European Union Network for the Implementation and Enforcement of Environmental Law

Inspecting using Copernicus and UAV Data (iCUD)

Final project report

Date of report: 28 February 2019
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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

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Executive Summary

Copernicus is a European Union Programme, coordinated and managed by the European Commission, aimed at developing European information services based on satellite Earth Observation and in-situ (non-space) data. This information is available without cost and can be applied to several domains.

Environmental law enforcement can be supported by this highly updated and valuable geographic information, gathering, storing, managing and assisting the field activities. However it is still uncertain the methods, institutional use and the legal application of these tools for the environmental and land use analysis.

Associated with the pre geo-analysis (Copernicus-based), mostly space-based data, there is a complementary related information that can be acquired through Unmanned Aerial Vehicles (UAV - Drone) for more detailed and specific (circumscribed) information on site. This information support the Copernicus images for specific, uncertain, miscellaneous (complex) areas, at high resolution and on demand.

* Luís Marques left the project team in August due to job relocation

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1. Introduction

1.1. Background

In 2017 IMPEL had lined up a project regarding the use of Drones and IGAMAOT was invited, later that year, to host a workshop on the theme in Lisbon. The event took place on the 11th of December and was attended by several IMPEL members and Portuguese authorities and institutions. The agenda included several presentations on the use of Drones for various purposes (i.e. heritage, environmental monitoring and compliance, risk assessment) as well as a set of presentations from Portuguese aviation authorities (to share best practices and safety when operating UAV) and a presentation from the prosecutor's office to give some clarifications on the use of data collected by these equipments as evidential value. Simultaneously, an interest developed in preparing a project to submit to IMPEL for 2018 regarding the use of Copernicus data for environmental compliance purposes. Considering that both technologies – Copernicus and UAV - can be used complementarily, the submitted project consisted on the evaluation of the use of these tools in environmental inspections and was named iCUD (inspecting using Copernicus and UAV data).

UAV and Copernicus

The use of UAV as a tool to support environmental inspections as become a reality in the past few years and there are currently many institutions already using or planning to use them. The use of new technologies always comes followed by doubts and the need to explore methodologies in order to maximize their use.

Copernicus is a European Union Programme, coordinated and managed by the European Commission, aimed at developing European information services based on satellite Earth Observation and in-situ (non-space) data. The Earth observation satellites, which provide the data exploited by the Copernicus services, are divided into two groups of missions: The Sentinels, which are currently being developed for the specific needs of the Copernicus programme and the Contributing Missions, which are operated by National, European or International organisations and already provide a wealth of data for Copernicus services. Although the information provided by the Copernicus services is available and cost free it is still not a widely used tool when dealing with environmental compliance mainly for lack of technical knowledge when using this type of data.

Environmental law enforcement may be supported by this highly updated and valuable geographic information, gathering, storing, managing and assisting the field activities. However it is still uncertain the methods, institutional use and the legal application of these tools for the environmental and land use analysis.

1.2. Objectives and structure of the project

Considering that, both Copernicus and UAV are tools recognized to be extremely useful in environmental inspections they are not being widely used among the majority of IMPEL members. The iCUD project's main objective was to search for examples of good practice using both technologies as well as examples of the evidential value of this type of data when used in court. Given these assumptions the four main objectives outlined by the project team were:

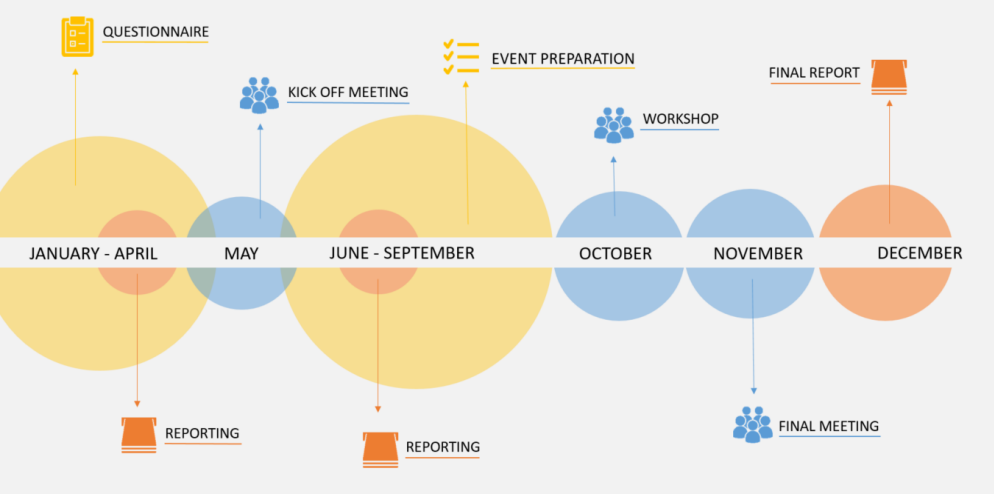
- Gather knowledge on the development of methodologies employed by IMPEL members who are currently using these tools/technologies;

