validated and delivered in future products and projects. From those networks a cross border RS innovation cluster will be developed, which will lead to aggregation of demands, increased technology transfer, cooperation with governmental organisations on legislation and regulation and possibilities for SMEs to engage in international activities.

Activity A 1.1

One of the activities in ICAReS is to build cross-border networks for the organisations within the three demanding sectors: agriculture, nature and water & infrastructure. To achieve this a questionnaire (regarding current use and identified needs of RS) was circulated amongst the demanding sectors. A midterm report of the results was created to present

- current RS use,
- identified RS needs,
- frequent mentioned RS needs (priority),
- RS needs mentioned in all three sectors (synergy),
- shortlist for joining masterclasses and demonstration days,
- and conclusions on the best setup of demonstrations and masterclasses.

(Please note, the short list mentioned above is part of this report but attached separately.)

Research setup

In order to gain insight in the use and needs of the demand organisations of the sectors agriculture, nature, water & infrastructure in the in the 2 Seas region, the ICAReS partners have chosen to develop a questionnaire.

Population

Together, the project partners created three long lists consisting 5823 companies in the agriculture sector, 104 organisations in the nature sector and 129 organisations and companies in the water & infrastructure sector in the 2 Seas area. The companies and organisations on the longlists were sent a questionnaire consisting of questions about Remote Sensing. The three questionnaires can be found in appendix A, B and C respectively attached to this report. Of the 5823 questionnaires sent out in the agriculture sector, 185 individual companies have responded, which makes a response rate of almost 3%. Of the 104 questionnaires sent out in the nature sector, 37 individual organisations have responded, which makes a response rate of almost 36%. Of the 129 questionnaires sent out in the water & infrastructure sector, 13 individual organisations have responded, which makes a response rate of 10%.

Methodology

The Questionnaire was created with the expertise of all the ICAReS project partners and reviewed thoroughly. Surveymonkey was used as means of distributing the questionnaire and to gain the summary of results. In the next chapter we have outlined the results of the questionnaire.

Agriculture Results

Current RS use

In total there were 184 responses on the questionnaires in the agricultural sector, 85 from The Netherlands, 98 from Belgium (91 Flanders and 7 Wallonia) and 1 from the United Kingdom. No responses from France. The questionnaires were available in three languages, in Dutch for The Netherlands and Flemish Belgium, in English for United Kingdom and in French for France.

From the total of 184 responses, 94 (52%) of the respondents were the owners or representatives of an agricultural farm, 42 (23%) of a fruit growing farm, 32 (17%) of a livestock farm, and 15 (8%) of a horticultural farm with the culture of vegetables in the open field. There are also a few farmers of strawberries in the open field, three nurseries and seed potato growers.

There are also 44 respondents who grow other crops or are representative of a company in the periphery of the agriculture sector.

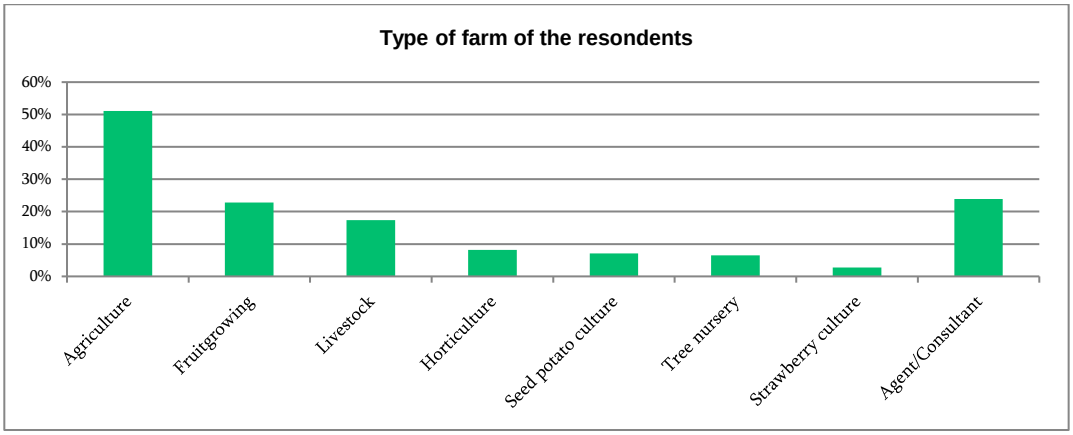


Figure 1 Types of farms of the respondents

Agriculture Results

Besides 7 farmers who have other cultures, like vineyards and greenhouse culture, there are also 9 consultants, 2 governmental representative, 4 contractors, 6 machinery sellers, 2 agricultural teachers and several representatives of food industries.

Of the 184 respondents there were 54 (29%) who have experience with remote sensing (RS). Most of these respondents have used remote sensing images from more than one platform. A group of 34 (63%) used remote sensing images got from a RPAS (UAV/drone), 31 (57%) from satellites, 21 (39%) from a manned aeroplane and 11 (20%) from a manned helicopter.

This meant that almost 30% of the farmers have had experience with remote sensing and the ones with experience tried more than one method to get the remote sensing images.

Most farmers used images from satellites at first. In 2008 “Mijn Akker” was introduced by BasFood in the Netherlands. A lot of the early pioneers used this program which provided them images from satellites. However, from the start there were problems with the availability of the images in spring during cloudy weather. In one year, there were hardly any good images available in the growing season for the farmers. Since 2013 several companies started to offer their service by making remote sensing images by RPAS, aeroplane of helicopter.

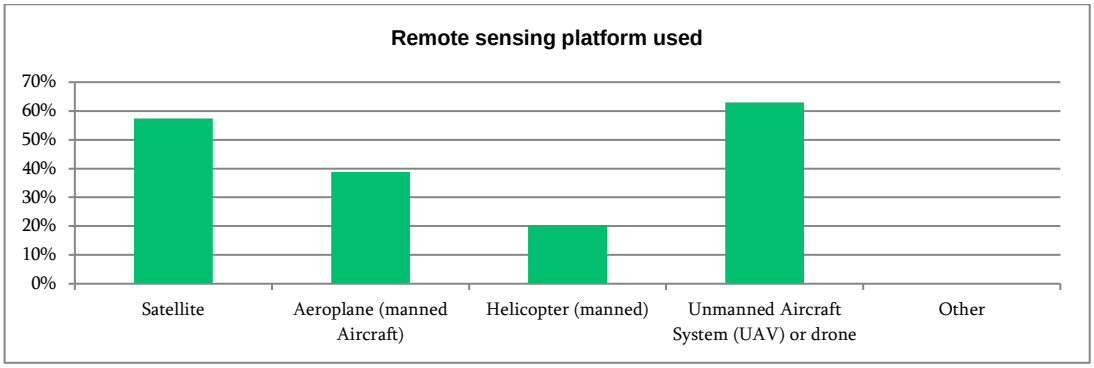


Figure 2 Types of platform used to make remote sensing images

Agriculture Results

The images were made of the potatoes 34 times, wheat 33 times, sugar beets 11 times, onions 9 times, seed potatoes and meadow both 6 times. A few also made remote sensing images of orchards, tree nurseries and other crops, like vegetables and carrots. One farmer made remote sensing images on bare land in the wintertime.

