INNOVATION CLUSTER ACCELERATING REMOTE SENSING

D 3.1.2.

D.3.1.2. Overall action plan for the selected sectors

(Nature & Heritage, Agriculture and Water & Infrastructure)

2S02-032 ICAReS

Tel+31 164 611 360

Postbus 24, 4630 AA, Hoogerheide,
The Netherlands

www.projecticares.eu
Icares@woensdrecht.nl

Content

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

ICAReS

Common challenges

The 2 Seas area has challenges regarding innovation and environment, like to strengthen innovation by more R&D and exploitation opportunities, climate adaptation, preservation biodiversity and natural resources. Agriculture, nature and water are 3 major sectors in the 2 Seas area. Just these sectors faces these challenges and need innovations to tackle. More use and development of Remote Sensing (RS) and data processing will create solutions to face these challenges and will also improve efficiency of these sectors. Obstacles to use RS are: lack of knowledge/awareness of the possibilities of RS, RS SMEs are not fully aware of the role they can play, a lack of suitable test/demo locations and unclear policy on legislation on the use of drones for RS. Challenges are: aggregation of sector demands, translation to RS SMEs and knowledge institutes, sites for demonstrating (new) RS applications, harmonisation of legislation/regulations and a structure (durable cluster) to work together on these issues.

Overall Objective

To develop a cross border innovation cluster and create the necessary conditions for innovation in the field of remote sensing and advanced data communication & processing, based on needs of priority sectors nature, agriculture and water & infrastructure. A durable innovation cluster will lead to the following benefits: cross border cooperation in these sectors to come to aggregation of demand, acceleration of creation of innovative remote sensing products & services, substantial use of remote sensing and improved business operation in these sectors, clarification of different national legislations, and a joint lobby for better regulations to create business opportunities.

Summery Workpackage 3

Based on the information gathered in work packages 1 and 2, the RS innovation cluster will develop two strategies and two action plans within this work package 3. One of the strategies and action plans is about the further innovation and usage of RS technologies in selected sectors, first per sector and then of the 3 selected sectors together. The focus of these actions is not only to explore new opportunities for innovative applications based on the aggregated demands, but also to strengthen the cluster itself. Another main issue is to develop a strategy and action plan for harmonisation of legislation and regulation in the 4 MS and if possible in the whole EU. The partnership realises that this isn't an easy job and that they will not achieve such a harmonisation in the time of this project, but the action plan of this strategy will also be executed beyond the end of the project. A third issue to be investigated in this work package is if there are other interesting sectors with demands for solutions that can be provided by the RS and data processing sector. An inventory will be made within different branches/sectors and if there is such a demand in specific sectors also for these sectors a concept strategy and agenda will be developed.

Activity A 3.1

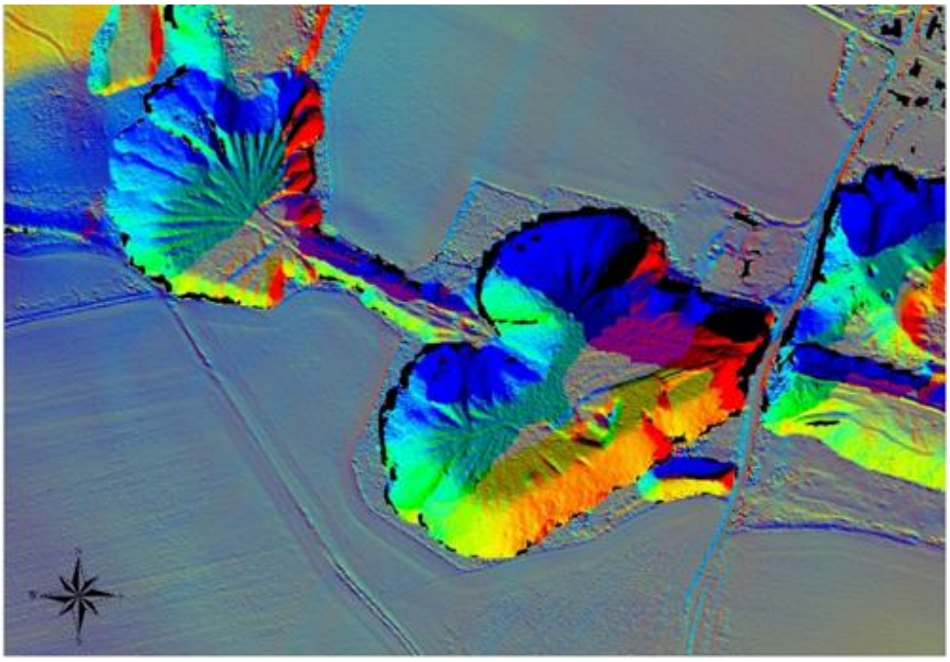
Based on the information gathered in WP1 and WP2, the RS innovation cluster will develop action plans about further innovation and usage of RS technologies in selected sectors, first per sector and then of the 3 selected sectors together. The focus of this activity is not only to explore new opportunities for innovative RS-applications based on the aggregated demands, but also to strengthen the cluster itself.

Research setup

Based on the information gathered in the masterclasses (D3.1.3) meetings, conferences, demonstrations, actions of the Impuls Group Demand, on-line and further discussions, the RS innovation cluster will develop three actions plan (D3.1.1.) about further innovation and usage of RS technologies in selected sectors agriculture, nature, water & infra.

Methodology

Different communication channels about remote sensing have been consulted to gain insight in the demands and translate them to actions. 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 and other meeting. In addition, the feedback from the masterclasses was taken into account. These aggregated demands were collected and in this actionplan translated to chances and actions.



Nature & Heritage

Action Plan for Remote Sensing in the Nature and Heritage sectors

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 found 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 recognition of the benefits of their use and increasing 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.

Unlike the agriculture, water and infrastructure sectors, the nature and heritage sectors tend to be dominated more by the public sector (both national and local government) along with the charitable and voluntary sectors. This means that cost is the most significant limiting factor and has prevented widespread adoption. This applies to the purchase of appropriate and capable drones as well as the use of other airborne remote-sensing techniques such as LiDAR and photogrammetry. Ground-based RS techniques have been adopted more widely within the heritage sector, and have been ground-breaking for archaeological recording and evaluation. Airborne LiDAR at a landscape-scale has been a much sought-after tool for landscape archaeologists, but costs for this have largely been prohibitive (although prices are noticeably reducing).

Open-source remote sensing data has provided much of the information available to this sector, although the production of this has been for other purposes e.g. LiDAR data for flooding models. However, Earth Observation Satellite information has historically been the main source of remote sensing data for many ecologists.

As with the other sectors that are the focus of the ICAReS project, regulatory control does limit the use of drones. Limitations in use that is 'Beyond Visual Line of Site' prevents effective use for some species observation where the focus of study is highly mobile (for example animal species) and may also prevent their use in complex or heavily vegetated landscapes.

The nature of the landscapes that are the focus of the ICAReS area (i.e. generally either in or close to large urban populations) also causes issues with data capture. Remote sensing techniques using manned aircraft mounted sensors can result in data capture being severely impeded by air traffic control restrictions, particularly in busy airspace around large airports. This can add significant cost or delays to data capture.

Similarly, as with all other sectors that are the focus of ICAReS, privacy concerns (particularly in the context of drone use) remains high on the agenda. Mainly as a consequence of a lack of regulation in the early days of drone use and a subsequent exponential growth particularly for domestic use, there considerable suspicion amongst the public where drones are used, the purposes for which they are being used and how the data that is collected is retained and managed.

The drone industry is becoming much more regulated, but with this regulation there is a danger that innovation in their use is being stifled and preventing the potential for this and other remote sensing techniques from being fulfilled.

Objectives for the Nature & Heritage Sector

1. Facilitating more cost-effective collection of good quality/high resolution aerial LiDAR and photogrammetry data to inform interrogation, exploration and understanding of the historic landscape. Improve advice and guidance available to enable that data is processed and analysed to maximise its use in this area.

2. Greater understanding of the ability and potential efficiency of using remote sensing to assess and monitor change of ecosystem services provided by natural areas (for example measurement of temperature regulation, carbon sequestration, flood prevention and soil health.

3. Investigate how the use of drones can be developed and enhanced for the delivery of targeted chemical treatment control invasive and pest species that threaten native biodiversity.