- Increase the knowledge and capability of IMPEL members who are planning to use these tools/technologies;

- Share methodologies and expertise in the use of geographic information applied in environmental inspections;

- Identify potential barriers in the use of geo-spatial technologies regarding their evidential value.

A project timeline was outlined to structure the project:



The project started; as is common practice with most IMPEL projects, with the preparation of an online questionnaire to be sent to all the IMPEL participants who had shown interest in the iCUD project. A kick-off meeting was held on the 28th of May and a final workshop on the 17th and 18th of October.

1.3. Participants

The project was led by Portugal, with *Cláudia Morgado, Luís Marques and Susana Silva* of the *Inspeção-*

Geral da Agricultura, do Mar, do Ambiente e do Ordenamento Território (IGAMAOT) acting as project managers. The remainder of the project team consisted of technical experts from five Member States:

- *Dario Bellingeri* (Arpa Lombardia, Italy)
- *Rory Hanlon* (Waste Enforcement Regional Lead Authorities, Ireland)
- *Kevin Lydon* (Environmental Protection Agency, Ireland)
- *Olga Janeiro Barandiaran* (Consellería de Medio Ambiente e Ordenación do Territorio, Spain)
- *Monique Stouten* (Provence of Overijssel, Netherlands)
- *Remko Wicherson* (Provence of Overijssel, Netherlands)
- *Stef Van der Zee* (Provence of Overijssel, Netherlands)
- *Joel Davidse* (Dutch Inspectorate of Human Environment and Water Management, Netherlands)
- *Mário Caetano* (Direção-Geral do Território, Portugal)

16 IMPEL member countries registered on the project site of Basecamp: Albania, Belgium, Czech Republic, Denmark, Greece, Ireland, Italy, Malta, Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey and United Kingdom.

2. Survey to evaluate the use of Copernicus services and UAV data

A survey was sent to all the IMPEL members registered in the IMPELs project site in order to assess their expertise in the use of Copernicus services and UAV in environmental inspections, specifically regarding existing experience, methodologies (in use or in development) and the use of data collected from these tools as probative value. A final section was added to evaluate each participant's project expectations.

2.1 Questions

The questionnaire was split into four sections: one related to the use of Satellite Imagery (i.e. Copernicus Services), one related to the use of UAV, another section evaluating the use of both technologies and a final segment related to the use of the data as evidence in court.

Satellites

1. Which is your entity experience... (Low/rarely - to - Very High/frequently)
2. In your entity, are there any human resources with technical capability in the field of

remote sensing?

3. In which fields are there higher necessities of improving knowledge?
4. Satellite imagery training interest

UAV

1. Which is your entity experience... (Low/rarely - to - Very High/frequently)
2. Which UAV product(s) does your entity produce/use?
3. There is interest in receive training concerning UAV data?
4. UAV training interest (level)

Satellite and UAV data complementarity

1. Does your entity uses both technologies (Satellite and UAV)?
2. Would your entity be interested in using both technologies (as complementary)?
3. How do you categorise these technologies as a support your activities?

Probatory Value

1. Your entity experienced the use of Satellite products as evidences in court?
2. Your entity experienced the use of UAV products as evidences in court?
3. How do you consider the legislation in your country, concerning Satellite and UAV data use as evidence?