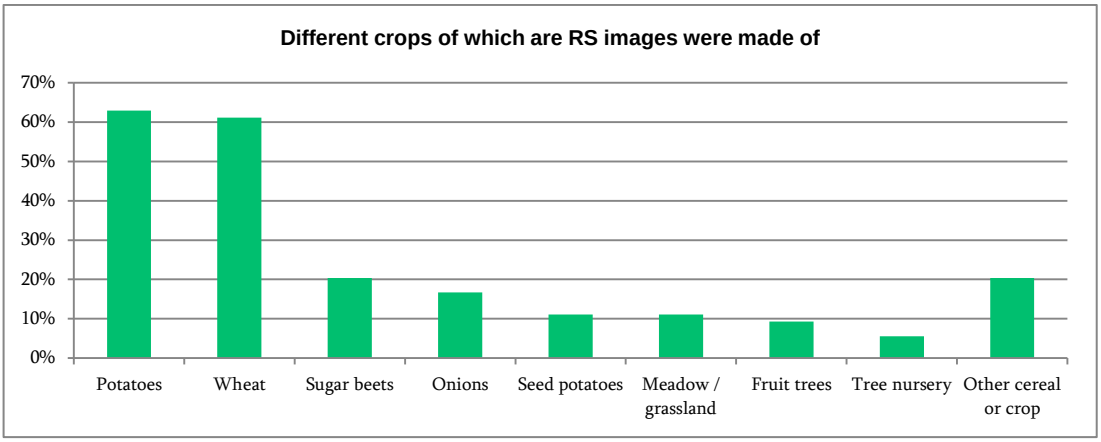


Figure 3 Different crops of which are RS images were made of

Of the 54 respondents who have experience with remote sensing, 42 made more than one image during the growing season. Most of them (63%) made 2-4 images per growing season.

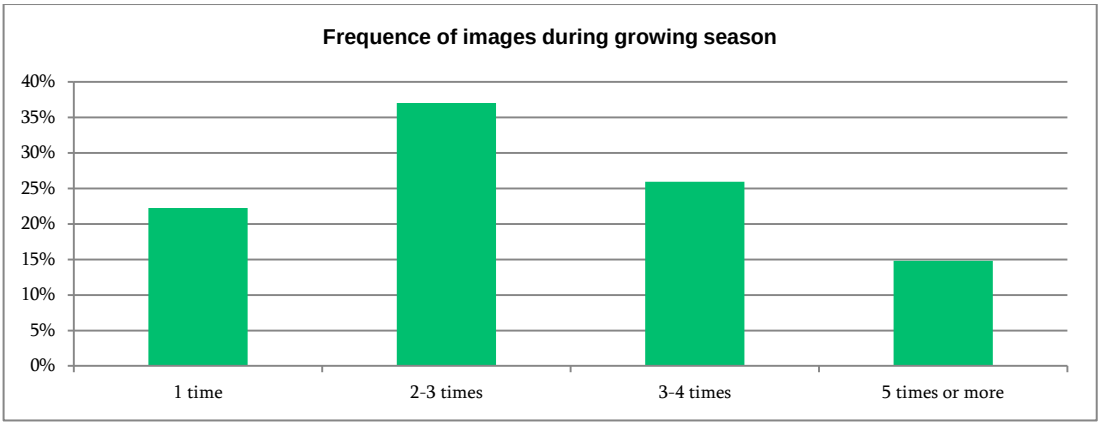


Figure 4 Frequence of images per growing season

Conclusions current use of Remote Sensing: About one third of the farmers have experience with remote sensing. Almost all tried two or more sources for the images. Regarding platform choice, they used mainly images from RPAS (UAV/drone) and satellite, but also from manned aeroplane and helicopter. More than half made 2-4 images per growing season of the main agricultural crops: potatoes, wheat, sugar beets and meadow.

Identified RS needs

From the 54 respondents who had experience of remote sensing, 40 (75%) are satisfied with the quality of the images, stating that the images are accurate and useful. But 13 of the respondents experienced bad quality images. However, this was mainly based on earlier experiences with images of satellites. It is known that there are problems with the availability of a good quality of the images of satellites during cloudy weather. The shadows cast by the clouds influenced the reflexion of the vegetation, in turn affected the results. This lead to poor data and a lack of availability. Also, the first images from a manned aeroplane were not sharp and clear. But, this was resolved over the time leading to higher quality images.

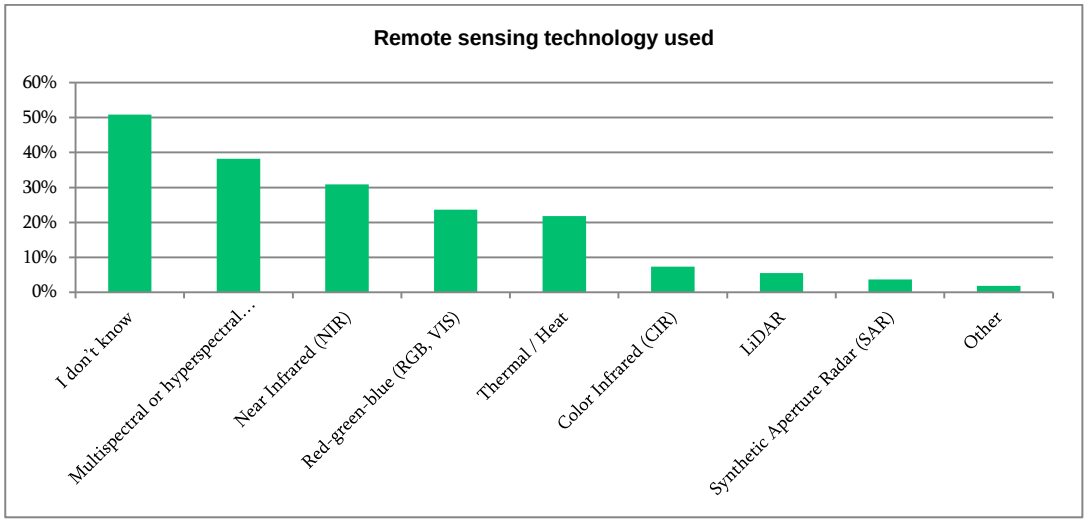


Figure 5 Used technology for remote sensing

Agriculture Results

More than half the respondents (51%) did not know which technology was used for the remote sensing images they have got. The remainder did know that there was more than one method used like Multispectral or Hyperspectral combined with a normal Red-green-blue (RGB) camera and/or Near Infrared (NIR). An overview of the used sensors is shown in figure 5.

The result of the remote sensing for the agriculture is mostly presented as a vegetation index. Of the 54 respondents who have experience with remote sensing 23 (42%) has no idea what vegetation index was used. All the ones who know got images of Normalized Difference Vegetation Index (NDVI), combined with Weighted Difference Vegetation Index (WDVI) and/or Leaf Area Index (LAI). This data is shown in figure 6.