4. Develop the use of drones to monitor and record water flow paths during flood events, testing the resilience of remote sensing hardware to operate in challenging weather conditions and provide usable data in real time.

5. Developing the effective use of a range of remote sensing techniques to measure and monitor change in landscape character over time. Landscape character is created by the unique combination of elements and features that make landscapes distinctive. It is influenced by a combination of several factors, generally occurs over a large area and can change of a long period of time. New forms of remote sensing can play an effective role in measuring that change to inform future management and interventions.

6. Developing improved techniques for using drones to monitor vegetation habitats/communities and their management at a landscape scale, assessing fragmentation of habitats, and determining forest health and structure. Accurate monitoring of vegetation communities is generally undertaken by ecologists in the field. However, drones have the potential to provide effective monitoring of the impact of large-scale habitat restoration and management by replicating imagery over long time periods.

7. Developing the effectiveness of drones and other RS techniques to measure fauna population size, distribution and movement, particularly 'difficult to measure' and highly mobile species such as bats.

8. Increasing the availability of open source remote sensing data. Remote sensing data is increasingly being made freely available to others, but is hindered by the formats and mechanisms for sharing to a wider audience.

9. Increasing the use of remote sensing technologies to enable members of the public to understand and engage with the natural and historic environment. Film footage collected by drones has become a mainstay for natural history programming and communicating the natural and historic environment to the public. However, there is a role for making

this technology and associated skills to collect it, more widely available and at a more accessible price point.

10. Developing the use of drones and other RS techniques to monitor visitor numbers, distribution and use at recreational sites in the countryside. Visitor pressure can put pressure on biodiversity and infrastructure at such sites and improving data quality and quantity enables better management of these pressures.
11. Developing hardware that can deliver the specific needs of the nature sector particularly in relation to noise suppression, not creating disturbance to sensitive species and not inadvertently changing the behavior of species being monitored.

Planned Actions for the Nature & Heritage Sector

1. **Facilitating more cost-effective collection of good quality/high resolution aerial LiDAR and photogrammetry data to inform interrogation, exploration and understanding of the historic landscape. Improve advice and guidance available to enable that data is processed and analysed to maximise its use in this area.**

Action

PP8 (Kent County Council) through the Kent Downs Area of Outstanding Natural Beauty Unit and its Darent Valley Landscape Partnership Scheme has undertaken a landscape-scale LiDAR of a significant area (approximately 200km^2). It is using this experience to develop a guidance and advice framework for others intending to collect remote sensing data for the same purposes. In particular, it will identify the issues that can arise for data collection including weather conditions, flight clearance issues, ensuring correct specifications are formulated, and how the data can best be interrogated post-collection. This will include the use of members of the public to analyse and 'ground-truth' data.

Benefit

Future users will be better informed and have clearer guidance on commissioning remote sensing surveys that provide the data that is required and is 'fit-for-purpose'. They will be better informed about the issues that may arise and how to overcome them.

Lead/support

PP8 Kent County Council will lead with other external partners.

Timeframe

2019 Results will be available within the operating timeframe of ICAReS.

2. **Investigate how the use of drones can be developed and enhanced for the delivery of targeted chemical treatment control invasive and pest species that threaten native biodiversity.**

Action

PP8 and other ICAReS partners to examine if there are transferable technologies from particularly the agricultural sector that could be applied to the context of this issue. PP8 to develop relationship with the Oak Processionary Moth Working Group in the UK to examine

the feasibility of developing a drone based response to an infestation if it were to occur (as well as assessing if an infestation has occurred) on highly sensitive and important veteran trees.

Benefit

This is an area that has not been extensively studied and provides a potential new commercial opportunity. Currently, there is no suitable and effective response to dealing with biological pest species occurring in highly sensitive habitats with significant biodiversity importance. Current responses are blanket spraying of infected areas and drones present a potential precision response that could minimise collateral loss of biodiversity.

Lead/support

PP8 working with other ICAReS partners including PP6 TerraDrone, PP7 ZLTO, PP11 ILVO and other external partners.

Timeframe

2020 onwards.

3. Develop the use of drones to monitor and record water flow paths during flood events, testing the resilience of machinery to operate in challenging weather conditions and provide usable data in real time.

Action

PP8 with the support of PP6 is testing the only current drone model capable of flying in the poor weather conditions associated with flood conditions (DJI Matrice 200). An assessment will be undertaken of the needs of equipment to support this type of work . This can be informed by the experience of other ICAReS partners, to support ongoing innovations in drone design.

Benefit

Within the nature sector, the conditions under which remote sensing is required to take place can be quite testing. Outcomes from this objective will inform future specialized drone design for this sector and provide a more suitable product for users.

Lead/support

PP8 and PP6

Timeframe

2020 but likely to extend beyond the life of ICAReS as further data is collected.

4. **The effective use of remote sensing techniques to measure and monitor change in landscape character over time.**

Action

PP8 is using a combination of remote sensing techniques to create a framework for the long-term measurement of change in landscape character in the Darent Valley area of the Kent Downs AONB. This will be the baseline for measuring change over future years. PP8 will work with PP6 to undertake a photogrammetry survey and combine this data with that derived from the airborne LiDAR and InfraRed data, and imagery captured through drones to build a picture of landscape character that can be replicated in future years.

Benefit

Methods for measuring landscape character change have remained largely the same for a long period of time. Remote sensing technologies present an opportunity to provide a more cost-effective, replicable and evidence driven method for doing this. This action will provide a model that could form the basis for a new model for landscape character monitoring that can be applied elsewhere within the 2 Seas region.

Lead/support

PP8, PP6 and other ICAReS partners and other external partners.

Timeframe

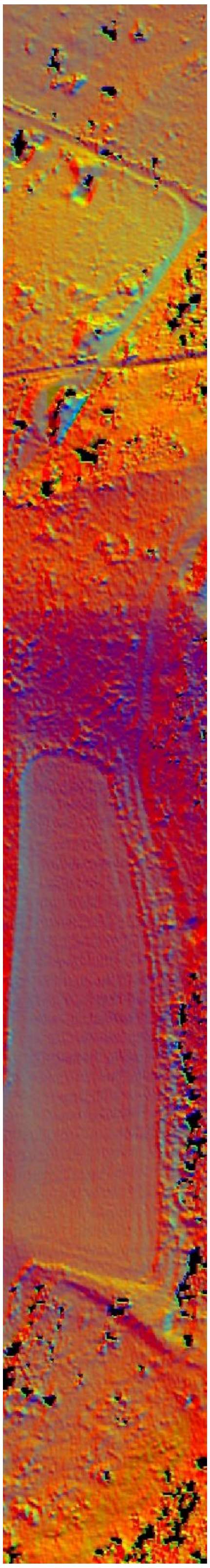
Initial model produced in 2019 but ongoing and application after ICAReS is complete.

5. **Developing improved techniques for using drones to monitor vegetation habitats/communities and their management at a landscape scale.**

Action

PP8 will work with other ICAReS partners to share and explore what the requirements are for developing drone use in this part of the sector. A training provision will be made to develop drone use and assess the specific requirements of partners in the nature sector. PP8 will develop its use on the mosaic of sites being managed through its Darent Valley Landscape Partnership Scheme to demonstrate the application of these techniques.

Benefit



More effective measurement of habitat and landscape management, with quicker, clearer and evidenced feedback to assess if management practices are providing the required outcomes.

Lead/support

PP8 and PP6.

Timeframe

Through 2019 and beyond

6. Increasing the availability of open source remote sensing data.

Action

PP8 will pilot a web-based portal to test the the functionality of enabling members of the public and partner organisations to access, interpret and provide feedback on the data from its completed LiDAR survey of the Darent Valley.

Benefit

This will provide the opportunity for a much wider audience to be able to access the data, interrogate it and also provide feedback. This will provide greater particpation in the use of remote sensing data as well as enabling more rapid sector development.

Lead/support

PP8

Timeframe

2019/20

7. Increasing the use of remote sensing technologies to enable members of the public to understand and engage with the natural and historic environment.

Action

PP8 will utilise wide range of remote sensing technologies to pilot interpretative techniques communicating the importance of the natural and heritage features of the landscape in the Darent Valley. It will explore how these can be best used by sharing and working with other partners in this field in the 2 Seas area.