2.2 Results

The questionnaire was sent on the 11th of April 2018 to all the registered IMPEL members. The survey was answered by 17 participants from the countries illustrated below:

Responses – Summary[1]
Satellite imagery

- Entity experience:
Mostly none experience especially in acquiring data. Some experience in using/processing satellite data

- Human resources with technical capability in the field of remote sensing:
70% answered yes

- Necessities of improving knowledge:
Less needs in satellite data acquisition and higher need in image analysis

- Satellite imagery training interest:
47% are interest in beginner training and 30% in advanced

UAV

[1] Full survey report can be reviewed in Annex 1

- Entity experience:
Mostly do not have experience in acquiring UAV data, however some members have medium experience in gathering data. Low experience or none in processing UAV data (high contrast as 4 answers have high experience in processing) and mostly no experience or low in using this data.

- UAV product(s) used:
Most used data is oblique image and video. However there is some experiences with 3D modelling and DEM products (5 examples each). One example of using UAV to monitoring gases.

- Receive training concerning UAV data:
Most of participants want to receive formation (88%)

- UAV training interest:
Majoraty as beginer (53%) and then as advanced (35%)

Satellite and UAV data complementarity

- Entity uses both technologies:
52.9% of entities uses both technologies

- Your entity be interested in using both technologies (as complementary):
100% answered yes, they are interested to use both technologies

- Both technologies as a support in inspection activities:
High to very high (60%)

Probatory value

- Your entity experienced the use of Satellite products as evidences in court:
90% answered no

- Your entity experienced the use of UAV products as evidences in court:
82.4% answered no

- How do you consider the legislation in your country, concerning Satellite and UAV data use as evidences:
Most answered is don't know, which reveal inexperience using as evidences in court
Satellite - second most answered "in development"
UAV - second most answered "in development" and "complex"
Traditional methods - second most answered "open" and then "simple" and "complex"

Project expectations

- Do you think these technologies are relevant for your entity activity:
91% answered yes

- Which field of activity could be more relevant:
Most answered by order:

1. Environmental inspections 100%
2. Land use management 47%
3. Define priorities 47%
4. Reporting 47%
5. Probatory value support 41%

3. Project Events

3.1 Kick-off meeting (Lisbon, 28th May 2018)

The meeting was held in IGAMAOT headquarters to display the team member's ongoing work with relation with the use of Copernicus Services and UAV data.

Participants:
- Cláudia Morgado, Luís Marques, Susana Silva (as Project Managers)
- Dario Bellingeri (Arpa Lombardia, Italy)
- Rory Hanlon (Waste Enforcement Regional Lead Authorities, Ireland)
- Kevin Lydon (Environmental Protection Agency, Ireland)
- Olga Janeiro Barandiaran (Consellería de Medio Ambiente e Ordenación do Territorio, Spain)
- Remko Wicherson (Provence of Overijssel, Netherlands)
- Stef Van der Zee (Provence of Overijssel, Netherlands)

- Joel Davidse (Dutch Inspectorate of Human Environment and Water Management, Netherlands)
- Mário Caetano (Direção-Geral do Território, Portugal)

The first part of the meeting was dedicated to the revision of the questionnaire responses. Afterwards all the team members made a presentation framing the institution they represent and the work they develop within it. The main objective was to learn and discuss all the work currently being executed by the different authorities and how it has been used for compliance, monitoring and enforcement.

Presentations Summary:

- Dario Bellingeri (Arpa Lombardia, Italy):
"Satellite and UAV data usage in environmental monitoring, inspection and control: experiences in ARPA Lombardia"

- Rory Hanlon (Waste Enforcement Regional Lead Authorities, Ireland):
"Developing Capacity in Satellite and UAV Applications"

- Kevin Lydon (Environmental Protection Agency, Ireland):
"EPA Landcover mapping"

- Olga Janeiro Barandiaran (Consellería de Medio Ambiente e Ordenación do Territorio, Spain):
"UAV data usage in environmental inspections carried out by the CMAOT-Xunta de Galicia"

- Remko Wicherson (Provence of Overijssel, Netherlands)
- Stef Van der Zee (Provence of Overijssel, Netherlands):

- Joel Davidse (Dutch Inspectorate of Human Environment and Water Management, Netherlands):
"Using RS for inspection of the human environment in The Netherlands: Our examples of learning by doing"

- Mário Caetano (Direção-Geral do Território, Portugal):
"Satellite Remote Sensing for environment monitoring: opportunities and challenges"

During the kick off meeting was also discussed what should be the next event of the project. Based on the responses from the questionnaire – there was a large number of respondents stating that they were interested in receiving training in both technologies - the team decided to organize a workshop to be scheduled during the month of October. This workshop would include presentations from all the team members and, possibly, other invited speakers.