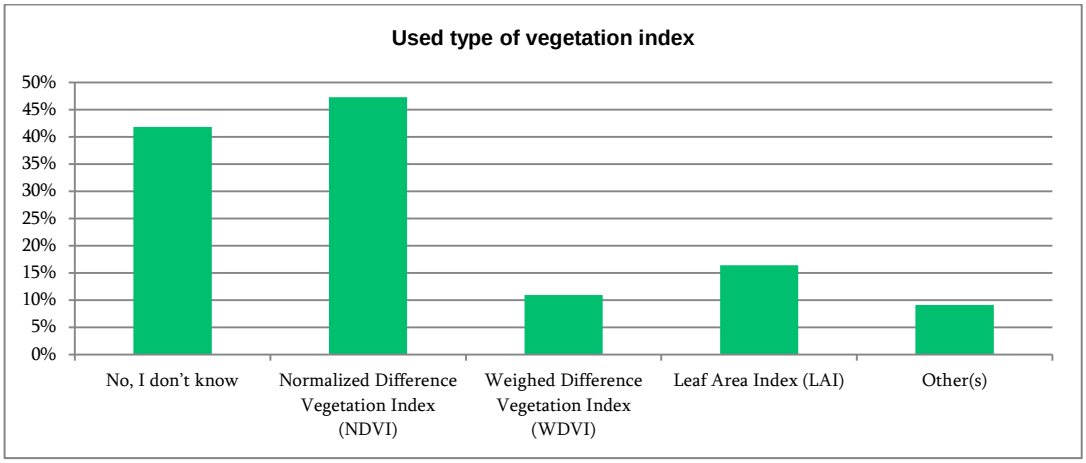


Figure 6 Presented vegetation indexes

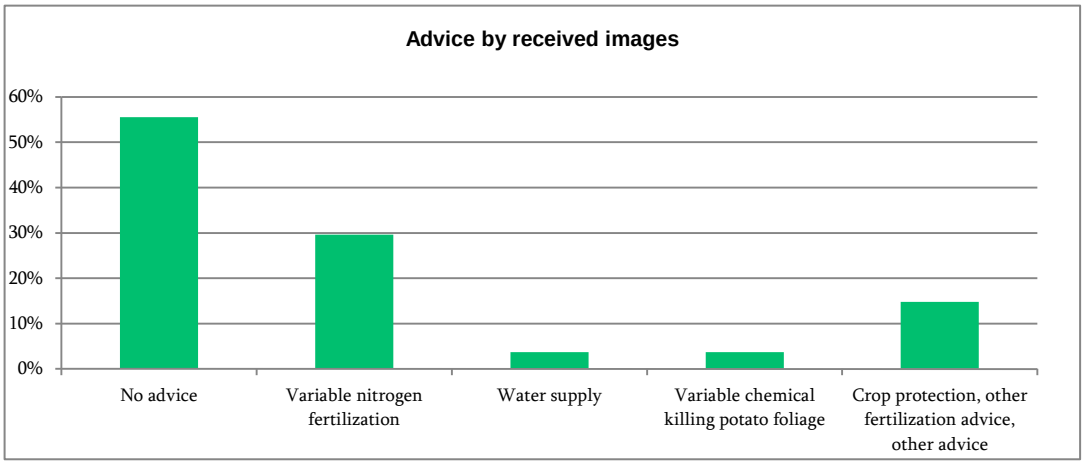


Figure 7 Received advice provided with the images

Most farmers (56%) did not get any advice on the images. Of the advice given, almost half was about variable nitrogen fertilization. The advice was mainly given by suppliers of fertilizers, like CZAV, Van Ieperen, Agrifirm and also direct from the producer Yara (Kemira GrowHow). Also, advice was provided via projects like WatchITgrow in Belgium and BDB Pwaro project. Just a few got their advice directly from the RS company who made the images, like Aerial Service Holland, Airinov and Agrometius.

Frequent mentioned RS needs (priority) in the Agriculture sector

Most wishes in the area of remote sensing and/or the use of RPAS (UAV/drones) are about the advice and the use of the images. All users want a good advice on how to interpret the images and advice what action should be taken. Several farmers are also looking for a software program to combine the images to make their own task maps. Some requests are towards application needs such as the detection of pests and diseases by drones.

In general, remote sensing is still in development and the use of the images needs a lot of attention. The image quality does not seem to be a problem anymore, but the interpretation and the advice or action is.

The obstacles or bottlenecks when using a drone or by hiring a drone service company are mainly the law and rules. In several areas there are no-fly zones, or the fields are too close to buildings, houses, power line and (rail)roads. The laws often state that drones are not allowed to fly close to these obstacles. Also, another obstacle mentioned was that the payload capacity of drones is limited, and the cost are quit high.

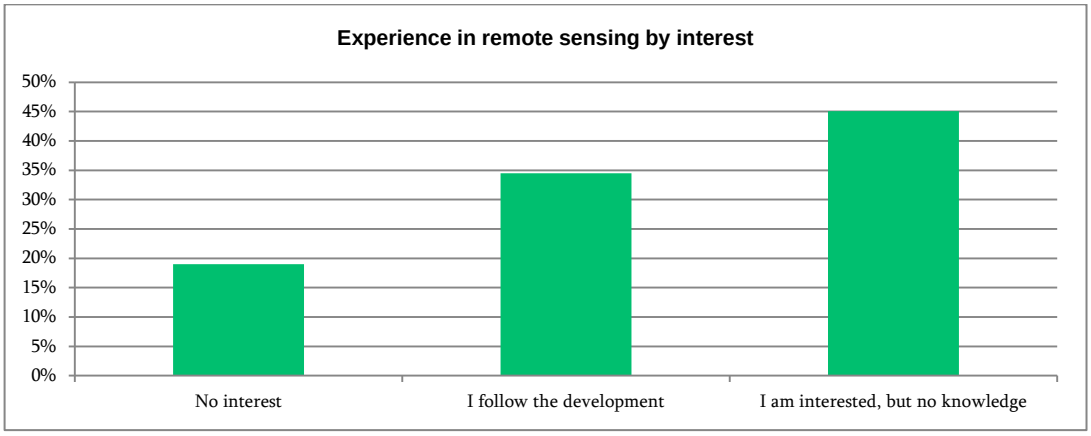


Figure 8 Why no experience

Almost half (45%) of the 142 respondents who have no experience with remote sensing on their farm are interested, but they have no clue which supplier or organisation they have to turn to for the right images and a good consultation. One third is following the developments in the industry but is currently waiting for better results and financial benefits.

Besides remote sensing, several respondents are interested in near sensing, sensing from the tractor or machines, and in soil scanning. Or, possibly a combination of all these techniques.

Most farmers who have no experience with remote sensing are considering to start using remote sensing on their farm within a few years. However, the starting problems, costs, benefits, profit and usefulness has to be clearer for this large group of farmers.

Appendix D (provided separately due confidentiality) shows the shortlist of respondents, which would like to be kept informed about the ICAReS project.

Nature Results

Current use of RS in the demand sector Nature

The majority of the responders of the questionnaire are working in an organisation for biodiversity conservation (79%). Followed by Landscape conservation (17%) and Heritage conservation (17%). The responders indicating other do not work themselves in one of the previously mentioned type of organisation but provide services or resources to these organisations. This data is shown in figure 1.

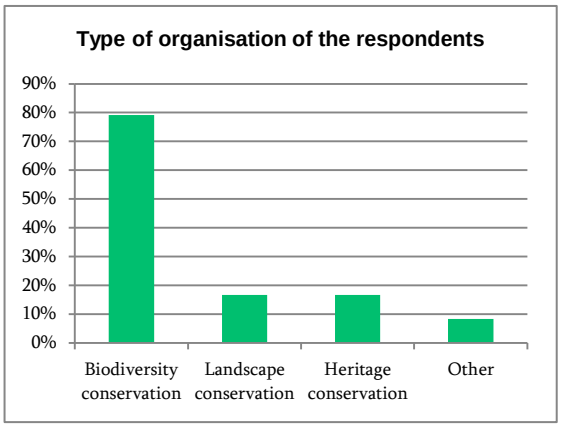


Figure 1 Types of organisation of the respondents

45% of the respondents already have experience with remote sensing (RS). Most of these respondents have collected data from a manned aeroplane (64%), followed by the use of RPAS (UAV/drone) (55%), satellite (27%) and ground based observations (9%). Shown in figure 2.

