INNOVATION CLUSTER ACCELERATING REMOTE SENSING

Interreg 2 Seas Mers Zeeën

D 2.2.2.

Reports of demand collections

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Content

"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 Workpackage 2

A second important issue for innovation is the development of facilities and services so that partners in the cluster can find each other, get a good picture of the demands and have appropriate facilities to test innovative applications. The main services and facilities for the RS innovation cluster are: well-equipped test- and demonstration sites including a kind of central organisation that coordinates demo flights, an office or virtual desk for demands, aggregation of demands and transferring demands to research institutes and SMEs and a (virtual) desk or info point for questions about regulation and legislation in the different countries. In this work package the majority of the ICAReS partners will participate in workshops to outline and describe the conditions for these 3 facilities/services. They will also make an inventory of existing and planned test sites in the 2Seas region and describe the facilities of those sites, including what is missing.

In this WP all Project Partners and Observer Partners are involved. Based on these descriptions the partners LP, and PP2 will (further) develop the test- and demo-sites in their area. The LP will develop a central organisation to coordinate demo flights. The branch organisation PP10 will develop (virtual) offices/desks together with the branch/sector organisations in the other countries. In this activity PP10 will get support from LP, PP5, PP7 and PP11.

Activity A 2.2

There is a missing link between demanding sectors/end users on the one hand and developers of RS applications and data processors on the other. This is the reason why the RS sector has not achieve its expected growth and the end-users have not made use of the applications available.

In this activity an Impulse Group Demand will be set up to overcome this challenge, but also to come to critical mass for R&D.

Research setup

To gain insights in the demands by the four pilot sectors in the 2 Seas region the Impulse Demand Group will collect these from different sources. These different tools are, for example, reports from Activity 1.1., cluster conferences and articles in sector magazines. The aggregated demands will be linked to SMEs and research institutes with the question if they can fulfil these demands.

Methodology

Different communication channels with the remote sensing have been consulted to gain insight in the demands. Mainly, past reports from the ICAReS project, but also publications regarding the topic of remote sensing and verbal communications with end users during sector conferences. These aggregated demands are collected in this report.

The report with the aggregated demands will be communicated with SMEs and research institutes with the question if they can fulfil these demands.

Agriculture

General challenges of remote sensing in Agriculture

Since remote sensing in agriculture is still in a development phase there are only a few finalised applications that are becoming more generally used in the industry. For example, using a multispectral camera allows the user to map a field and create a normalized difference vegetation index (NDVI). This deviation map can be used as input for precision agriculture. With the right data set, programming skills and knowledge of the machinery this deviation map can be translated to an application map that for example can be used on a spraying machine. At this moment there are only a few service providers that provide the whole chain (going from flying to an application map usable by the implements). The development is mainly in these automations of decision-making algorithms to provide the correct advice.

Aggregated demands for Agriculture sector

Arable land

- **Automated disease detection and quantification by remote sensing.** Using remote sensing (RGB or multispectral), a field can be mapped to provide an overview of the whole field. From this overview image, a vegetation index map can be made. An algorithm to detect certain diseases, as well as the quantity and specific location, should be developed to help for automated analysing of these maps and provide advice to the farmer. And following this, even provide an application map that can be loaded onto an implement to automatically apply the right treatment in the field.