Benefit

Whilst physical conservation of the natural and historic environments, communication of their importance and the work being undertaken builds momentum and support for this work. People will only protect what they value, and information gained from remote sensing provides an opportunity to communicate this in an interesting and engaging manner.

Lead/support

PP8, PP6 and other ICAReS partners and external partners.

Timeframe

2019 and beyond.

8. Development of sector specific forum to influence the continued development of hardware and techniques that address the particular requirements

Action

The influencing, development and amalgamation of existing fora and clusters to continue the development of the machinery and techniques required within the nature and heritage sectors. This can build on the work developed in the UK around protected landscapes and within the other member states concerning nature conservation and management, as well as other groups that currently operate separately to the ICAReS project.

Benefit

The equipment (particularly related to drones) has not been designed specifically for the nature sector. Currently drones designed principally for infrastructure monitoring are being used, and whilst they represent considerable improvements over traditional monitoring techniques, are not entirely suitable. By supporting the ongoing development of existing fora, there will be increased influence on equipment providers to to provide drones that fulfil the requirements of reduced noise and disturbance for lower profile use. Recognition of this potentially significant market presents a business opportunity for an equipment supplier to cater for the sector's needs.

Lead/support

All ICAReS partners and external partners will be involved in this.

Timeframe

Long term - 2020 and beyond.

Agriculture

Actionplan remote sensing in the Agriculture sector

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 allow to map a field to create a normalized difference vegetation index (NDVI). This deviation map can be used as input for precision agriculture. Although with the right background, 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 automation of decision making algorithms to provide the correct advice. In this actionplan several objectives are mentioned to be set up in the near future.

Objectives for the Agriculture sector

Arable land

1. Automated disease and pest 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 can be a vegetation index map can be made. An algorithm to detect certain diseases or pests, as well as in quantity as location, should be developed to help for automated analysing of these maps and provide advice to the farmer. And following even provide an application map that can be loaded onto an implement to automatically apply the right treatment in the field.

2. Automated weed detection and quantification by remote sensing. Very similar to above but instead of detecting diseases or pests on the cultivated crop it's focus is on detecting 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. As to apply the necessary amount of the right treatment on a detailed zone or even plant level.

3. 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 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's possible, with the right equipment, to make a height model for a crop. Yet at this moment what's missing is the advice model to go from there.

4. 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 translation have to be done by the farmer refencing 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.

5. 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 allow to use the advice input to have a planting implement plant variable.

6. Variable haulmkilling by potatoes. Before the potatoes are harvested the haulm 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 remote sensing images an application map can be made to variable doses.

Livestock

7. 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

8. Using remote sensing for damage assessment for insurance claims. Damage could be caused by pests or by weather, it's 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 isn't an automated process in place that shifts normal from damaged parts in the field.

Fruit growing

9. 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.

10. 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.

11. Regulation of production of fruit trees by mapping the intensity of the flowering in the spring by remote sensing. This to develop maps for chemical and/or manual fruit thinning. If there are too much fruits on a tree, the fruits will be to 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

12. Counting plants and 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 also 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.

Plant-breeding and seed companies

13. Counting seedlings or young plants. For plant-breeding and seed companies it is important to follow up the germination of their seeds. With a high resolution camera germinating seeds can be counted. The speed and numbers of germination is a qualification for the quality of the seeds.

Planned actions for the Agriculture sector

Arable land

1. **Automated disease and pest detection and quantification by remote sensing.**

Introduction

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

Action

The agriculture sector has a broad variety of crops with there own specific pests and diseases. In several research and knowledge institutes in the 2 seas area there is various range research on automated detection and quantification of pests and diseases. For example:

-Detection of fungal diseases in potatoes (e.g. ILVO (PP11) and KULeuven)

-Detection of virus diseases in potatoes (e.g. WUR)

-Detection of fire blight (bacterial disease) in pears (e.g. PCFruit and VITO (OP01), SALK-project)

-Detection of powdry mildew (fungal disease) and thrips (pest) in strawberries (e.g. REWIN (PP05), ZLTO (PP07), CLTV, Proefcentrum Hoogstraten and Polarix)

-Detection of Suzuki-fruitfly in softfruit (e.g. WUR)

Field research on potato diseases at ILVO

Benefit

Scouting in the field for diseases and pests is a time-consuming task. This can be automated by using remote sensing and deeplearning camera's who can determine the disease or pest attacking the crop. By using autonomous flying RPAS, for example a drone-in-a-box, the field can be daily scouted for diseases and pests.

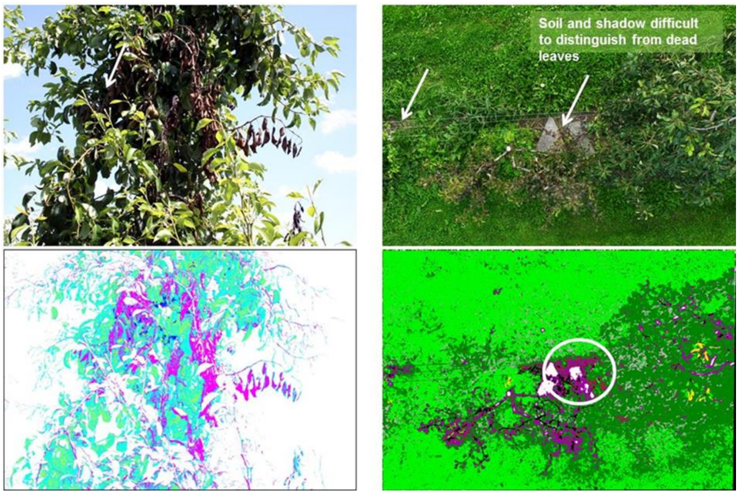
Lead/support

ILVO (PP11) and KULeuven for detection of fungal diseases in potatoes and REWIN (PP05), ZLTO (PP07), CLTV, Proefcentrum Hoogstraten and Polarix for detection of powdry mildew (fungal disease) and thrips (pest) in strawberries.

Timeframe

At the same time as the ICAReS project started the research for detection of fungal disease by remote sensing started at ILVO (PP11). Within the timeframe of the ICAReS project the first results will be presented.

At the end of 2018 REWIN (PP05) and ZLTO (PP07) set up a research project for detection of powdry mildew (fungal disease) and thrips (pest) in strawberries with Polarix a deeplearning hyperspectral sensing technic together with CLTV, Proefcentrum Hoogstraten and Stichting Aardbeienonderzoek. Within the timeframe of the ICAReS project the first results will be presented.



Detection of fire-blight in pear trees, SALK-project PCFruit and VITO (OP01)

2. **Automated weed detection and quantification by remote sensing.**

Introduction

Very similar to above but instead of detecting diseases or pests on the cultivated crop it's focus is on detecting 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. As to apply the necessary amount of the right treatment on a detailed zone or even plant level.