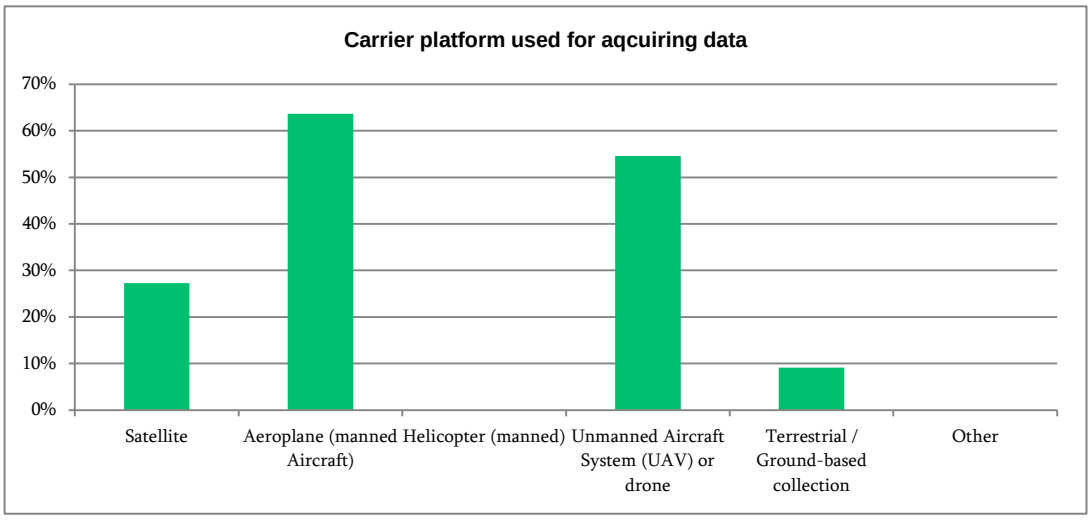


Figure 2 Types of platform used to make remote sensing images

Half of the organisation collect this data multiple times a year. Another 20% collect data once a year or once every few years, as shown in figure 3. The respondent that indicated other replied that they collect and use the data that is freely available. This is also reflected in the source of the collected data. While the majority of the data is collected by (table 1) commercial contractors (44%), own staff (25%) or available data (6%). It is indicated by the group replying other (25%) that they use data freely available, as in open source data (like certain satellite images) or by using volunteers to collect this data (for areal imagery).

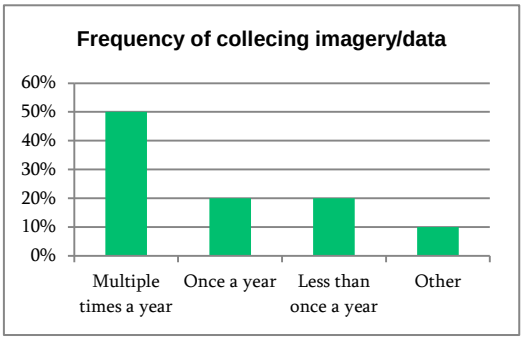


Figure 3 Frequency of collecting imagery or data

How data is acquired	%
Own staff	25%
Commercial contractors	44%
Buy 'off-the-shelf' data	6%
Other	25%

Table 1: Data provider

Identify RS needs

As to better understand the needs of the nature sector for remote sensing. It is important to know their reasons and interests better. The used sensors are a good first impression of their interests. Unsurprisingly aerial photography is mainly used, by 55%. Followed by LiDAR (27%) and near infrared (27%). An overview off all possible sensors is shown in figure 4.

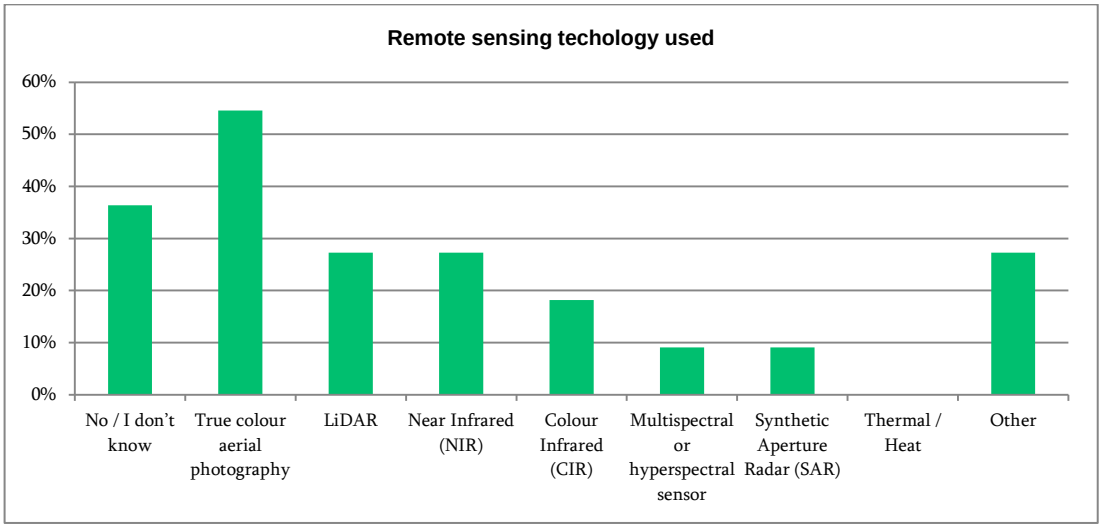


Figure 4 Remote sensing technology used for aqcuiring data

These used sensors are closely related to the interests of the nature organisations. From a conservation point of view, it is important to sense change in time. Photos are a good help for this. By taking pictures from known locations they can be compared to previously acquired pictures and change can be observed from them. The LiDAR technology allows users to calculate an accurate elevation model from a broad region and again observing change in time. A region map made from photos can be used to see land coverage, estimate biomass, have a better view on change in time and asses ground quality. Linked with this land coverage, these maps can be used for inventory of vegetation although with today's technology this is more of an estimation. Also, the ecological succession of trees can be monitored by comparing these digital elevation maps made from photos. Going from flora to fauna these areal images can be used to assess habitats, find bird colonies, or even count animas, resting birds or find and count nesting spots.

Overall, the data received through air to ground techniques meets the expectations. This mainly depends on the application of this data. Translating the received images to useful data or conclusions is mentioned to be a bigger issue.

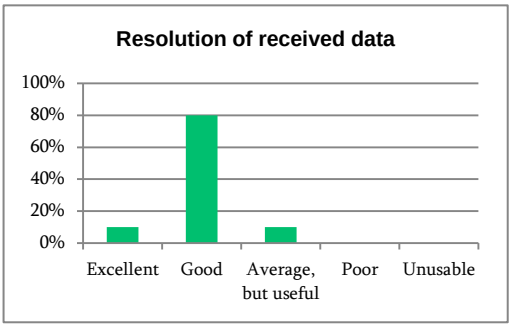


Figure 5 Quality of received data

This is also to be seen in the barriers to start using remote sensing more. Although pricing is the main drawback (64%), where this is related to the technology price, as the translation of collected data towards usable data and also getting the knowledge to start using these technologies. Although none mention a lack of service providers as a main barrier, it feels like most organisations try to be self-sufficient in technology and knowledge. All barriers are mentioned in Figure 6. However, the main feedback is that the price of these new technologies should be more accessible.