- **Automated weed detection and quantification by remote sensing.** Very similar to the above idea, but instead of detecting diseases or pests on the cultivated crop, it detects unwanted weeds between the crops. If the different kind of weeds can be detected by specie and quantity, then an application map can be made for precision mechanical and/or chemical weed control. Then, the necessary amount of the right treatment can be applied on a detailed zone or even plant level.
- **Yield determination as an input for future precision agriculture.** There are different ways to approach yield determinations, for certain crops it is already integrated in in the harvesters. But like stock management in quarries a height model could be used to determine yields based on location. In the next growing season this yield map could then be used for better field preparations or variable plant densities. At this moment it is possible, with the right equipment, to make a height model for a crop. Yet at this moment what is missing is the advice model to go from there.
- **Prescription maps as an input for current precision agriculture.** Remote sensing can be used to create variation indexes from fields. These variation maps should be translated to zone- or plant-level advice. Much like previous demands there is not yet an advice model and the translations have to be done by the farmer referencing the map with field checks. Also, if an advice model is in place the following link is to use the variation maps as input for implements, like spreaders or sprayers, to allow for zone- or plant-based adjustments during the growing season.
- **Variable plant density as an output from precision agriculture.** Using data from remote sensing from previous growing seasons or other sources as input for variable plant density. At this moment, the advice on what kind of remote sensing or input data to use for variable plant density is missing. Also, there are no good systems yet to use the advice input on a planting implement to plant variably.
- **Variable foliage killing by potatoes.** Before the potatoes are harvested the foliage of the potato plants is killed by spraying a chemical. The dose of the chemical can be variable depending on the volume of the foliage. After using remote sensing to create images, an application map can be made to apply the variable doses.

Livestock

- **Using remote sensing for localisation and/or counting of livestock, localisation of missing or immobile animals and conducting regular surveys of fencing.** Although loose images or maps can be checked and counted by the farmer, automation systems are not yet in place and there aren't many service providers offering this service.

Damage assessment

- **Using remote sensing for damage assessment for insurance claims.** Damage could be caused by animals or by weather, it is difficult to assess damage from the ground by manual measurements. Remote sensing from the air, by making overview maps, helps this progress but again the decision model is up to the end user. There is not an automated process in place that shifts normal from damaged parts in the field.

Fruit growing

- **Deploy protective measures for fruit growing.** Using drones deploy cables for protective facilities, for example hail nets, are flown over the orchard for the attachment to a special construction on the other side of the orchard.
- **Growth and height maps for fruit growing.** By combining 3D height maps of fruit trees and NDVI chlorophyll maps an application map can be created for variable cutting of roots to reduce growth of the fruit trees, to get a better balance between growth and production of the apple and pear trees.
- **Regulation of production of fruit trees by mapping the intensity of the flowering in the spring by remote sensing.** This could develop maps for chemical and/or manual fruit thinning. If there are too many fruits on a tree, the fruits will be too small during the harvest period and the tree doesn't make new flower buds for next year. This causes biennial bearing or alternate bearing.

Nurseries ornamental plants

- **To measure plant diameter in nurseries of ornamental plants.** In nurseries of ornamental plants, the plants are manual measured and selected in plant diameter. Ornamental plants are sometimes sold by different heights but some varieties by diameter. Most nurseries plant their propagated plants by GPS equipped machinery. By combining drone images with GPS raster, the diameter of the plants can be measured. An application map can be made for stock administration and as guide for the seasonal workers for digging up the trees or shrubs.

Nature

General challenges of remote sensing in Nature & Heritage

The use of drones, as well as other forms of remote sensing, is still considered to be in its infancy in the nature and heritage sectors. Its adoption falls well behind that in the agricultural, water and infrastructure sectors where its use is probably more commercially driven. Early adoption has generally been through academic and research institutes, where its use was identified as an adaptable tool to inform and support scientific work. However, many uses within the agriculture, water and infrastructure sectors are directly transferable to the nature and heritage sector, and there is now a growing demand to utilise these tools. This also means that the nature and heritage sectors present a significant area of growth that could develop rapidly and provides an opportunity that can be exploited commercially.

Aggregated demands for Nature & Heritage sector

- **Recording of archaeological sites and heritage buildings**. Photography, video, photogrammetry, and LiDAR are all methods that are used extensively within the heritage sector to collect and aggregate data on sites and structures that are of historical interest. LiDAR is a much sought-after form of remote sensing. However, on a landscape scale (when it is often needed for archaeology), it is expensive, time consuming and limited to being undertaken at certain times of year. It is often compromised when there are large amounts of vegetation, and expertise in its interpretation and understanding is limited. Other issues also include gaining flight permissions when surveying areas with crowded airspace, appropriate data processing skills.

  UAV mounted LiDAR is an under-used resource, but sensors are expensive and specialist processing skills are required.

