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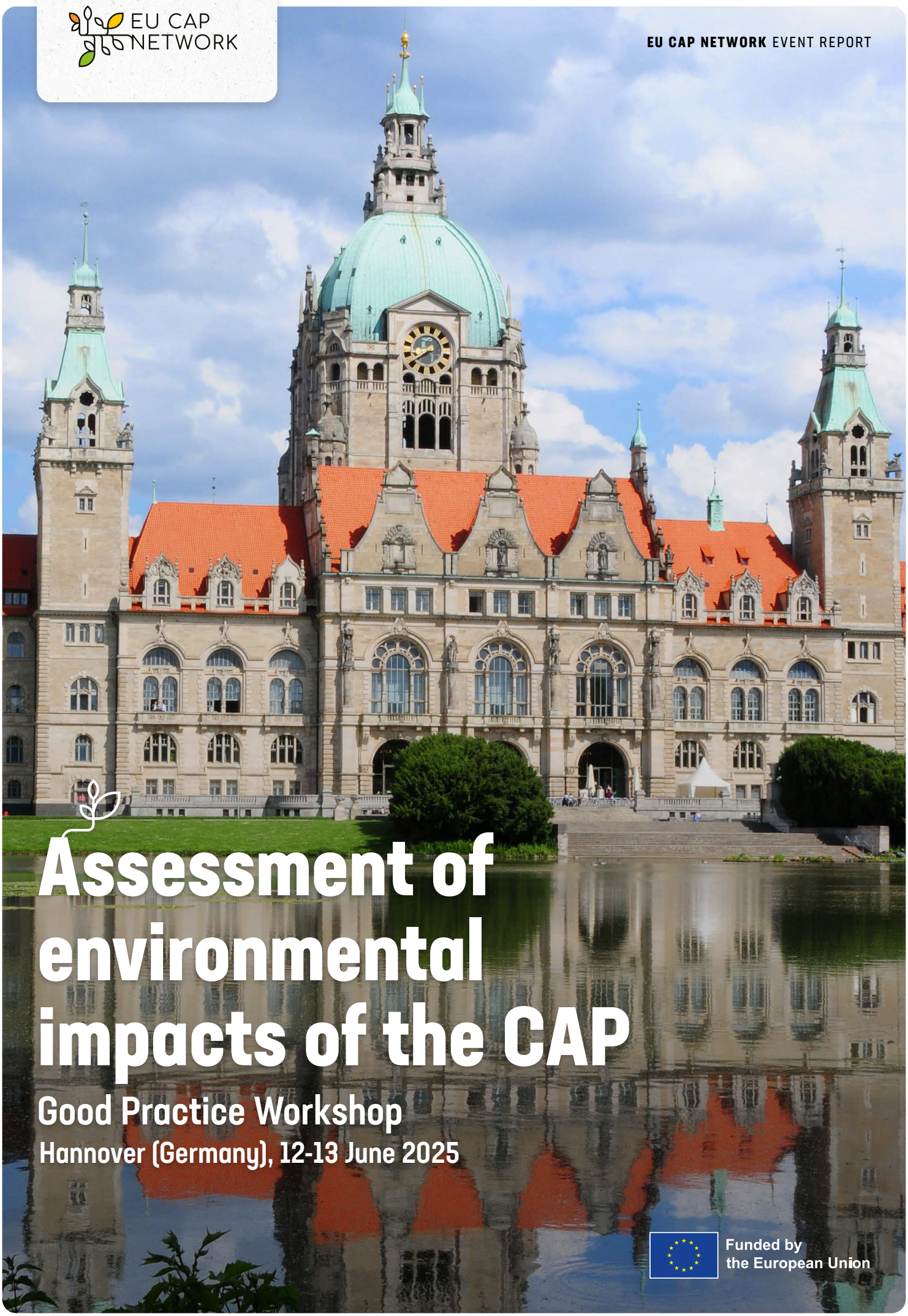

Assessment of environmental impacts of the CAP

Good Practice Workshop

Hannover (Germany), 12-13 June 2025

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EU CAP NETWORK

The European Evaluation Helpdesk for the CAP is responsible for providing support to monitoring and evaluation activities at the EU and Member State level. It works under the guidance of DG AGR's Unit A.3 (Policy Performance) of the European Commission. The European Evaluation Helpdesk for the CAP supports all evaluation stakeholders, in particular DG AGRI, national authorities, managing authorities and evaluators, through the development and dissemination of appropriate methodologies and tools; the collection and exchange of good practices; capacity building and communicating with network members on evaluation-related topics.

Additional information about the activities of European Evaluation Helpdesk for the CAP is available on the Internet through the Europa server https://eu-cap-network.ec.europa.eu/support/evaluation.