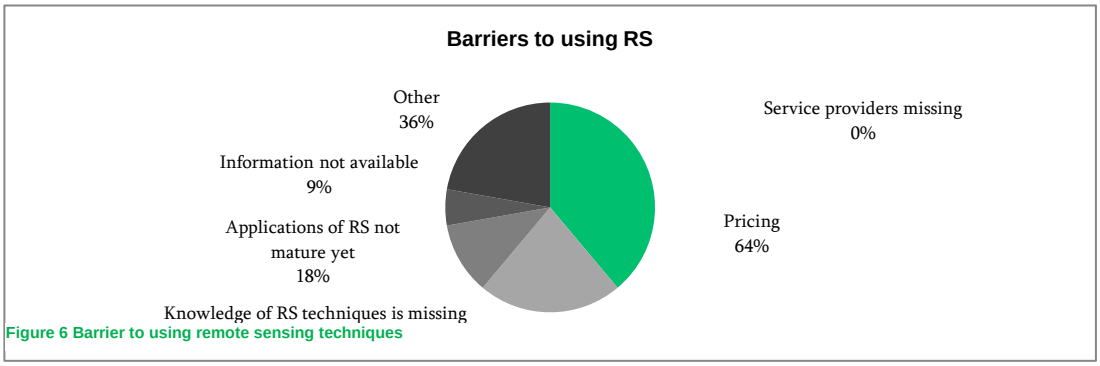


Figure 6 Barrier to using remote sensing techniques

40% seeks advice from third parties, like study offices or more knowledgeable similar organisations, depending on how difficult the interpretation of this data is. The threshold to go to another organisation is the difficulty in assessing the abilities and skills of such organisation. The organisations like to see the existing technology advance in both usability and diverse applications. Also, it is good to keep in mind that nature preserves are generally forbidden areas to fly with drones, although an exception can be acquired.

Challenges in the development of RS using UAVs

Challenges for the development of remote sensing using UAVs are mainly in the area of costs of the equipment or contractors, according to the respondents. On top of this, assessing the ability or skills of companies can also play a significant part. Then there are the regulations that goes along with using UAVs. Some respondents mention the lack of knowledge to start using UAVs for RS. And in case of landscape conservation, for covering very large areas manned aircraft is more cost efficient to this day. All obstacles are mentioned in figure 7.

When asked which development in RS techniques they follow, as for platforms most of the respondents (65%) mention that UAV/Drone development has their attention. Another significant part of the respondents (50%) mentioned that satellite and earth observation techniques have their interest. As for the technologies used to acquire data,

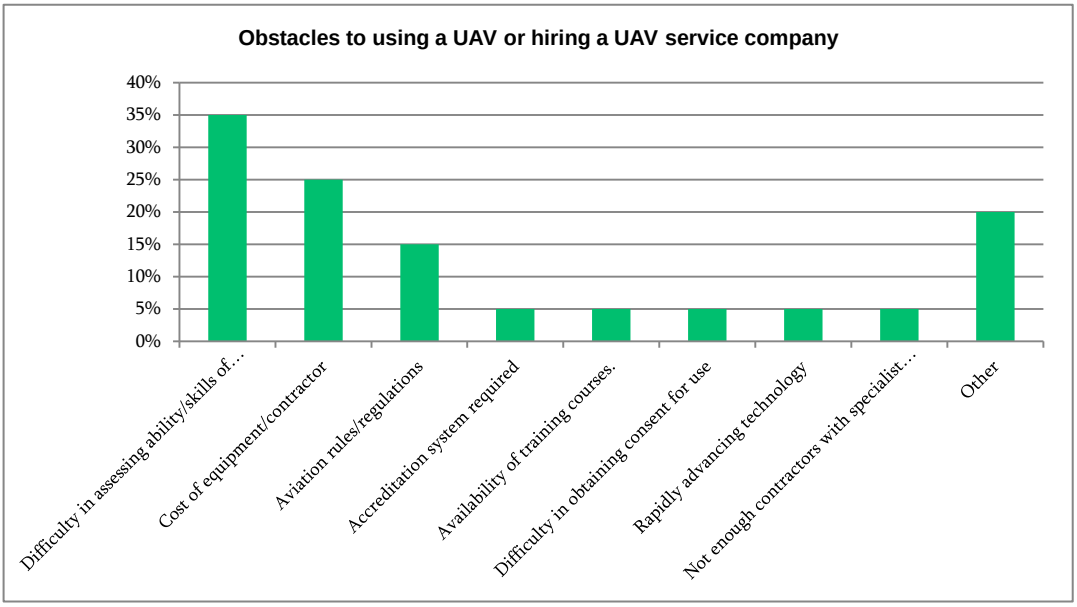


Figure 7 Obstacles to using UAV or hiring UAV contractors

the regular true colour aerial photography has their most attention (40%). Followed by near infrared (25%) and LiDAR (20%). While all these three sensors are already used by some, the technology of thermal/heat is followed by 20% but not yet used. All this data is collected in figure 8.

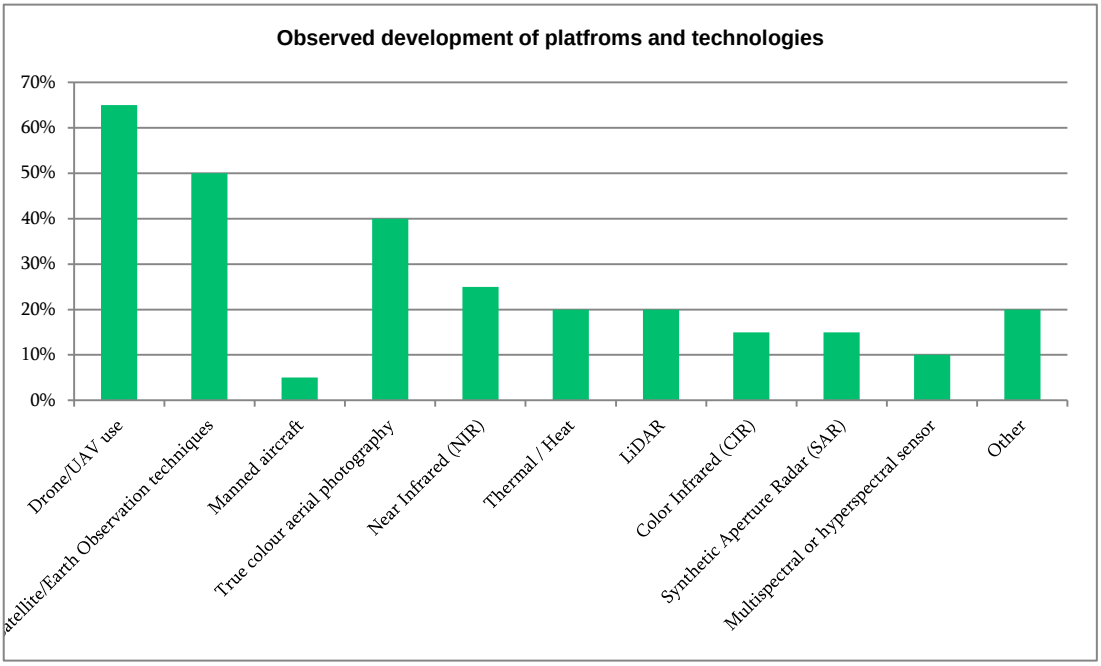


Figure 8 Obstacles to using UAV or hiring UAV contractors

The majority of the responders indicate they will be using remote sensing techniques in their future works (90%), 95% of them would like to be kept informed about remote sensing and the development of the ICAReS project. 70% of the responders would like to discover the possibilities of using remote sensing techniques for biodiversity, landscape and heritage through ICAReS and is prepared to cooperate with the projects for demonstrations and trails.

Appendix D (provided separately due confidentiality) shows the shortlist of respondents, which would like to be kept informed about the ICAReS project.

Results Water and Infra

Importance of RS for demand organisations.

40% of the respondents are already working with remote sensing, and of the respondents not yet using remote sensing, 56% plans to do so in the near future. The respondents that are neither yet working with RS (Remote Sensing), nor have plans to do it in the future, indicated that it was because of they don't see any use or benefits for their organisation (20%), don't know about the possibilities (20%), or did not have the required knowledge or capabilities (40%). Of the respondents not yet working with RS, but with interest in remote sensing/UAV technology, 44% already has concrete plans to invest and start using RS. Figure 1 depicts the time span in which those respondents are planning to invest and start using RS. The respondents that checked the box 'other', specified they are following the development to see the possibilities.