  Photogrammetry is an extremely useful tool for archaeologists to support the visualisation and interpretation of features, but cost and training requirement tends to be an obstacle for its widespread use.

- **Habitat and vegetation management and monitoring.** UAVs provide a time and cost-efficient method of assessing plant communities. Whereas previously a protracted process of sampling on the ground was required, UAVs are enabling data collection at a much quicker rate. This is much better suited to broad vegetation types, and in the UK for example, identification down to National Vegetation Community level is still not possible. However, trials in Arizona (USA), the Hoge Veluwe (NL) and the Dutch Air Force, have proven that usable data can be obtained over a much shorter period than if ground surveys had been undertaken.

  The limitations are around accuracy, and there is considerable additional development required. For nature conservation purposes detailed species identification is required if it is to inform management for enhancing biodiversity, and much improved accuracy is required. Innovation is required to develop accuracy, and to test against conventional methods.

- **Monitoring change in landscape character.** Landscape character is defined as a distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another. It is shaped by multiple physical factors including geology, landform soil types and vegetation, but also includes the impact of people living on the land. Changes in landscape character are difficult to measure as they can occur over long periods of time and can also remain hidden. UAVs provide an opportunity to deliver a consistent and repeatable approach to recording and monitoring changes in landscape character, and therefore helping to identify early interventions that can prevent unwanted changes to it. Potentially this will be far superior to existing limited techniques such as fixed-point photography.

  Landscape scale photogrammetry also has the potential to aid the measurement of landscape character change. However, the cost of image acquisition and the equipment and expertise required to process the photographs remains an issue. There is evidence that costs are reducing, but on a landscape-scale UAVs are not able to cover the area required, and aircraft surveying remains the only viable option.

- **Delivery of targeted chemical treatment.** Within land management for nature, pest species (particularly invertebrates) can cause significant environmental damage. Species such as Oak Processionary Moth (OPM) can potentially defoliate an entire tree, putting it under severe stress and potentially causing its death. This can be most extreme in veteran and ancient trees. Blanket pesticide treatment for a pest species can also decimate all other invertebrates associated with the tree (e.g. oaks may support 350 different invertebrate species and over 30 different lichen species). UAVs could provide precision delivery of chemical treatment (potentially adapted from precision agriculture purposes) to minimise 'collateral damage' and ensure that a healthy invertebrate and bryophyte population is maintained. In addition, the development of drone use to identify and confirm infestations where environmental conditions make physical access for surveyors difficult.

- **Monitoring of water flow paths during flood events.** This has direct links to the water and infrastructure sector, but is a more specific application where consideration is being given to Natural Flood Management (NFM) and landscape-led responses to flood events. During flood events, water pathways can be varied, and the manner in which flows interact can be complicated. Computer modelling provides some data, but observation during actual events provides 'real-life' data that can inform, confirm, or dispute the modelling. UAVs capable of flying in more extreme weather conditions are required to be able to observe these flood events. They need to be able to fly during significant rainfall as well as during wind speeds that prevent use of conventional UAVs.

- **Tackling environmental crime with UAVs.** UAVs have been adopted by police forces in the UK as a way of tackling crime. Within the environment sector, new opportunities are available to support certain forms of environmental crime. This may include particular crimes such as illegal 4x4 driving in remote wooded areas (as experienced in Kent, UK) where the ability to deploy drones quickly when a crime is occurring would be beneficial. Close working with the police authorities to understand how these opportunities can be taken advantage of. There is some public resistance to the use of UAVs by the police, and they are closely controlled.

- **Animal population analysis.** UAVs are already extensively used for measuring animal movement and measuring population size. However, this is generally

limited to larger animals where manual counting of data captured is relatively easy. It is also often used in combination with other technologies where individuals have been tagged and are being monitored. One of the key limitations is through visual or sound contamination caused by the UAV. This may be caused by rotor noise which may change animal behaviour, or in the case of fixed-wing drones, may be interpreted as a predator. The result is that data collected may not be representative of the true animal behaviour. Consequently, the design of UAVs for nature conservation purposes may require specific design changes to minimise these impacts i.e. noise suppression, outline camouflage, avoidance of threatening flight trajectories etc.