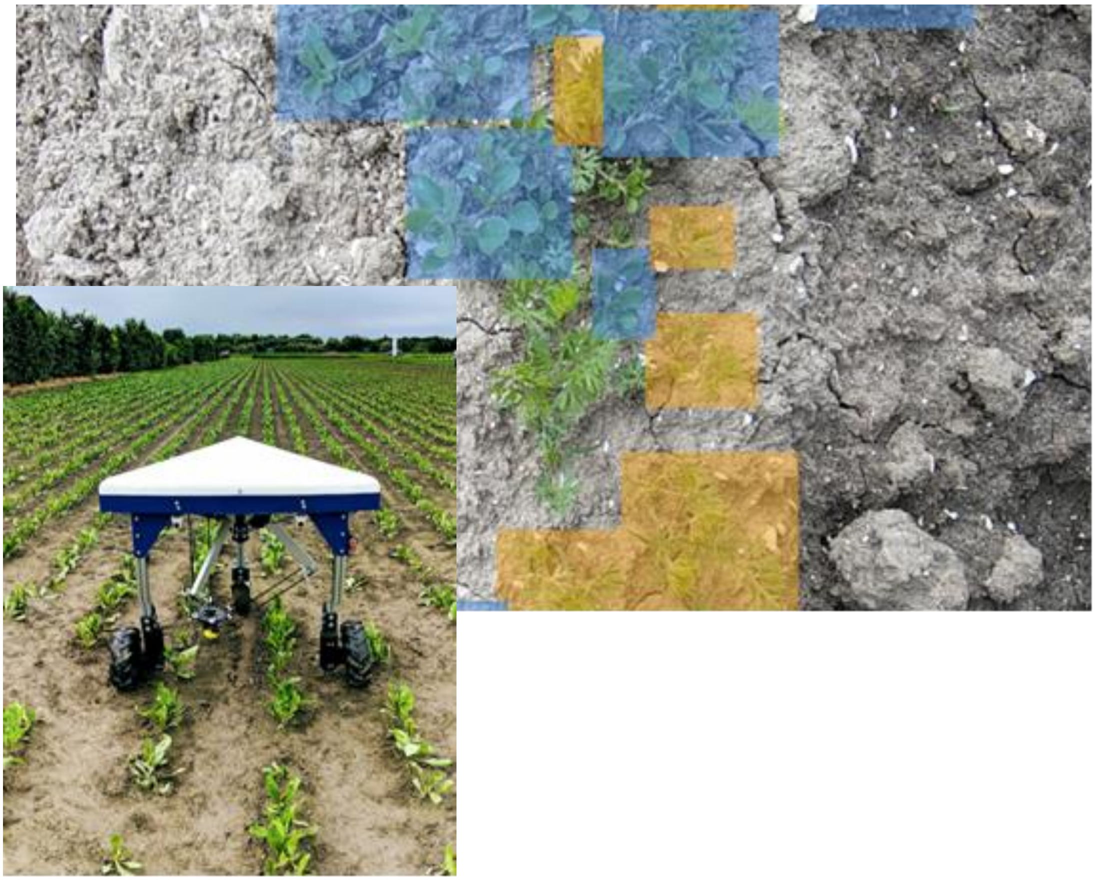
Action

Collecting data from fields in a realistic state in which they normally get treated, on this data develop computer algorithms that automatically detect, quantity and specify the weeds in the image. Once that is possible on single images then they must be location tagged to allow for treatment. In case of spray booms the recognition to treatment has to be optimised to allow treatment while collecting data.

At this moment during this years growing season data has been collected to start developing the automated detection algorithm.

Corn field with weeds, left image from drone, right image from spray boom

A start-up in the Netherlands is Odd.bot. They are developing a autonous weedrobot with a spectral camera to detect weeds between a crop. In the OPZuid project 'Proeftuin voor Precisielandbouw' a demonstration was organized for farmerson on the 6th of June 2019. ICAReS is via ZLTO connected with this OPZuid project.


Source: Odd.bot

Benefit

Reduced needs of spraying volume.

Lead/support

ILVO (PP11) and UGent together with other partners (like Robovision) in the Smart Agri Hubs Flagship Innovation Project about weed dectection in fields.

Timeframe

This ILVO project runs over multiple years with its start in 2019.

3. Yield determination as an input for future precision agriculture.

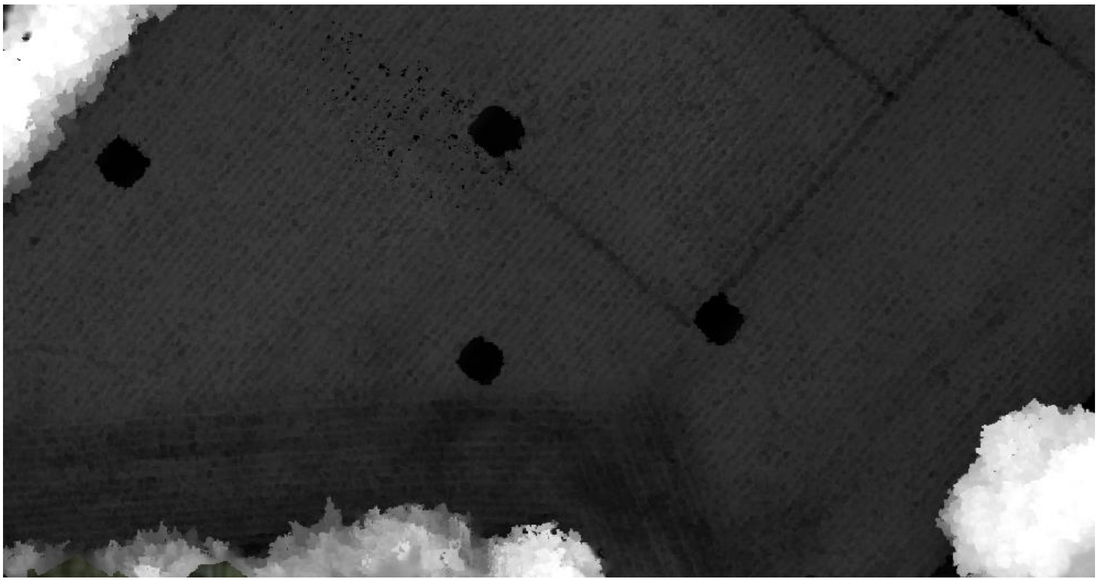
Introduction

There are different ways to approach yield determinations, for certain crops it is already integrated 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's possible, with the right equipment, to make a height model for a crop. Yet at this moment what's missing is the advice model to go from there.

Action

Experimental trails should be setup on existing field to see if yields can be normalised, having the same yield across the field, over multiple years. By using this years yield or height model for next years variable plant density. And then collecting yield data or height model data that year to determine if this technique is an improvement.

For example in the following height model the corn field is surrounded by trees, it's is visible that the corn in close proximity to the trees is less developed.



Height model from experimental corn field

Benefit

By taking good decisions there is a financial gain.

Lead/support

There is currently none working on this topic, there is not a running project

Timeframe

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4. Prescription maps as an input for current precision agriculture.

Introduction

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 translation have to be done by the farmer refencing 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.

Action

By scanning the field and therefore the soil, it is possible to variate in doses of soil herbicides, it is also possible that by scanning the foliar there can be made some conclusions about the growth of that particular crop. It is a misunderstanding that every element can be scanned and made into an fertilizer prescription map. The knowledge gap by agronomists and technicians is for the moment to big.

Benefit

By various dosses the farmer can save chemicals. This is good for the environment and for economical costs for the farmer. This application is a good example of precision farming or smartfarming.

Lead/support

Bioscope, Dronewerkers, Vantage Agrometius and others.

Timeframe

During the start of the ICAReS project this application came available for the farmers. There should be noted that, there is a lag in knowledge in understanding the data and translate that into direct actions for the farmer. The agronomist of the future becomes an expert in data reading.

5. Variable plant density as an output from precision agriculture.

Introduction

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 allow to use the advice input to have a planting implement plant variable.

Action

At the moment there are various systems, which can map the soil. The density of the soil makes a huge difference in the way the potatoes could be planted. The yield and the quality are hugely depending on the stems per hectare. This system could also be copied to other crops, from our information there isn't a lot of information and knowledge available.

Benefit

The benefits for the farmer are obvious, a better yield per hectare in combination with better quality. Should make more profit for the farmer.

Lead/support

Dronewerkers, bioscope and WUR

Timeframe

During the start of the ICAReS project this application came available for the farmers.

6. Variable haulmkilling by potatoes.

Introduction

Before the potatoes are harvested the haulm 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 remote sensing images an application map can be made to variable doses.

Action

Wageningen University and Research developed an online application and an app to translate the vegetation index of the leaves of potato plants to an application map for haulmkilling. If there is a natural dieback of the leaves or a lower volume of the leaves there is less chemical needed to kill the haulm. The haulm has to be dead before the potatoes can be harvested.

Benefit

By various dosses the farmer can save chemicals. This is good for the environment and for economical costs for the farmer. This application is a good example of precision farming or smartfarming.

Lead/support

Wageningen University and Research

Timeframe

During the start of the ICAReS project this application came available for the farmers.

From collected data by remote sensing Weighted Difference Vegetation Index (WDVI) to an application map for haulmkilling in potatoes by Reglone

Livestock

7. Using remote sensing for localisation and/or counting of livestock, localisation of missing or immobile animals and conducting regular surveys of fencing.

Introduction

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.

Action

Using drone made images (like thermal images) to easily detect cattle. Detection algorithms have to be made to do this in an automated way. In case of missing or immobile animals a live video with watching operator or pilot should allow for fast localisation as the colour difference

Thermal image of a cow in a field.

Benefit

Prevent financial losses.