3.2 Workshop (Lisbon 17th and 18th of October 2018)[2]

The workshop was held at IGAMAOT headquarters during the 17th and 18th of October. On the 17th there was a training session given by one of the Portuguese team members – Doutor Mário Caetano -

[2] Full workshop program, authors Bios and presentations abstracts can be accessed on Annex 2

on satellite data acquisition and processing. The 18th was a day composed by presentations made by the team members and other invited speakers.

The event was attended by approximately 50 participants – 20 IMPEL members from 13 countries (Albania, Belgium, Czech Republic, Finland, Germany, Greece, Ireland, Italy, Malta, Netherlands, Spain, United Kingdom and Wales), portuguese national authorities and institutions and inspectors from IGAMAOT.

Presentations Summary:

- IGAMAOT:
"iCUD Project Presentation"

- Ray Purdy; Air & Space Evidence:
"How satellites can be used operationally to provide evidence of waste crime"

- Dario Bellingeri; ARPA Lombardia:

"Satellite and UAV data usage in environmental monitoring, inspection and control: experiences in ARPA Lombardia"

- Monique Stouten and Remko Wicherson; Provence of Overijssel:
"SMART 2030"

- Joël Davidse; Dutch Inspectorate of Human Environment and Water Management:
"Satellite-Data driven approaches for Inspection purposes"

- Adriano Baptista and Luis Marques; SatCen - UE:
" Geospatial Intelligence (GEOINT) as Support to EU Decision Makers"

- Martin Davies; Natural Resources Wales:
"Combatting Waste Crime"

- Rory Hanlon; Waste Enforcement Regional Lead Authorities:
"UAV applications supporting environmental monitoring in Ireland"

- Cláudia Morgado; IGAMAOT:
"UAV data as a supporting tool in environmental inspections"

- Stefano Mariani; National Institute for Environmental Protection and Research:
"The use of UAV and Copernicus Sentinel data for developing hydromorphological monitoring tools for medium-large river systems to support the implementation of the EU WFD 2000/60/EC and FD 2007/60/EC"

3.3 INSPIRE Conference (Antwerp 18th to 21st of September 2018)[3]

Apart from the kick off meeting and the workshop the iCUD project was also presented at the INSPIRE conference of 2018. An abstract detailing the objectives of the project was submitted to the conference and accepted by the organization.

INSPIRE conferences have been held since 2009 with the objective of providing a forum for government, academia and industry to hear about and discuss the latest developments of the INSPIRE Directive. The conferences are organised through a series of plenary sessions addressing common policy issues, and

[3] INSPIRE participation report can be accessed on Annex 3

parallel sessions and workshops focusing in particular on applications and implementations of SDIs, research issues and new and evolving technologies and applications.

The iCUD project was presented on the environmental monitoring, reporting and indicators session on the 19th of September.

4. Conclusions and recommendations

From the team members input throughout the project, the following conclusions and recommendations may be drawn:

- Copernicus services and UAV data are widely recognized as supporting tools for environmental inspections. However there is still a lack of technical knowledge within some institutions on how both technologies can be used.

- Copernicus services are currently being applied in a variety of areas related to environmental monitoring. The team members contributed with many examples of their own work in several domains:

    - Detection of water over-abstraction through SAR remote sensing (WODA IMPEL project);

    - Manure spreading monitoring and control;

- UAV examples:

    - Hydropower reservoirs monitoring;

    - Inspections in industrial facilities;

    - Support of obligations under EU water framework and Birds Directive;

    - Habitat quality assessment;

    - Plant conservation;

    - Object-based Image analysis for coastal habitat mapping.

- Legal constraints: flying procedures and authorizations as well as the possible evidential value of the collected data is still a recognized limitation to most users.

Annexes

Annex 1: Full survey report

Annex 2: iCUD Workshop Program

Annex 3: INSPIRE Conference – Report