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AMS	Area monitoring system
CLMS	Copernicus Land Monitoring Service
CSP	CAP Strategic Plan
DIB	Data for interventions and beneficiaries
DG AGRI	Directorate-General for Agriculture and Rural Development
eBMS	European Butterfly Monitoring Scheme
EEA	European Environment Agency
EO	Earth observations
FADN	Farm Accountancy Data Network
FSDN	Farm Sustainability Data Network
GPW	Good Practice Workshop
GSSA	Geospatial Aid applications
IACS	Integrated Administrative and Control System
IAS	Invasive alien species
IFS	Integrated Farm Statistics
JRC	European Commission's Joint Research Centre
LUCAS	Land use and land coverage survey
LPIS	Land parcel identification system
NDVI	Normalised difference vegetation index
MA	Managing Authority
PA	Paying Agency
RDP	Rural Development Programme
VLCC	Vegetated Land Cover Characteristics

Executive summary

The tenth Good Practice Workshop of the European Evaluation Helpdesk for the CAP explored the use of big data for the assessment of environmental impacts of the CAP. It took place in Hannover (DE) on 12-13 June 2025, hosted by the German Federal Ministry of Agriculture, Food and Regional Identity (Department CAP Strategic Plan, Direct Payments EAFRD) and the German Network – the Deutsche Vernetzungsstelle Ländliche Räume - für die Gemeinsame Agrarpolitik der EU (DVS). It was attended by 78 participants from 25 different Member States, including Managing Authorities, evaluators, Commission representatives, Paying Agencies, Local Action Group representatives, researchers and other relevant stakeholders.

The workshop aimed to showcase the possibilities of using big data and different data sources for assessing the environmental impacts of the CAP via a capacity-building component and presentations of practical examples from Italy, Germany, the Horizon project Sen4CAP, the Commission's Joint Research Centre (JRC) and the European Environmental Agency (EEA).

Key messages from the workshop are:

- **Big data offers significant potential for evidence-based policy making**. The workshop highlighted how datasets like Earth observations (EO), the Integrated Administrative and Control System (IACS) and the evolving Farm Sustainability Data Network (FSDN) enable more accurate evaluation findings and timely and cost-effective evaluations of the environmental impacts of the CAP, including indicators such as soil erosion, biodiversity and carbon sequestration.
- **Access to and integration of data remain major challenges**. While numerous datasets exist (e.g. EO, IACS, citizen science), limitations in access (esp. for high-resolution or administrative data), interoperability and data harmonisation across Member States hinder their effective use for evaluation. The need for common identifiers and collaborative efforts was greatly stressed.
- **Methodological development and cooperation are critical**. Presentations and discussions revealed both the potential and limitations of current approaches (e.g. simulation models, counterfactual analysis and the use of high-resolution satellite data), and emphasised the importance of cooperation among Member States, data validation and tailored approaches to link data sources to specific environmental indicators.
- **Capacity building and awareness are necessary to fully exploit existing data**. It was noted that valuable data already exists but is underused due to limited awareness, insufficient expertise in linking data to policy evaluation and a lack of coordination between institutions. Strengthening communication, training and collaboration could help make better use of these resources for evaluating the CAP's environmental impacts.

Participants of the Good Practice Workshop 'Assessment of environmental impacts of the CAP', 12-13 June 2025, Hannover, Germany.

1. Introduction

The tenth Good Practice Workshop (GPW) of the European Evaluation Helpdesk for the CAP (Evaluation Helpdesk) took place in Hannover (DE) and focused on the possibilities of using big data and different data sources for assessing the environmental impacts of the CAP.

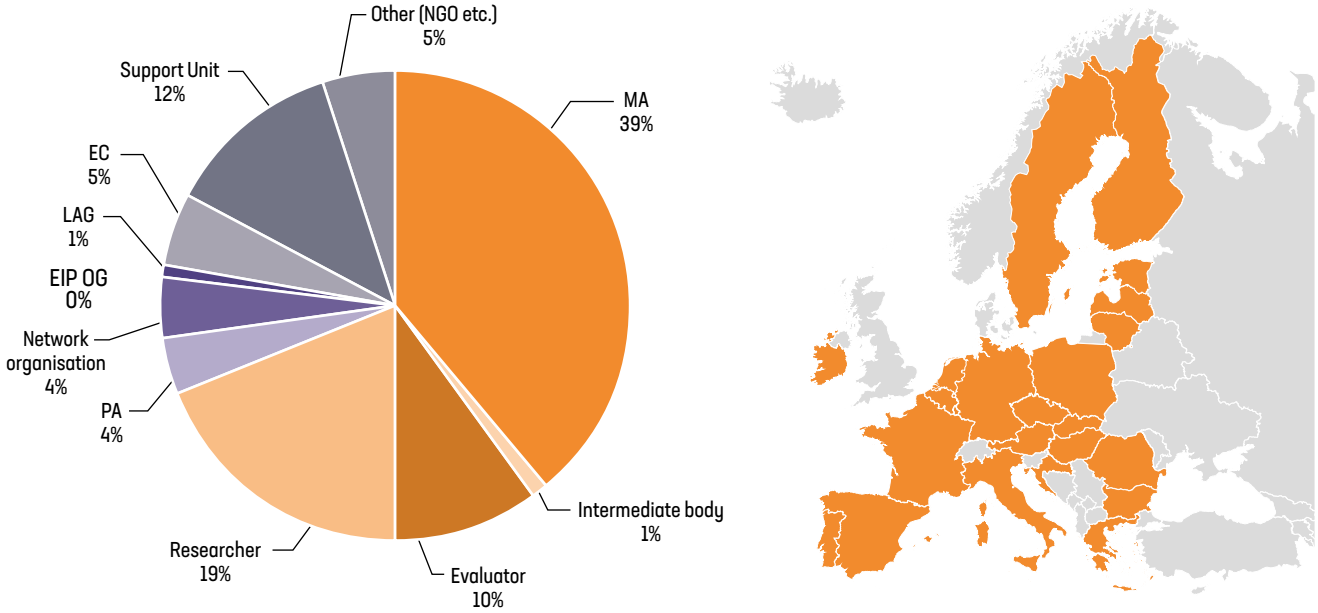
Supporting and improving environmental protection and climate action are high priorities for the EU, reflected in its ambitious objectives in these areas. The CAP is expected to play a role in both reducing negative impacts and strengthening positive impacts on the environment and climate. To assess these impacts, various evaluations are planned based on multiple impact indicators, with high-quality data, which is needed to calculate these indicators, is expected to come from several established sources.