Lead/support

-

Timeframe

-

Damage assessment

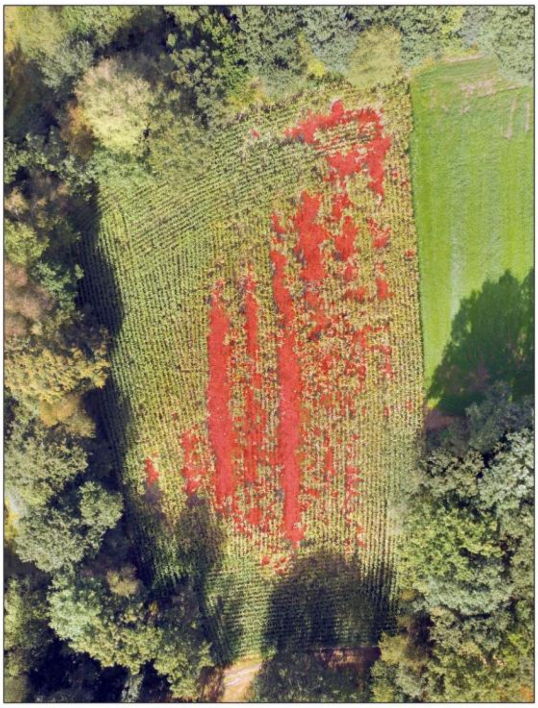
8. Using remote sensing for damage assessment for insurance claims.

Introduction

Damage could be caused by pests or by weather, it's 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 isn't an automated process in place that shifts normal from damaged parts in the field.

Action

Visualising and mapping economical damage made by boars has been done and proven by Anneleen Rutten (UAntwerpen/INBO) during her doctorate.



New method utilises a drone to measure crop damage fast, automated and objective.

Benefit

From the side of a corn field it's hard to see the damage, an objective assessment is difficult to perform.

Lead/support

Anneleen Rutten (UAntwerpen/INBO)

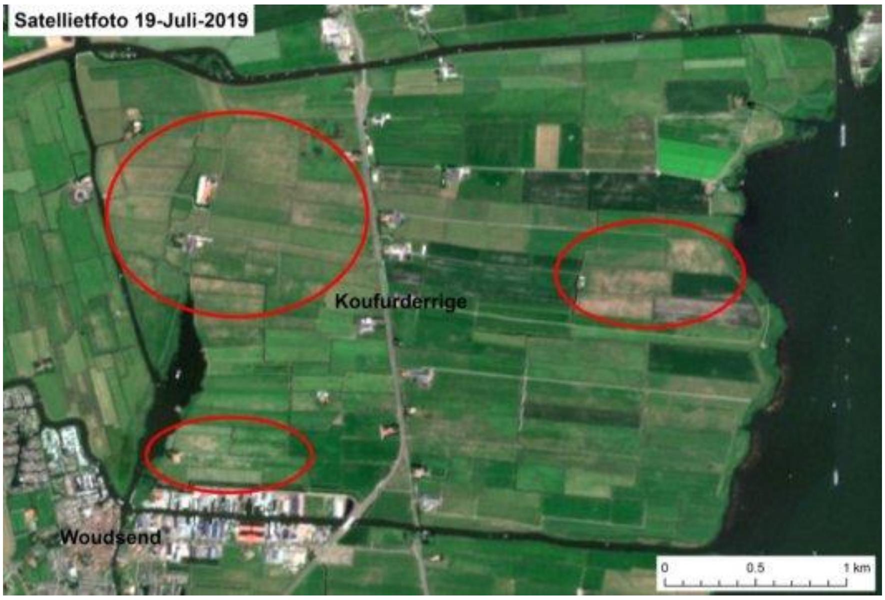
https://www.uantwerpen.be/popup/nieuwsonderdeel.aspx?newsitem_id=3115

WUR is working in the Netherlands together with an insurance company to detect damage in meadows caused by mice.

Timeframe

The UAntwerpen/INBO research is finalised

The WUR research is still in progress



Detecting mice by satellite images in the Northern province Friesland in the Netherlands in meadows. In the red circels the grass died back.

Two meadows, above the ditch the mice are killed by a water treatment and the meadow below no treatment against mice. Image by drone.

Fruit growing

9. Deploy protective measures for fruit growing.

Introduction

Using drones deploy cables for protective facilities, for example hail nets, raincovers, are flown over the orchard for the attachment to a special construction on the other side of the orchard.

Action

GEO Infra (PP04) and ZLTO (PP07) want to set up a fieldtest to deploy cables of hailnets above fruittrees.

Benefit

Now employees has to bring the cables over the rows, especially in hedge systems like the V-shape hedge for pear trees, it is very labour intensive. By using drones it is possible to save a lot of time.

Lead/support

GEO Infra (PP04) and ZLTO (PP07).

Timeframe

Winter 2019-2020.

A lot of labour is necessary to deploy cables of hailnets above fruittrees.

10. Growth and height maps for fruit growing.

Introduction

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.

Action

In 2017 and 2018 Delphy team Fruitgrowing and Aurea Imaging tested the combination of 3D height map of fruit trees and NDVI chlorophyll map to create an application map for variable cutting of roots of the fruittrees. This technic and advice is introduced in the spring of 2019 to the fruitgrowers. The first practical results will be presented before the end of the ICAReS project.

Benefit

For an equal production of good quality fruit the growth of the fruittrees has to be in control. Fast growing trees doesn't produce a good quantity and quality of fruits, therefor growers reduce the growth by pruning the roots with a colter behind the tractor. This for a better balance between growth and production of the apple and pear trees.

Pruning the roots with a colter behind the tractor.

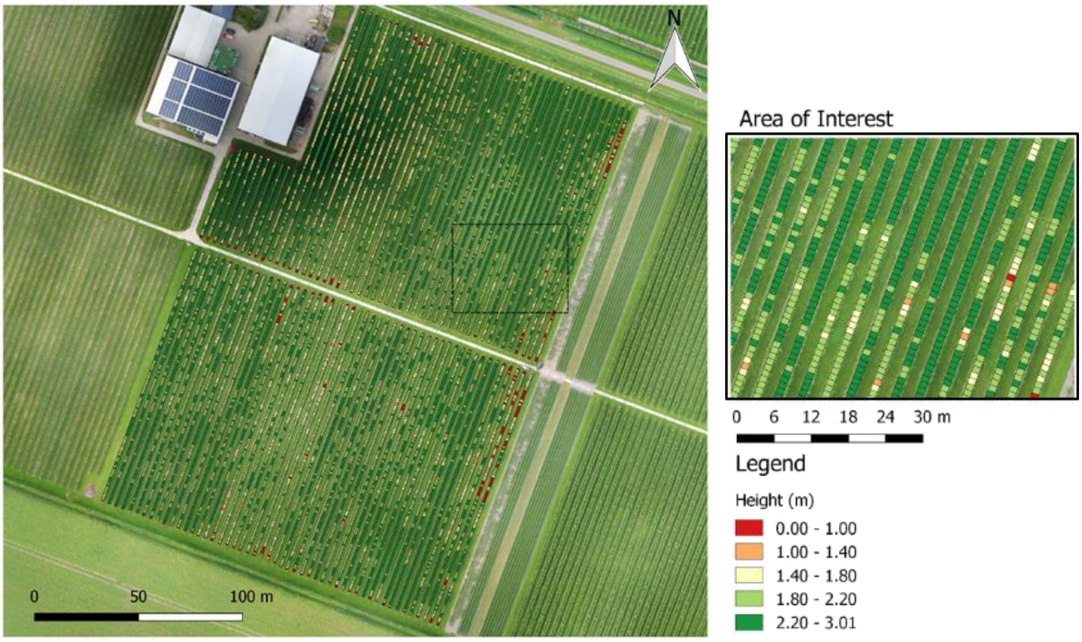
The colter can varies in dept and distance to the tree

Lead/support

Delphy team Fruitgrowing and Aurea Imaging developed and tested the combination of 3D height map of fruit trees and NDVI chlorophyll map to create an application map for variable cutting of roots of the fruittrees. ZLTO (PP7) supported some of the trials via the Interreg Vlaanderen-Nederland project Intelligenter Fruit Telen IFT (Intelligence Fruit Growing). Some of the test are done in the Fruit 4.0 project of Wageningen University and Research and Experimental garden Randwijk (PPO Fruit)

Timeframe

This application is introduced in the spring 2019 and the information is further spread by the ICAReS project in meetings with groups of fruitgrowers.