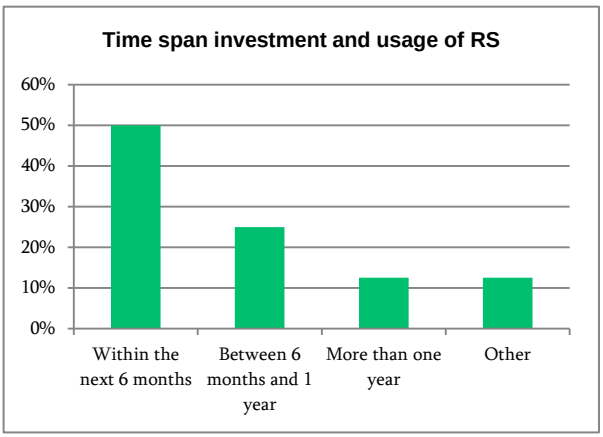


Figure 1 Time span investment and usage of RS

Products & Services in Remote Sensing

The most frequently used platform for remote sensing is an UAV, illustrating the belief, of the respondents, in the potential of this relatively new technology. The other respondents are using other remote sensing platforms such as helicopters or satellites. This is shown in table 1.

Remote Sensing platform	%
Unmanned Aircraft System	26,7%
Helicopter	20,0%
Satellite	13,3%
Autonomous Underwater Vehicle	6,7%
None	33,3

Table 1: Platform used for RS by respondents

Results Water and Infra

Unmanned aerial vehicles are significantly more used for remote sensing then the traditional platforms, such as aeroplanes and satellites. Respondents which are still using traditional platforms will also use UAV platforms when they give the same results.

When asked about their reason for using remote sensing, most of the respondents mentioned carrying out inspections as their main goal for using remote sensing. Another significant part of the respondents' mentions using remote sensing to quickly get information from all sort of objects, often the main goal is to get an elevation model.

This is corroborated by the outputs of remote sensing that are being used. While unsurprisingly visual Images (e.g. aerial images, orthophoto mosaic, satellite image) and height information (Digital Elevation Model or Digital Terrain Model) are most often used - respectively by 40% and 50% of the respondents – index maps (NDVI, yield, other indices) and non-visual images or mosaics (NIR, thermal) are not often used by the respondents. 10% of the respondents uses NIR sensors to produce non-visual images.

The sensor technology that is used, is most of all LiDAR technology combined with RGB (70% of the respondents). 10% of the respondents mention Near Infra-Red (NIR) as the sensor technology that is used. These technologies are readily available for use with UAVs, so it is not surprisingly respondents are using this technology. Other respondents (10%) uses sensors to measure the quality of the air and the noise in various areas.

Challenges in the development of RS using UAVs

Challenges for the development of remote sensing using UAVs are mainly in the area of regulation and law, according to the respondents, while development in technology can also play a significant part.

The restrictive regulations regarding the use of unmanned aerial vehicles is the most often mentioned hurdle (mentioned by 20% of the respondents) for further use of UAVs for remote sensing, followed by technology (10% of respondents), acceptance of the public, pricing are not mentioned by the respondents. Many of the respondents experience other restrictions or hurdles, but don't specify what sort of hurdles that are.

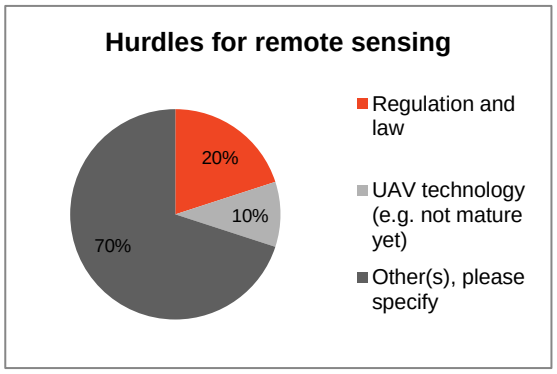


Figure 2 Time span investment and usage of RS

The respondents consider regulations and laws as the most restrictive factor in the further use of UAVs for remote sensing. When asked what factors cause the restrictions, most often the restrictions in flying with UAVs - such as the requirement to fly within visual line of sight or abstain from congested areas are mentioned.

The respondents also experience troubles with the processing of the data and have a lack of expertise to specify the information which is needed for their projects. Also choosing equipment for remote sensing is a restrictive factor. For small demand organisations the choice is between so many variables (choice of a vehicle, choice of a sensor) and a too high-threshold to gain good quality data by themselves using remote sensing.

Interest in the ICAReS innovation cluster

Of the respondents that indicated the reason for their interest in ICAReS, most respondents hope to be informed about new technologies (44%), and/or hope to encounter new contacts and extend their network (11%). Figure 3 depicts the full distribution of reasons.

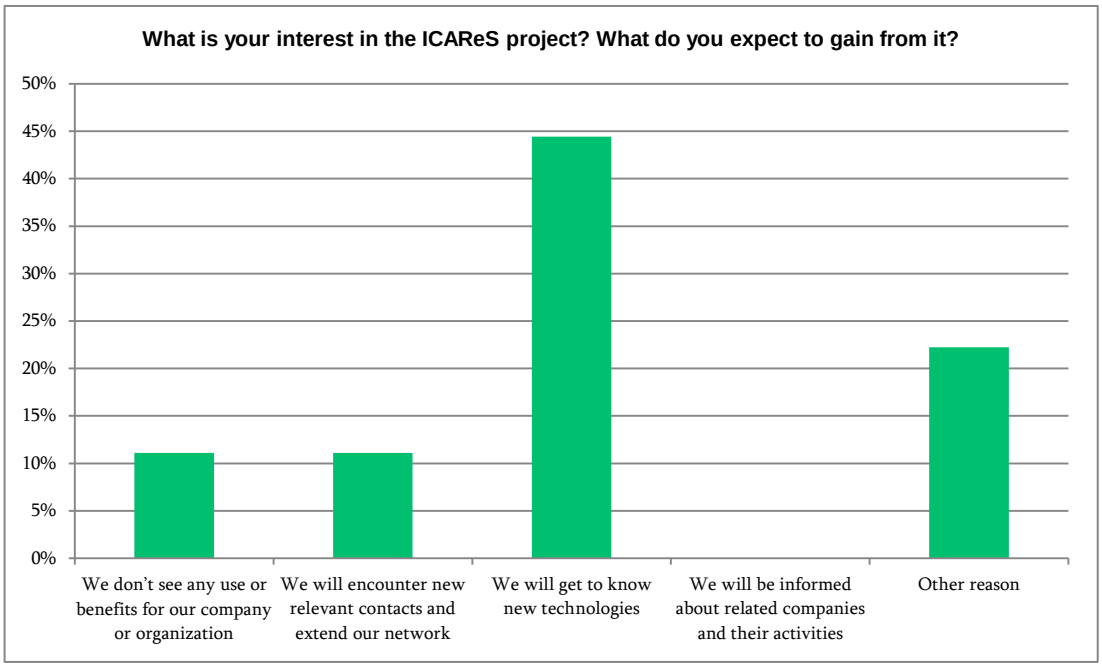


Figure 3 Time span investment and usage of RS

Of the demand organisations already active in RS, 20% is interested and available to give demonstrations and lectures about RS, which is a total of 2 demand organisations. A high percentage of 50% is interested in joining a future remote sensing innovation cluster and would like to cooperate with the (inter)national research institutes. Finally, 4 respondents provided us with additional contacts for the ICAReS cluster to contact.

Appendix D (provided separately due confidentiality) shows the shortlist of respondents, which would like to be kept informed about the ICAReS project.