Since 2016, the European Commission has emphasised the need to improve information gathering and data utilisation to support better policymaking, highlighting the potential of big data to enhance evaluation capabilities, enabling early detection of trends, faster feedback, evidence-based policymaking and demonstrations of results to all stakeholders[1]. Big data, referring to data sets of increasing volume, velocity and variety, is too complex or too large for traditional data-processing systems and requires advanced tools and computing power. However, technological advances and digital innovations in agriculture can overcome this issue.

In the context of CAP evaluations, big data can be used to support evidence-based decision-making and policy implementation of the CAP and refers to data such as Earth observation (EO) data, including remote sensing, in situ sensing or data linked to the Integrated Administrative and Control System (IACS). Big data can be processed to generate inputs for analytical work in the context of evaluations of the environmental impacts of the CAP. In addition, the Farm Accountancy Data Network (FADN) provides microeconomic data, and although not considered big data per se, it can be combined with big data and form part of the wider datasets used for evaluations. The expansion of FADN to Farm Sustainability Data Network (FSDN) is a key step in enabling the provision of environmental data at farm level, in addition to economic data.

Seventy-eight participants from 25 different Member States attended the workshop over the two days, including Managing Authorities (MA), evaluators, Commission representatives, Paying Agencies (PA), Local Action Group representatives, researchers and other relevant stakeholders.

Figure 1 – Participants of the Good Practice Workshop per role and Member State



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025).

[1] 2016 Communication from the Commission on "Data, information and knowledge management at the Commission"

2. Day 1

2.1 Setting the scene

2.1.1 Introduction to big data

Guillaume Pierre, European Evaluation Helpdesk for the CAP

Mr Guillaume Pierre (Evaluation Helpdesk) gave a presentation on basic concepts of big data and the rationale for using it in CAP evaluations. He outlined the definition of big data and several use cases for evaluation. Potential sources of big data were discussed alongside illustrations of the use of big data in the agricultural sector outside of the CAP.

Link to Mr Pierre's presentation: Introduction to big data

After the presentation, participants posed the following questions and/or comments	
A **researcher (AT)** asked when a large dataset becomes big data, and if a dataset processed in 'MS Access' is big data.	Mr Pierre conveyed that there is no commonly agreed-upon quantitative threshold to qualify big data, but considers that, if a dataset can be opened on a regular computer, it is not big data as one would need dedicated tools to interact with big data. He clarified that MS Access could indeed handle both small datasets as well as big data.
The **Dutch MA** wondered to what extent big data is open and available.	Mr Pierre answered that a lot of data (e.g. EO/remote sensing) is openly available thanks to EU programmes, while for other types of data (e.g. administrative, private transactions or usage data), Mr Pierre was unsure. Most machinery and transactions data at farm level are not publicly accessible, according to Mr Pierre. Mr Raphael D'Andrimont (DG AGRI) added that FSDN is growing closer to big data due to the integration with IACS and data for interventions and beneficiaries (DIB). Furthermore, he added both value and veracity (i.e. good quality of data, such as less than 2% error) to the definition of big data. A researcher (DE) would also add 'messiness' to the definition of big data, as it comes from different sources collected for different purposes under different aspects. Citizen science data is similar, as there is a lot of unstructured data, so one needs to work around errors to combine the data and reach the needed added value.
A **researcher (AT)** found that a lot of big data is not accessible, which is problematic as good quality EO/remote sensing data, needed for biodiversity assessment, is not openly accessible. Copernicus is open and accessible, but it does not include high-resolution sentinel data. As a lot of data is already collected and could be used for evaluations, researchers underlined the need to access this to perform the best possible assessments.	
A **researcher (DE)** questioned if the applications outside the CAP, mentioned in the PPT, are correct, as there are many applications for big data inside the CAP as well (e.g. insurances).	Mr Pierre agreed and clarified that the listed examples were presented as they could inspire or be replicated within the context of the CAP (more for monitoring and reporting but potentially also for evaluation).