- **Using UAVs to communicate environmental stories.** A key role in nature and heritage conservation is the 'telling of a story' and educating the public with what is being done and why. UAVs present an engaging way of communicating this story. Whilst a significant market has already developed around moving aerial imagery, the specialist knowledge required to do this for nature/heritage conservation is very limited (beyond specialist broadcasters). There is an opportunity to develop this area considerably and engage the public more fully with the sector.

Water & Infrastructure

General challenges of remote sensing in the Water & Infrastructure sector

Despite how far drone technology has come, there are still many challenges facing the industry. Today's professional drones for example have not reached the level of efficiency required to truly optimise inspection operations.

This is apparent in the short battery life and limited payloads that today's drones can carry. As far as battery endurance is concerned, the average professional drone can fly for approximately 30 minutes with a minimal payload.

Furthermore, for drones to complete a useful inspection that provides actionable data, they require high-end cameras as well as connectivity hardware, both of which add more weight and strain on battery life. These two significant factors, plus overall drone ease-of-use and weather durability (i.e. in harsh weather conditions) are preventing professional drones from making their full impact on the water and infrastructure sector.

Current regulations prevent drone pilots from utilising Beyond Visual Line of Sight (BVLOS) capabilities. This means that drones can only be flown as far as the pilot can see them. Integrating drone powered solutions into the operational processes of the water and infrastructure sector will face other challenges:

- National aviation authorities, together with private companies, have to develop a complex air traffic management system for drones to prevent collisions with other aircraft. Such systems have to allow drones to see and avoid other aerial vehicles and potential obstacles, as well as communicate with air traffic controllers. In addition, the systems have to be integrated with air traffic management systems for manned aviation from other countries to guarantee an undisturbed, fast flow of information.

- Privacy is another concern expressed in the context of drones. Drone operators perform flights over various types of sites, collecting a vast amount of data, sometimes including confidential or sensitive information about private property or behaviour. There are no clear rules, or even guidelines, on how companies should store data, what types of data should not be collected, or how individuals and companies can defend their privacy rights. The uncertainty regarding possible use of data gathered by drones may discourage companies from implementing drone-powered solutions.

Aggregated demands for Water & Infrastructure sector

1. **Functional deployment of drone images for monitoring flood control areas:** Based on the validated photogrammetric products, the functional availability to monitoring of the dynamics in topography of the test areas should be checked. This work package should be done in close cooperation with PP12 in order to arrive at the desired product on the basis of a few examples.

2. **Functional deployment of R&D image processing techniques on drone images for the analysis of studying possible seepage zones:** Very specifically, there is the question to investigate the possibility of certain sensors and platforms and linked image processing being eligible for the identification of seepage zones in areas to be determined (e.g. dikes).

3. **Dike inspection with remote sensing:** For the application of remote sensing, a number of locations are identified in consultation with Waterboard Brabantse Delta. Some of these locations may already be in the "Drone practise area". The aspects to be examined are:
   - Drought cracks.
   - Holes caused by drought, rabbits, or something else.
   - Determine the size of fauna bunkers and other characteristics of the dike.
   - Monitoring deformation of the dike.
   - Survey to detect the presence of water bubbles in dikes.
   - Survey to detect the presence of invasive exotics such as the "Giant Hogweed" in the dike vegetation.
   - Detection and determination of quantities and locations of thistles, nettles, and sorrel.

4. **Survey of mowing maintenance:** By means of drone flights, the survey of mowing maintenance, which is carried out by the waterboard or third parties. The main benefit is that fewer man hours are needed.

5. **Detection and inspection of pressure pipeline routes:** By means of drone flights, the inspection of pipeline routes and the detection of leaks. This can be done with, for example, thermal images. Especially in flood defences, critical locations can be visualised in advance.

6. **Cable works in high voltage networks:** Using drones, high-voltage power lines are transferred between the electricity pylons. Elements such as rivers, canals, but also roads and railways are no longer an obstacle. A drone can be a cost-efficient tool to bring a first line across. A drone may fill a gap between a line gun and a helicopter.

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