Map of height and growth of pear trees

11. Regulation of production of fruit trees by mapping the intensity of the flowering in the spring by remote sensing.

Introduction

This to develop maps for chemical and/or manual fruit thinning. If there are too much fruits on a tree, the fruits will be to small during the harvest period and the tree doesn't make new flower buds for next year. This causes biennial bearing or alternate bearing.

Action

ZLTO (PP07) is also partner in the Interreg Vlaanderen-Nederland project Intelligenter Fruit Telen (Intelligence Fruit Growing). This project started in januari 2018, together with observing partner VITO (OP01), PCFruit (Research Station for Fruit Growing in Belgium), Fleuren Boomkwekerijen (Fruittree Nursery) and Xroads (ICT). In this project mapping by remote sensing of an orchard is tested. Can remote sensing technics used on arable land also be used in orchards or are other technics needed, cause of the height of the trees, f.e. 3D lidar.

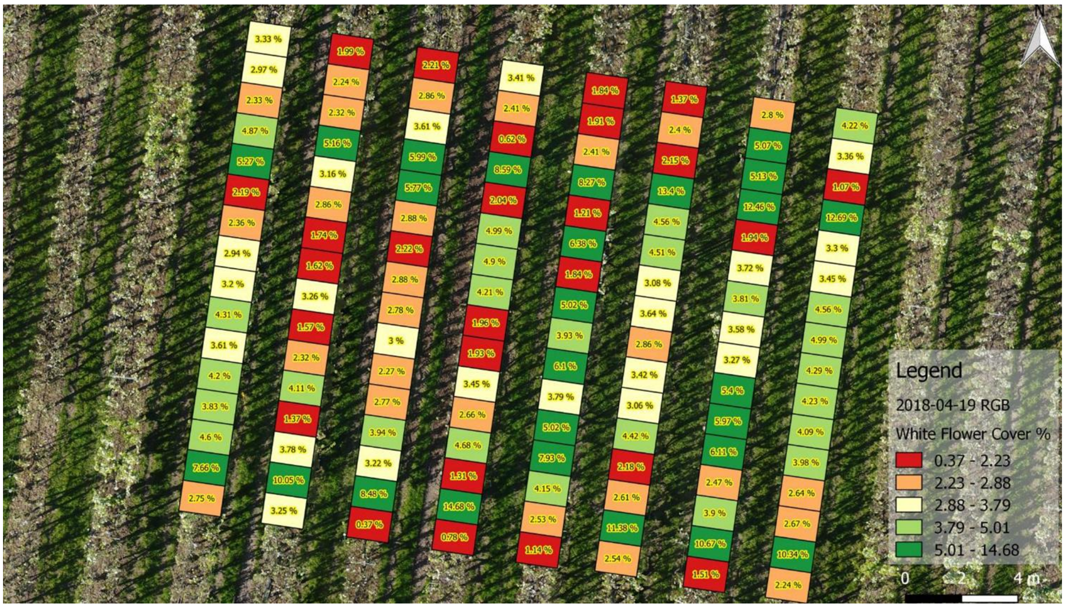
One of the first tests is done on counting flowers during the bloom of the fruittrees. If all flowers set there will be a problem, there will be too much fruits on the trees, which will be to small and have a negative effect of developing new flower buds for next year. This causes biennial bearing or alternate bearing. By chemical thinning of the young fruits and later by manual thinning these effect will be minimalized.

Besides the project IFT there is also a trial in the project Fruit 4.0 of WUR. Both projects and partners have contact to provide double research and to exchange experience.

Benefit

Thinning of young fruits is a delicate decision for fruitgrowers. Too much fruits on a tree gives small fruits and causes biennial bearing or alternate bearing. Not enough fruit on a tree gives not enough production to cover the economical costs and for some varieties also to big fruits. B

The decision for using chemical thinningsprayings has to be made in a few weeks after bloom. By counting the flowers the chemical for thinning can be variously sprayed.



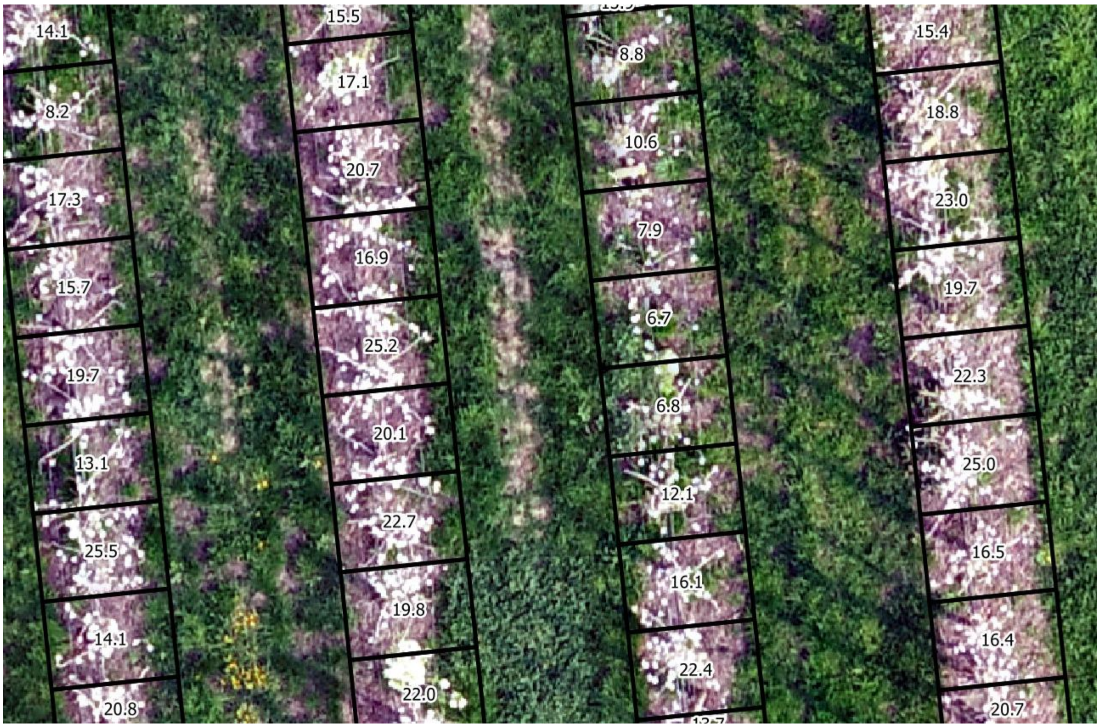
Test in 2018 by Aurea Imaging

Lead/support

ZLTO (PP07), observing partner VITO (OP01), PCFruit (Research Station for Fruit Growing in Belgium), Fleuren Boomkwekerijen (Fruittree Nursery) and Xroads (ICT) set up the Interreg Vlaanderen-Nederland project Intelligenter Fruit Telen (Intelligence Fruit Growing). This project started in January 2018. Aurea Imaging collects and process the data for ZLTO (PP07)

Timeframe

January 2018 – December 2020.