2.2 Practical examples

2.2.1 Satellite Earth observations for evaluation

Dimitris Skuras, Professor of Economics, University of Patras, Greece

Mr Dimitris Skuras (University of Patras) gave a presentation on 'Satellite Earth observations for evaluation'. He showed how satellite EO can powerfully support the evaluation of the CAP. He explained key remote sensing markers, illustrated their application through a real-world case study on evaluating the effectiveness of cover crops and demonstrated how EO can support the measurement of performance monitoring and evaluation framework (PMEF) indicators, such as soil erosion and carbon sequestration. Aimed at Managing Authorities, Paying Agencies and evaluators, the presentation advocated for broader use of EO to boost precision, reduce costs and support planning, monitoring and risk management across the CAP.

Link to Mr Skuras's presentation: Satellite Earth observations for evaluation

After the presentation, participants posed the following questions and/or comments	
Ms Parissaki asked if it is still possible to make an assessment if there is no baseline, such as by using a map of the area.	Mr Skuras answered that it is usually not critical if there is no baseline, since there is European-wide data (e.g. for soil erosion) which can fill in this gap. This depends on the Member State, as many maintain their detailed national databases.
A **researcher (DE)** asked how European corporations could address the issue of having larger overhead costs for MAs and how collaboration among Member States could be established to avoid each one having to establish its own soil map.	Mr Skuras highlighted that there are many opportunities to get finance for the initial establishment costs. For example, the European Space Agency, Commission and Copernicus supported the project Sen4CAP, which initially covered regions in six Member States. Horizon 2020 and LIFE programmes have supported the use of EO in almost all Member States. For example, in Cyprus, a central EO hub was initially funded by Horizon 2020 and LIFE+ to become a centre of excellence for the use of EOs.
An **evaluator (CZ)** asked how possible it would be to go back to satellite data.	Mr Skuras clarified that for the current CAP programming period, it is possible to go back and establish a baseline based on EOs.
An **evaluator (IT)** stressed the importance of a baseline for the evaluators' work and asked if, in case the baseline is not available, it is possible to use a proxy of the baseline.	Mr Skuras replied that a proxy can be used as long as the evaluator can establish a sound and scientifically valid relationship between the indicator and the proxy.
A **researcher (SE)** inquired about the minimum size of plots for which the presented EO could provide valid markers and information, and asked for suggestions on what to do in cases where there is no possibility of classification with remote sensing.	Mr Skuras clarified that in the presented case study, the team had plots as small as half a hectare. For evaluation purposes (not controls or audits), unclassified plots should be treated as missing values. A **researcher (DE)** commented that for the Sen4CAP project, the rule was half a hectare, and if a higher resolution were available, it would be possible to obtain even more granular information. However, he stressed that this always depends on the type of data required.
The **Greek MA** inquired about the comparability of the same impact indicators across Member States.	Mr Skuras explained that the absolute size of the effect is less relevant and that the attention should be on the changes made from the baseline.

The **French MA** asked about the feasibility of the analysis, specifically for the CAP, when there are overlaps among different types of ongoing evaluations.	Mr Skuras responded that, in the presented case study, they managed to undergo the analysis in only three months because they had people able and willing to provide the requested information concerning the EO and their connection to IACS.
Ms Parissaki proposed whether collaboration among Member States could reduce the costs associated with large datasets.	Mr Skuras clarified that this could be feasible for neighbouring Member States, alongside the collaboration established among institutions within the same Member State.
The **Dutch MA** asked if it is also possible to focus the analysis on more than one marker at the same time or to combine different ones.	Mr Skuras proposed that it is better to focus on as many markers as possible to limit the costs, also if different evaluators are involved. In this case, he suggested that it would be better to gather the EO data centrally at the MA.

2.2.2 Copernicus Land Monitoring Services: high-resolution products for evaluating environmental impacts of the CAP

Luca Battistella, European Environment Agency (EEA)

Mr Luca Battistella (European Environment Agency (EEA)) gave a presentation on the Copernicus Land Monitoring Service (CLMS) and how it harmonises high-resolution, pan-European data products (e.g. the Vegetated Land Cover Characteristics (VLCC) suite) that enable robust, evidence-based evaluations of the CAP environmental impacts, including grassland maintenance, crop rotation, mowing intensity and land use change. These products facilitate harmonised reporting and assessment of CAP environmental outcomes, helping to safeguard biodiversity, promote sustainable land management and monitor compliance with key CAP standards such as permanent grassland protection and crop diversification.