Synergy of Remote Sensing in all 3 sectors

RS needs mentioned in all 3 sectors (synergy)

Every demand organisation at this moment is working with remote sensing in its own way. Where nature organisations are using this technology to create an overview picture of a part or a preserve to have a good representation from an otherwise hard to reach angle, agriculture is using the collected data to find relations and help in decision making. While infrastructure would be using remote sensing as a means to recreate a 3D representation of an area or a building. These examples are just the beginning off possible applications. Yet for all demand organisations the topic of remote sensing is relatively new and therefore they are open to learn about these new technologies. They approach ICAReS with an open mind to learn and experience what is possible. Because these technologies are relatively new, when talking about remote sensing, innovative ideas instantly come to mind for these demand organisations. These ideas vary from technologies to perform at this moment labour intensive jobs or new not yet existing product solutions.

But every demand organisation mentions the same. In this relatively new field, the knowledge isn't yet widespread. The applications aren't as user friendly as they are in the concepts. And the translation of pure sensor data to a usable format isn't always as easy as hoped for. While this is for some applications still in a development status, current price point isn't yet there for the general public.

The needs of the demand organisations are that they like to see a novel application through the whole value chain. Having a certain sensor on a UAV capturing data would be the first step in this progress. But seeing how this data is translated into a usable format that fits their needs is just as important, if not more important. This is because the process to reform sensor data to another wanted format is where the value of collect the data is made. This could vary from an easy progress like combining pictures to form a panorama

to more complex processes such as identifying or quantifying subjects in the data and process this into a report that helps in decision making.

A few of these ideas, but not limited to this would be:

- quantifying biomass in a region or a field,
- assessment of vegetation in species and quantity,
- detection of diseases in crops and allow for local actions,
- differentiate weeds from crops, also to allow for local actions,
- or record accurate digital elevation models from a region to allow to detect change in time.

It is important to see how one use-case in one of the demand sectors can be useful in another sector with little modification. Also, when the use of new technology becomes more widespread the price of these should lower.

Short list for joining Masterclasses and demonstration

Appendix D (provided separately due confidentiality) shows the shortlist of respondents, which would like to be kept informed about the ICAReS project.

Conclude on best setup of demonstrations (D1.1.5)

Of all 182 respondents 163 (90%) likes to be informed about the development on remote sensing and the use of RPAS (UAV/drone) by the ICAReS-project. Of them 109 are prepared to open their farm for demonstrations and test with remote sensing and the use of RPAS (UAV/drone) by the ICAReS-project. They are also open for a consultation about the possibilities.

Appendix A: ICAReS – Questionnaire Remote Sensing/UAV technology for demand organisations in Agriculture

After the introduction of GPS on the tractor in the agriculture, there is a fast growing interest to start using sensor technology to get images and data of crops and soils. This with the aim to manage the crop place specific (smart farming).

Sensor or camera images created of a field using a satellite, airplane, helicopter or drone, is called remote sensing.

From the ICAReS project, a collaboration between 11 organisations in the Netherlands, Belgium, France and England, we'd like to ask a few questions. This to develop and introduce remote sensing with drones (UAVs) in practice.

To better serve and inform you, we ask you for your name, address, email and phone number. Your answers will be used anonymous for our project.

1. General / contact information

Person name

Street

Zipcode

City

E-mail

Telephone

tick the best answer(s), multiple answers possible

2. What type of farm do you own or do you represent?

- [ ] Agriculture
- [ ] Seed potato culture
- [ ] Horticulture; vegetables in the open field
- [ ] Livestock
- [ ] Fruitgrowing
- [ ] Strawberry culture in the open field
- [ ] Tree nursery
- [ ] Agent/Consultant for/Other, please specify

3. Do you have any experience with remote sensing on your farm?

- ( ) Yes
- ( ) No, go to question 15

4. What carrier was used to make remote sensing images at your farm?

- [ ] Satellite
- [ ] Aeroplane (manned Aircraft)
- [ ] Helicopter (manned)

- [ ] Unmanned Aircraft System (UAV) or drone
- [ ] Other

5. Of which crops were those images made?

- [ ] Wheat
- [ ] Potatoes
- [ ] Seed potatoes
- [ ] Onions
- [ ] Sugar beets
- [ ] Meadow / grassland
- [ ] Fruit trees
- [ ] Tree nursery
- [ ] Other cereal or crop, please specify

6. How often in the growing season were those images made?

- ( ) 1 x
- ( ) 2-3 x

- 3-4 x
- 5 x or more

7. How is the quality of the images?

- Accurate and useful, go to question 9
- Not very good, go to question 8

8. What is the problem with the quality of the images?

9. Do you know which technology was use for remote sensing?

- [ ] No, I don't know
- [ ] Red-green-blue (RGB, VIS)
- [ ] Near Infrared (NIR)
- [ ] Colour Infrared (CIR)
- [ ] Multispectral or hyperspectral sensor
- [ ] Thermal / Heat
- [ ] LiDAR
- [ ] Synthetic Aperture Radar (SAR)
- [ ] Other, please specify

10. Do you know which vegetation indexes are presented?

- [ ] No, I don't know
- [ ] Normalized Difference Vegetation Index (NDVI)
- [ ] Weighed Difference Vegetation Index (WDVI)
- [ ] Leaf Area Index (LAI)
- [ ] Other(s), please specify

11. Do you receive advice on the images?

- [ ] No advice (Go to question 13)
- [ ] Variable nitrogen fertilization
- [ ] Water supply
- [ ] Variable chemical killing potato foliage
- [ ] Crop protection, other fertilization advice, other advice, please specify

12. Who gives this advice?

13. What are your wishes in the area of remote sensing and/or the use of drones (UAV)? Other applications?

14. Are there obstacles or bottlenecks when using a drone or by hiring a drone service company? (Go to question 16)

15. Why do you have any experience with remote sensing on your farm?

No interest (Go to question 18)

I follow the development (Go to question 16)

I am interested, but I have clue which supplier or organisation I have to turn to for the right images and a good consult.

16. Which development do you follow?

17. When do you think you will apply remote sensing at your farm? And what do need to?

18. Would you like to be kept informed about remote sensing and be invited for demonstrations or other happenings about this subject?

No thanks, I am not interested

Yes, keep me informed.

19. Would you like contact with one of the partners of the ICAReS project to discovery the possibilities of remote sensing for your farm. And are you prepared to cooperate with the project for demonstrations and trials on your farm?

Yes, you can contact me.

No thanks

Thanks for your time and filling in this questionnaire.

Appendix B: ICAReS – Questionnaire Remote Sensing/UAV technology for demand organisations in Nature

Remote sensing is the science of obtaining information about objects or areas from a distance. This is often through means of satellite, aircraft or unmanned aerial vehicles (UAVs or drones) and also ground-based collection. It may include techniques such as radar, ultrasound, light detection and ranging (LiDAR), photogrammetry, aerial photography and several other techniques.

The use of remote sensing technology in the fields of biodiversity, landscape and heritage conservation is still in its infancy. However, this new technology has the potential to make a significant contribution to work in these areas and is a rapidly growing sector.

The ICAReS (Innovation Cluster Accelerating Remote Sensing) is a cross border innovation cluster to create the necessary conditions for innovation in the field of remote sensing and advanced data communication and processing. It is a collaboration between 11 organisations in the Netherlands, Belgium, France and UK that is seeking to explore, understand and develop the use of remote sensing in the above fields as well as agriculture, water and infrastructure.

With this in mind, we would like to understand your organisation's awareness and use of remote sensing technologies for biodiversity, landscape and heritage conservation, and whether you have intentions for its use in the future.