Test 2019 testfield IFT by Aurea Imaging

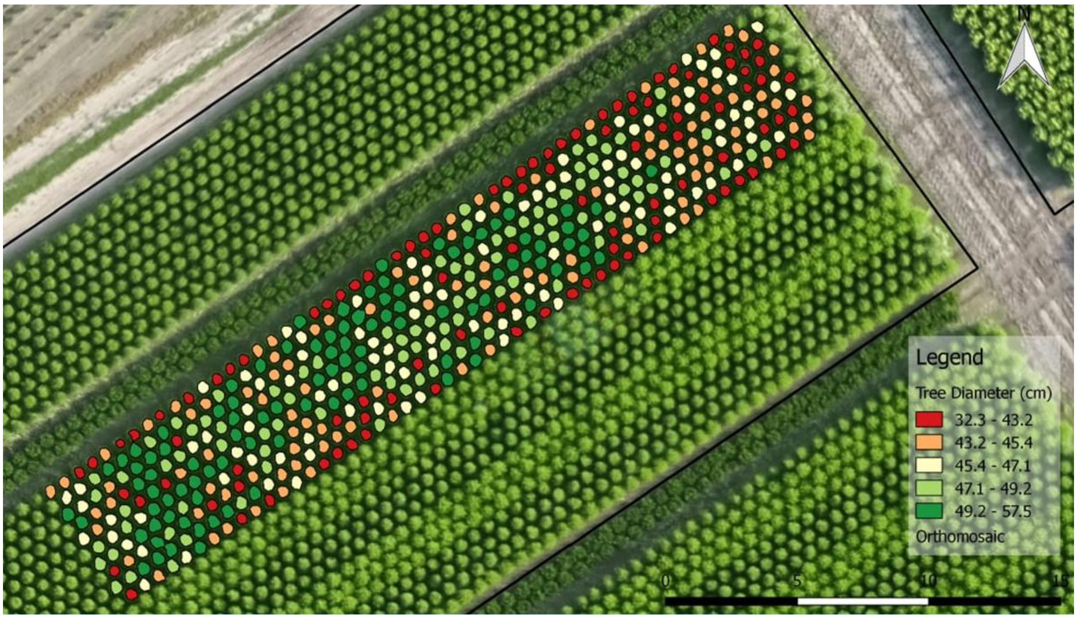
Dense cloud of flowering orchard

Nurseries ornamental plants

12. Counting plants and measure plant diameter in nurseries of ornamental plants.

Introduction

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.



Measure plant diameter of ornamental plants (Buxus) in the nurseries. In an application map employees can dig up plants of the same diameter for a specific client.

Action

Aurea Imaging (Dronewerkers) tested measuring plant diameter of ornamental plants at the nursery Liwardi. It helps to sort the plants in size and diameter. Every client has their own wishes for the quality and size of the plants.

Benefit

Saves time for counting in the field and sorting plants by hand in the field.

Lead/support

ZLTO (PP07) promotes further research by Aurea Imaging (Dronewerkers) and spread of information about these applications. Together with REWIN (PP05) there will be a demonstration for growers of ornamental plants.

Timeframe

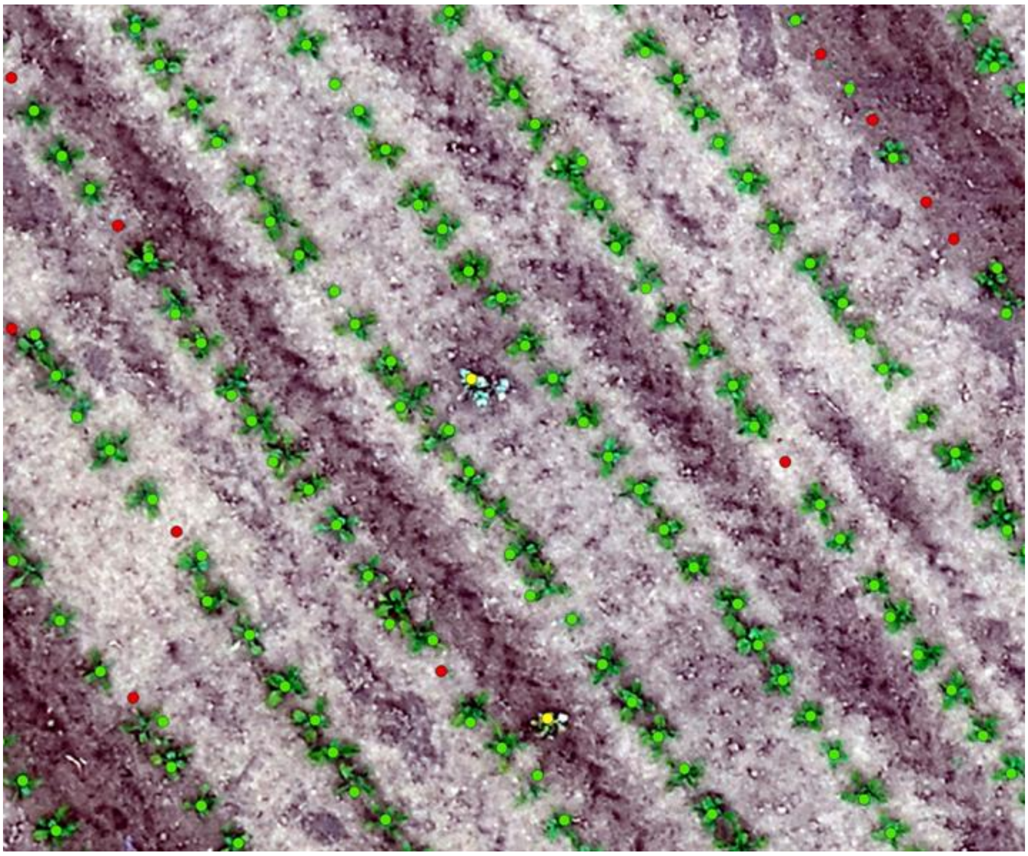
First tests were in 2017 by Aurea Imaging (Dronewerkers). During the ICAReS project more results will be presented.

Plant-breeding and seed companies

13. Counting seedlings or young plants

Introduction

In testfields of seedcompanies or in arable land germinated seeds and seedlings can be counted from above by using RPAS with a high resolution camera.For plant-breeding and seed companies it is important to follow up the germination of their seeds. With a high resolution camera germinating seeds can be counted. The speed and numbers of germination is a qualification for the quality of the seeds.



Counting seedlings in a testfield of a seed company

Action

Aurea Imaging tested at several test fields the possibility to count seedlings or young plants in the field. Seed companies want to know how many and how fast their seeds germinate.

Benefit

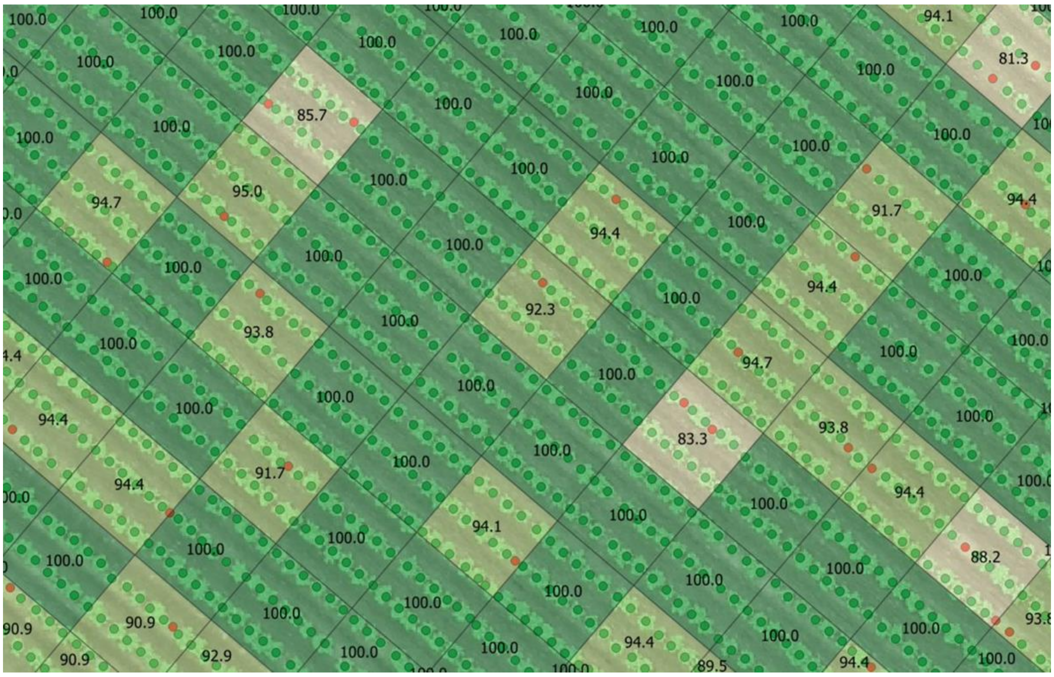
Saves time for counting in the field by hand in the field.

Lead/support

ZLTO (PP07) promotes further research by Aurea Imaging (Dronewerkers) and spread of information about these applications.

Timeframe

First tests were in 2017 by Aurea Imaging (Dronewerkers). In autumn 2018 they started with a new 100 Megapixel camera to count seedlings. During the ICAReS project more results will be presented.



Counting seedlings in a test field

Water & Infrastructure

Action plan 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 several 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.

In this action plan several objectives are mentioned to set up in the near future.