Link to Mr Battistella's presentation: Copernicus Land Monitoring Services (CLMS): High-Resolution Products for Evaluating Environmental Impacts of the CAP

After the presentation, participants posed the following questions and/or comments	
A **researcher (AT)** asked if the data sets came with certainty of results, and if so, what the certainties of results are for single trees in datasets on small landscape features.	Mr Battistella confirmed that the datasets came with certainty of results. He explained that the data is published with an algorithm theoretical base document and validation report, and that the outcome of the validation is published on the dataset pages in the CLMS portal. Regarding the small landscape features, Mr Battistella would follow up separately.
A **researcher (DE)** noted that the EEA worked with normalised difference vegetation index (NDVI), which is difficult to convert to something with meaning for an agro-economist, and asked if the EEA was working on a product where the NDVI for crops (or whatever vegetation period) can be transferred to scientific information that tells something about, for instance, yields or productivity in corn yield across Europe.	Mr Battistella underlined that the EEA also works with other products and not just NDVI. However, under the CLMS programme, a product that would transfer NDVI information to detect yields was not being developed.
The **Luxembourgish MA** asked why the EEA would produce the presented index as it sounds more like a control instrument for the Commission, while Member States are controlling the same thing through the area monitoring system (AMS).	Mr Battistella explained that the cropping and mowing events were developed to monitor and evaluate CAP outcomes per CAP requirements, but they were also used for nature regulations and the EU Green Deal. An as broad as possible context was maintained to make the most sense of information harvested from the satellites and make it available to the public and researchers.

A **researcher (DE)** was curious to gain more insights into the pros and cons from all the information being generated, as well as from the products at the national level.	Mr Battistella found that the most important factor in the use of the provided information is harmonisation across Europe, and across different products and classes of each product. The presented product was developed while keeping in mind that there are specificities in each Member State and Mr Battistella acknowledged that a dedicated product could perform better. The CLMS is working at the pan-European and global scale, and it is important to consider the resolution and how the information is used.

2.2.3 Leveraging data from EO, IACS and citizen science in Germany's farmland biodiversity monitoring (MonViA)

Sophie Ogan, Thünen Institute, Germany

Ms Sophie Ogan (Thünen Institute) gave a presentation that showed that (i) agriculture is a highly complex system, and understanding the diverse drivers of biodiversity is essential to reverse current negative trends; (ii) IACS and EO data offer (complementary) strengths and limitations in describing land use and land cover in space and time; and (iii) data on how farmland organisms respond to land use and land cover remains limited, while citizen science holds great potential to fill these knowledge gaps.

Link to Ms Ogan presentation: Leveraging data from EO, IACS and Citizen Science in Germany's farmland biodiversity monitoring (MonViA)

After the presentation, participants posed the following questions and/or comments	
As national schemes were used, **Mr D'Andrimont** (DG AGRI) asked if it was considered to use the European Butterfly Monitoring Scheme (eBMS) as the data is available (though not harmonised) at European Level.	Mr Norbert Röder (a colleague from Ms Ogan at Thünen Institute) explained that the European bird dataset is a sub-sample dataset for the German dataset, and this is also the case for the butterflies.
An **evaluator (CZ)** asked to what extent the presented data could be used for evaluating CAP measures.	Ms Ogan found that such a link is difficult, as the monitoring data is not linked to IACS data. Therefore, Ms Ogan cannot say which measures have an impact on wild bees; all that could be done would be a correlation analysis. Mr Röder added that another methodological problem would be that wild bees do not care why grassland, or a meadow, is there, so that no statistical arguments could be made.
The **Greek MA** asked if the trend of recording more fallow land in protected areas is because of a policy or intervention, and if it would be recommended to change this policy.	Mr Röder explained that Germany does not have a specific policy that directs fallows to protected areas, but that it is due to economic reasons for farmers (e.g. use fallows on less fertile areas). One argument could be that one cannot apply pesticides in fallow areas in Germany, so it is an action that would allow for the increase of butterflies in protected areas.

After the presentations, participants exchanged experiences and ideas regarding what they would use big data for when assessing the environmental impacts of the CAP, as well as the related challenges they encounter in the use of big data.

3. Day 2

3.1 Setting the scene

3.1.1 The possibilities offered by FSDN and the links with other datasets

Raphael D'Andrimont, DG AGRI, European Commission

Mr Raphael D'Andrimont (DG AGRI) gave a presentation on the FADN and its transition to FSDN, as well as its linkages with other datasets and the relevance of these linkages for policy making. He described the rationale for adding new domains to FADN, notably environmental and social domains, which are now part of FSDN. The new variables will be progressively introduced, with full availability achieved by 2027. He stressed the actual and potential linkages of FSDN to DIB, IACS and geospatial big data, highlighting the interoperability challenges and the potential to enrich analytical capacities for policy design, monitoring and evaluation.