1. Do you have any experience of using remote sensing for biodiversity, landscape or heritage conservation?

2. What type of work does your organisation undertake (please tick as many that apply)?

☐ Biodiversity conservation

- [ ] Landscape conservation
- [ ] Heritage conservation
- [ ] Other (please specify)

3. Does your organisation currently use remote sensing to inform or guide its work? Please indicate which techniques are used.

- [ ] No / I don't know
- [ ] True colour aerial photography
- [ ] Near Infrared (NIR)
- [ ] Colour Infrared (CIR)
- [ ] Multispectral or hyperspectral sensor
- [ ] Thermal / Heat
- [ ] LiDAR
- [ ] Synthetic Aperture Radar (SAR)
- [ ] Other

4. What type of carrier has been used to collect remote sensing imagery?

- ☐ Satellite
- ☐ Aeroplane (manned Aircraft)
- ☐ Helicopter (manned)
- ☐ Unmanned Aircraft System (UAV) or drone
- ☐ Terrestrial/ground-based collection
- ☐ Others (please specify)

5. How do you collect your remote sensing imagery?

- ☐ Use own staff
- ☐ Use commercial contractors
- ☐ Buy 'off-the-shelf' data
- ☐ Others (please specify)

6. How does your organisation use the RS imagery (please provide specific details of its use)?

7. How regularly do you collect imagery/data?

- Multiple times a year (please specify)
- Once a year
- Less than once a year
- Other (please specify)

. How good would you consider the resolution of the imagery is/was for your planned use?

- Excellent
- Good
- Average, but useful
- Poor
- Unusable

Please provide more information

9. Please explain what the problem is with the image quality/resolution.

10. What do you consider are the main barriers to using remote sensing techniques?

- ☐ Cost
- ☐ Lack of awareness of RS techniques available
- ☐ Lack of awareness of applications of remote sensing
- ☐ Too few specialist contractors
- ☐ Lack of availability of training for staff
- ☐ No barriers
- ☐ Other (please specify)……

11. Can you identify any potential solutions to these barriers?

12. In interpreting the images produced, did you seek any advice from others?

Yes (please specify who)

No (please explain why)

13. How would you like to see the use of remote sensing develop in the future? Can you foresee any new uses?

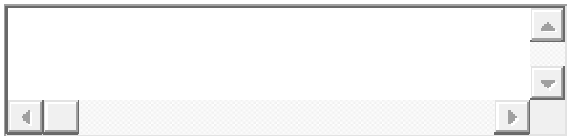
14. What are the obstacles to using a UAV or hiring a UAV service company?

- Difficulty in assessing ability/skills of company
- Accreditation system required
- Availability of training courses.
- Cost of equipment/contractor
- Aviation rules/regulations
- Difficulty in obtaining consent for use
- Rapidly advancing technology
- Not enough contractors with specialist knowledge in my field
- Other (please specify)

15. Do you follow the development in the use of these technologies? Which ones? (Tick as many as appropriate)

- [ ] Drone/UAV use
- [ ] Satellite/Earth Observation techniques
- [ ] Manned aircraft
- [ ] True colour aerial photography

- [ ] Near Infrared (NIR)
- [ ] Colour Infrared (CIR)
- [ ] Multispectral or hyperspectral sensor
- [ ] Thermal / Heat
- [ ] LiDAR
- [ ] Synthetic Aperture Radar (SAR)
- [ ] Other



16. Are you likely to use remote sensing techniques in your work in the future?

- [ ] No thanks
- [ ] Yes – but I'm not sure which
- [ ] Yes – Please explain which

17. Would you like to be kept informed about remote sensing and be invited for demonstrations or other happenings about this subject?

- [ ] No thanks, I am not interested
- [ ] Yes, keep me informed.

18. Would you like contact with one of the partners of the ICAReS project to discovery the possibilities of using remote sensing techniques for biodiversity, landscape and heritage? Would you be prepared to cooperate with the project for demonstrations and trials?

☐ Yes, you can contact me.

☐ No thanks

19. General / contact information

Person Name

Job title

Organisation

Address

Street

City

Postcode

E-mail

Telephone

Appendix C: ICAReS – Questionnaire Remote Sensing/UAV technology for demand organisations in Water and Infrastructure

1. General / contact information

Person Name

Organisation Name

2. Does your organisation have any experience regarding remote sensing/UAV technology?

- Yes (Go to question 7)
- No

3. Does your organisation have any interest or plans to start using remote sensing/UAV technology in the near future?

- Yes (Go to question 5)
- No

4. If you don't have any interest or plans regarding the use of remote sensing/UAV technology. What is the reason?

- We don't see any use or benefits for our company or organisation
- It is too expensive for our company or organisation
- We don't know about the possibilities
- We don't have the required knowledge/capabilities

Other reason (please specify)

5. What is your interest in the ICAReS project? What do you expect to gain from it?

☐ We don't see any use or benefits for our company or organisation

☐ We will encounter new relevant contacts and extend our network

☐ We will get to know new technologies

☐ We will be informed about related companies and their activities

☐ Other reason (please specify)

6. Your organisation has interest or plans to start using remote sensing. How concrete are your plans?

○ We are interested, but have no concrete plans. And we like to be informed by ICAReS and be invited for your activities. (Questionnaire finished)

○ We have concrete plans to invest and start with using remote sensing.

7. Your organisation plans to invest and start using remote sensing/UAV technology:

○ Within the next 6 months

○ Between 6 months and 1 year

○ More than one year or later

○ Other;

8. What are the main applications for remote sensing within your organisation?

9. What carrier do you use for remote sensing?

- ☐ Multicopter Unmanned Aircraft System (UAV) or drone
- ☐ Fixed Wing Unmanned Aircraft System (UAV) or drone
- ☐ Aeroplane (manned Aircraft)
- ☐ Helicopter (manned)
- ☐ Satellite
- ☐ Ground based platform
- ☐ Autonomous Underwater Vehicles (AUV)
- ☐ Autonomous Surface Vehicles (ASV, i.e. boats)
- ☐ Other …….

10. Which technology do you use for remote sensing?

- ☐ Red-green-blue (RGB, VIS)
- ☐ Near Infrared (NIR)
- ☐ Colour Infrared (CIR)
- ☐ Multispectral of hyperspectral sensor

- [ ] Thermal / Heat
- [ ] LiDAR
- [ ] Synthetic Aperture Radar (SAR)
- [ ] Air quality measurement system
- [ ] Other;

11. What is the output of the data?

- [ ] Visual Images (e.g. aerial images, orthophoto mosaic, satellite image, …)
- [ ] Height information (Digital Elevation Model or Digital Surface Model or Digital Terrain Model)
- [ ] Non visual images or mosaics (NIR, thermal, …)
- [ ] Thematic maps (habitat, vegetation or water, classifications, …)
- [ ] Index map (NDVI, yield, other indices)
- [ ] Other(s);

12. Can you identify further potential applications for remote sensing within your organisation?

13. Do you have any problems or challenges when using remote sensing/UAV technology?

14. Are there any restrictions and/or hurdles that need to be tackled to facilitate more use of UAV's for remote sensing?

- [ ] Regulation and law
- [ ] UAV technology (e.g. not mature yet)
- [ ] Pricing
- [ ] Acceptance of the public
- [ ] Other(s), please specify

15. Are you interested in joining a future remote sensing innovation cluster?

- ○ No
- ○ Yes, why:

16. Do you know of any test site for remote sensing/UAV that you are using or could be used for tests or demonstrations?

- ○ Yes, please specify the site name and location
- ○ You are not currently using it
- ○ You are using it already
- ○ What tests did you perform? Please specify

Please specify

17. Do you know about other relevant organisations for us to contact? Please provide us with their contact details

18. Are you involved in any related projects regarding remote sensing / UAV that you would like to share? Please specify

19. Do you have any additional remarks or suggestions?

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