Objectives for the Water & Infrastructure sector

1. Functional deployability of drone images for the monitoring (eg difference maps) of the dynamics of Sigma areas (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. Under product here is understood either a result grid (difference file) or a service.

2. Functional deployability of R&D image processing techniques on drone images for an analysis of the possibilities for studying 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 (eg dikes).

3. Dike inspection with remote sensing: For the application of remote sensing, a number of locations are indentified 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 caused by ....;
   - 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 defenses, critical locations can be visualized in advance.

6. Cable works in high voltage networks: By the use of 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 efficiant tool to bring a first line across. A drone may fill a gap between a line gun and a helicopter.

Planned actions for the Water & Infrastructure sector

1. Functional deployability of drone images for the monitoring (eg difference maps) of the dynamics of Sigma areas (Flood control areas).

Action

PP12 The Flemish Waterway wishes, within the framework of the cooperation agreement (MONEOS program) between DVW and EVIV-EODAS, and the Interreg project ICARES to start a Proof of Concept to test a number of issues with regard to the further deployment of data capturing via drones within the own organization. VITO (Observer partner 1) will be involved in the data analysis. 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 DVW in order to arrive at the desired product on the basis of a few examples. Under product here is understood either a result grid (difference file) or a service.

Benefit

Better and faster analysis and usability of drone data after an analysis of the photogrammetric accuracy of the collected data.

Lead/support

PP12 The Flemish Waterway + OP1 VITO + other external partners

Timeframe

2019: The first results of this PoC were presented within the timeframe of ICAReS at the conference "Fladers Digital" on the 28th of November. They generated interest with the attendees for a platform able of processing and showing the results after hours instead of months.

2. Functional deployability of R&D image processing techniques on drone images for an analysis of the possibilities for studying seepage zones.

Action

PP12 The Flemish Waterway wishes, within the framework of the cooperation agreement (MONEOS program) between DVW and EVIV-EODAS, and the Interreg project ICARES to start a Proof of Concept to test a number of issues with regard to the further deployment of data capturing via drones within the own organization. VITO (Observer partner 1) will be involved in the data analysis.

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 by PP12 The Flemish Waterway (eg dikes).

Benefit

Better and more efficient inspection protocols along with earlier detection of problem areas. All of this could mean a significant increase in safety.

Lead/support

PP12 The Flemish Waterway + OP1 VITO + other external partners

Timeframe

2020: The results of this PoC will be presented within the community of ICAReS in 2020.

3. Dike inspection with remote sensing

Action

Waterboard Brabantse Delta is observer-partner within the European Interreg project ICAReS. Waterboard Brabantse Delta wants to investigate the possibilities of using Remote Sensing for dike inspections.

For the application of remote sensing, a number of locations are indentified 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 caused by ....
- 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.

Benefit

Better and more efficient inspection protocols along with earlier detection of problem areas. All of this could mean a significant increase in safety.

Lead/support

PP4 Geoinfra ltd + OP7 Waterboard Brabantse Delta

Timeframe

2019?

4. Survey of mowing maintenance

Action

Waterboard Brabantse Delta is observer-partner within the European Interreg project ICAReS. Waterboard Brabantse Delta wants to investigate the application possibilities of Remote Sensing for the inspection of the urgency of mowing maintenance

By means of drone flights, the survey of mowing maintenance, which is carried out by the waterboard or third parties.

Benefit

The main benefit is that fewer man hours would be needed for current inspections.

Lead/support

PP4 Geoinfra ltd + OP7 Waterboard Brabantse Delta

Timeframe

2019?

5. Detection and inspection of pressure pipeline routes

Action

Waterboard Brabantse Delta is observer-partner within the European Interreg project ICAReS. Waterboard Brabantse Delta wants to investigate the application possibilities of Remote Sensing for 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 defenses, critical locations can be visualized in advance.

Benefit

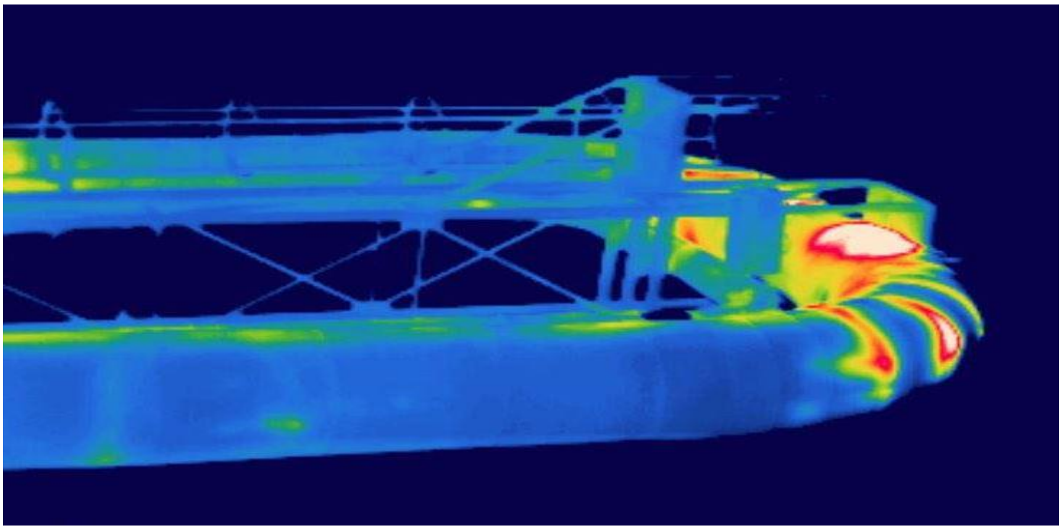
Better and more efficient inspection protocols along with earlier detection of problem areas. All of this could mean a significant increase in safety.

Lead/support

PP4 Geoinfra ltd + OP7 Waterboard Brabantse Delta

Timeframe

2019?



6. Cable works in high voltage networks

Action

Managers of high voltage networks want to investigate these applications in order to achieve a cost reduction on transporting the cables between the pylons.

By the use of 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.

Benefit

A more cost efficient and safer way of working.

Lead/support

Conceptuel phase: lead to be allocated

Timeframe

To be decided

Contact information

Lead Partner	Municipality ofWoensdrecht
Program manager	Bsc. S. Willemsen
Phone	+31 164 611 360
E-mail:	icares@woensdrecht.nl

Acronym:	2S02-032 ICAReS
Full name	Innovation Cluster Accelerating Remote Sensing
Address:	Postbus 24, 4630 AA, Hoogerheide, The Netherlands
Website:	www.projecticares.eu

Authors

Kent Downs Area of Outstanding Natural Beauty	**Name**	Rick Bayne
	Function	Landscape Partnership Manager
	Phone	+44 (0)1732 494505
	E-mail:	rick.bayne@kentdowns.org.uk

Company	Kent Downs Area of Outstanding Natural Beauty Unit
Address:	Darent Valley Landscape Partnership Scheme, The Tea Barn, Castle Farm, Redmans Lane, Shoreham, Kent, TN14 7UB
Website:	www.darent-valley.org.uk

ZLTO	**Name**	Ing. J.J.M. (John) Bal
	Function	Projectmanager
	Phone	+31-(0)6-21232601
	E-mail:	john.bal@zlto.nl

Company	**ZLTO**
address:	Noordlangeweg 42 B, 4486 PR Colijnsplaat
Website:	www.zlto.nl

ILVO Instituut voor Landbouw-, Visserij- en Voedingsonderzoek	**Name**	Jürgen Vangeyte
	Function	Scientific director
	Phone	+32 9 272 27 65
	E-mail:	jurgen.vangeyte@ilvo.vlaanderen.be

Company	**ILVO: Research Institute for Agriculture, Fisheries and Food**
address:	Burg. van Gansberghelaan 115 bus 1, 9820 Merelbeke, Belgium
Website:	www.ilvo.vlaanderen.be

De Vlaamse Waterweg nv	**Name**	Ronny Brosius
	Function	Senior Engineer
	Phone	+32 3 224 67 11
	E-mail:	Ronny.brosius@vlaamsewaterweg.be

Company	De Vlaamse Waterweg
Address:	Lange Kievitstraat 111-113 Antwerpen 2018
Website:	www.devlaamsewaterweg.be

Partners of ICAReS

PARTNERS