Link to Mr D'Andrimont's presentation: The possibilities offered by FSDN and the links with other datasets

After the presentation, participants posed the following questions and/or comments	
Ms Parissaki asked if the idea was to have one unique identifier that could be used across the datasets.	Mr D'Andrimont explained that Eurostat offers Integrated Farm Statistics (IFS) data, which is a full set of data every ten years, and a survey every three years. There is work done on a common identifier, but every Member State may have a different implementation and there are different definitions of holdings in different systems. Further details on the differences can be found in the presented report. For the core FSDN variables, such work is ongoing to see how this could be implemented, but there are different choices for Member States.
The **German MA** asked if it would be interesting for DG AGRI if MAs could link the FSDN to DIB data, and how did DG AGRI account for the flexibility that is offered to Member States in the benchmarking tool.	Mr D'Andrimont underlined that flexibility is only at the level of granularity of data that Member States provide, meaning that some data is optional and some data is mandatory. In most cases, Member States asked to establish such a link, so it is not something that comes from the top. Regarding the incentivisation of farmers to participate in FSDN, Mr D'Andrimont acknowledged the challenge, and explained that this is why during meetings of the Expert Group on the Implementation of CAP Strategic Plans Regulation, various Member States present their approach to incentivise participation in the sample.
A **researcher (DE)** asked three different questions: (i) is the sample scheme adapted for FSDN to address the fact that the FADN is representative for farm output so in most Member States there is an underrepresentation of low input farms when compared to the census; (ii) will the IFS and the linkages result in an outflow of census data from statistical offices; and (iii) as one looks at a huge number of support measures, should one standardise by basic type of interventions or should the data be on basic interventions.	Mr D'Andrimont explained that the key concept remains the same for the sample scheme and he acknowledged it to be a weakness (due to the key focus of the survey) but also highlighted that there are strategies to mitigate this (e.g. post-stratification). Regarding access to data from statistical offices, Mr D'Andrimont explained that a regulation and legal basis are needed to connect IFS with FSDN data, but that this must be done at Member State level. There is also work on explorative statistics to spatialise the IFS data while respecting anonymity and privacy.

An **evaluator (IT)** found that the sample of beneficiaries in FADN is too small (especially at regional level) for both the past and current CAP programming periods and asked what strategies could be implemented to increase the number of CAP beneficiaries under FSDN for the post-2027 CAP programming period (e.g. link CAP support to the obligation to participate). Furthermore, the evaluator asked what the first year would be in which FSDN data could be used.	Mr D'Andrimont clarified that Member States must provide DIB for all the farms, so this information could be used for evaluation. He acknowledged that a solution should be found for sharing the data, but it was created for evaluation. The number of farmers cannot simply increase as there is a legal basis in the legal text. Lastly, Mr D'Andrimont explained that FSDN data collection is done every year but that it would be available two years later (i.e. collected in 2025, available in 2027).

3.2 Sharing experiences

3.2.1 Environmental impacts of the CAP 'Greening' obligations – a counterfactual exercise in the Spanish context

Zelda Brutti, JRC, European Commission

Ms Zelda Brutti (JRC) stressed that big data from administrative sources has strong potential for CAP evaluation. Geospatial aid applications (GSA or GSAA) datasets feature universal coverage of beneficiaries and high precision in plot size and land use. With farm holding identifiers, geographic merging enables the identification of causal links between farm-level policies and direct environmental outcomes.

Link to Ms Brutti's presentation: Environmental impacts of the CAP 'Greening' obligations – a counterfactual exercise in the Spanish context

After the presentation, participants posed the following questions and/or comments	
An **evaluator (CZ)** asked whether other approaches were applied in relation to the soil organic carbon analysis.	Mr Brutti clarified that more aggregated data from local administrative sources were gathered to obtain results, but the case study reported limitations due to limited data related to the number of farms in Spain.
The **Finnish MA** asked whether a counterfactual analysis was applied before and after the policy reform.	Ms Brutti explained that there is no need to have a baseline for the counterfactual method known as discontinuity designs. Further, it was verified that in the 2009 census data, there was no bunching below the threshold, providing further validation of the fact that bunching ensued as a reaction to the later greening provisions.
A **researcher (DE)** commented that a similar exercise was done in Germany.	Ms Brutti commented that Denmark also undertook a similar exercise. Mr D'Andrimont clarified that LUCAS provides a stratified sample for area statistics and that LUCAS has improved over the years for the soil module and Copernicus module. The last sample had 40 000 points, compared to the previous 20 000 points. At the same time, he pointed out that data on erosion is obtained from LUCAS.

3.2.2 Assessing CAP impact on soil carbon stocks with big data

Irene Criscuoli, Italian council for agricultural research and agricultural economics (CREA)

Ms Irene Criscuoli (CREA) explained that to evaluate the climate change mitigation potential of Rural Development Programme (RDP) measures (2014-2022 CAP), a simulation of soil carbon dynamics was run at the parcel level, based on big data and modelling. The simulation was made on all farms in Sicily (IT), implementing a sub-selection of RDP measures. The choice was based on data availability and methodological considerations. Although complex, the simulation showed an overall positive impact of RDP measures on soil organic carbon in Sicily and could be expanded at the Italian level and replicated by other Member States.

Link to Ms Criscuoli's presentation: Assessing CAP impact on soil carbon stocks with big data

After the presentation, participants posed the following questions and/or comments	
An **Austrian evaluator** asked if the effects were netted out or matched.	Ms Criscuoli clarified that the study did not include any counterfactual methodology. The implementation of RDP measures was compared with the non-application of RDP measures (i.e. the control scenario).
An **Italian evaluator** asked how the collaboration with the PA was and how they managed to get the relevant data needed for the analysis.	Ms Criscuoli clarified that the PA became more collaborative in sharing the information since the implementation of a recent Italian law on carbon credits, though she highlighted that personal contacts were also key.
A representative of the **Dutch MA** asked if there are other examples across MS.	Ms Criscuoli reported that they had interactions with many Member States in the framework of the European Joint Programme on Soil, but the analysis was done only in Italy due to some budget constraints in the other countries.
The **Luxembourgish PA** confirmed that doing soil analysis is very expensive; therefore, it is advisable to find solutions in this regard to demonstrate soil organic carbon variation over time.	Ms Criscuoli agreed and mentioned that there are other solutions, such as modelling or remote sensing, even if technically complex. In her opinion, in the framework of carbon credits, the certification body is the most expensive cost, especially for small farms.
A representative from the **Swedish MA** highlighted that the Swedish data from invasive alien species (IAS) and land parcel identification system (LPIS) are available for evaluators and researchers, but they are often not aware of this resource; thus, it is a matter of data awareness, keeping in mind confidentiality agreements.	Ms Criscuoli agreed and mentioned the limitation of having experts involved in research analysis who do not have experience with the policy environment. A Spanish researcher added that often, stakeholders have the limitation of working in silos.

After the presentations, participants jointly brainstormed potential solutions or strategies to overcome the challenges identified the day before.

4. Field trip

A field trip organised by the hosting organisation, the German Federal Ministry of Food and Agriculture - Department CAP Strategic Plan, Direct Payments EAFRD, and the German Network - Deutsche Vernetzungsstelle Ländliche Räume - für die Gemeinsame Agrarpolitik der EU (DVS), took place following the GWP, during which participants were introduced to the LIFE+ project 'Hannoversche Moorgeest'. Years of drainage had severely disrupted the hydrologic balance of these bogs, but the EU-funded project is now working to re-wet the moor landscapes, restore vital habitats, and contribute to climate protection. The guided tour led participants along the 'Moor Adventure Trail' and off-trail deep into the moors, highlighting key challenges such as land acquisition, practical re-wetting methods, and sustainable agriculture near protected Natura 2000 sites.

Participants of the field trip to the 'Moor Adventure Trail' near Hannover

5. Concluding remarks

The presentations and discussions on both days of the workshop identified a series of challenges for using big data in assessing the environmental impacts of the CAP, as well as key actions to facilitate its use.

Data fragmentation and accessibility are the most frequently mentioned challenges, as data is fragmented across sources (e.g. soil maps, administrative data, private companies) and collected for different purposes. For example, soil maps are helpful but not always designed with CAP evaluations in mind. At the same time, accessing big data can be complex due to legal, technical or administrative barriers. For example, data may be in formats that are not accessible, as evaluators stressed the difficulty in locating and interpreting available datasets. Some datasets, like Copernicus, are open, but high-resolution or harmonised administrative data can be restricted or not readily usable. At the same time, farmers may be reluctant to share data (e.g. in FSDN) and require incentives to do so.

There are **several ways to improve data availability and access**. A first step is to increase awareness among evaluators and researchers about the usefulness of big data, inform them about the available datasets, and provide guidance on how to access them. For instance, the PA, potentially in collaboration with the MA, may offer documentation on accessing IACS and establish user-friendly overviews of all available datasets by topic. For this to work effectively, the PA may need to increase the budget and staff dedicated to the provision of data. Another step is to create centralised or shared big data platforms/hubs for CAP-related data and metadata, which will reduce costs through the economies of scale derived from sharing. A good example to be replicated is the INSPIRE Geoportal, which provides an overview and access to geospatial high-value datasets and other core datasets (e.g. IACS, GSAA, LPIS) shared as high-value datasets. Another idea is to standardise protocols for sharing data across Member States, like for LUCAS. Finally, long-term data accessibility and storage (e.g. permanent storage across programming periods) can be fostered.

Data quality, reliability and accuracy are other challenges. It relates to open-source satellite data, which may lack the resolution to detect small features (e.g. woody elements under 20m are not visible in many datasets), while AI-based maps may contain errors due to unvalidated algorithms. For biodiversity, limited monitoring (concentrating on only a few species) or ambiguity about some indicator definitions (e.g. what constitutes an improvement in biodiversity) may result in an incomplete picture.

Timeliness and evolution of big data are also a challenge. More specifically, time lags in data collection and availability slow down evaluations, e.g. anonymisation and data cleaning delay access to usable datasets. Additionally, some environmental effects (e.g. water quality) may not become evident until after long periods, rendering short-term evaluations unreliable. EO products and data sources evolve, affecting comparability; for example, shifts in satellite systems or classification algorithms make it difficult to assess long-term trends. At the same time, the lack of consistent longitudinal data, when missing or incomplete, makes it difficult to establish causal links between CAP interventions and environmental effects.

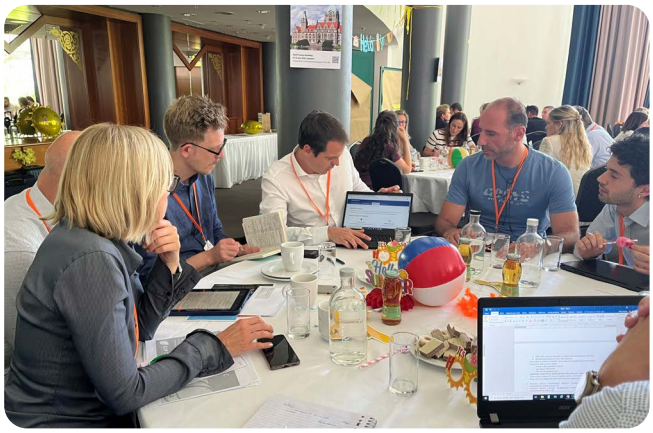
The **development of methodological tools and infrastructure may address issues related to data quality, accuracy and timeliness**. MAs and PA may use researchers or knowledgeable staff to develop reusable, open-source data processing tools and methodological guides for evaluators and promote remote data access models, e.g. analysis without downloading sensitive data. They may also pool resources to create shared data centres that clean, structure, and distribute data. The integration of EO, administrative and environmental data into cross-sectional datasets (e.g. meteorological/climate data plus interventions) may also address some data quality and accuracy issues. The accuracy of results from using big data can be improved through triangulation approaches, which combine big data with fieldwork or case studies.

Handling and merging large datasets is technically challenging without proper tools or trained personnel. **Skills, capacity and interpretation of large datasets** are therefore another challenge. Often, MAs, PA, or relevant national ministries lack in-house technical skills and computing capacity, making it challenging to manage and interpret big data outputs. **Key steps to build capacity and skills** include the development of specific training on big data handling and interpretation tailored to specific target groups (MAs, PA, ministries, evaluators/researchers, etc.) and using people with big data and analytical expertise either in-house or through cross-country technical expert exchanges.

Data protection and governance may limit data availability and usability. For instance, anonymisation is resource-intensive and time-consuming, which can slow down the preparation of data for evaluations. Furthermore, legal uncertainty and risk aversion delay sharing even non-sensitive data across ministries or between Member States. There are **suggestions on how to address data protection and trust challenges at three levels**. At the farmer level, it is essential to develop clear communication strategies to build trust with farmers and explain how data is utilised. At the regional or national level, contractual agreements can regulate secure access to sensitive data for evaluators. At the EU level, Member States can support a regulation that permits the use of geographically identifiable high-value data (e.g. IACS) with appropriate privacy safeguards.

Weak **coordination between stakeholders** (e.g. among MAs, PA, researchers and evaluators) may lead to duplicated efforts, especially when responsibilities for data collection and usage are unclear. Institutional competition and misalignment of expectations may hinder collaboration (e.g. MA are comfortable with approximations, while researchers require exact metrics). **Coordination between stakeholders can be improved** by involving relevant stakeholders in evaluations of environmental impacts from the outset (e.g. MAs, PA, evaluators and researchers), while also fostering cross-cooperation among Member States to share costs, expertise and methodologies. Such coordination would bring benefits, such as making more efficient use of the available expertise and resources, while establishing better points of comparison by analysing comparable findings across different conditions and contexts.

Finally, high upfront **costs for infrastructure, staff and software** are needed to manage and use big data, which may deter investments by public authorities. Similarly, from the farmers' side, data collection is burdensome (e.g. mowing, grassland maintenance), making participation in data systems like FSDN less attractive. It is **important to strike the right balance between the costs and benefits of using big data**. There are ways to keep costs low when starting small and scaling up, e.g. pilot region-based evaluations before national ones. The usefulness of big data can be demonstrated by showcasing success stories and practical examples. At the same time, the use of big data can be cost-effective when integrated into ex ante evaluations and policy design and specified in the terms of reference and procurement processes.



Debates and group activities at the Good Practice Workshop 'Assessment of environmental impacts of the CAP', 12-13 June, Hannover, Germany.

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