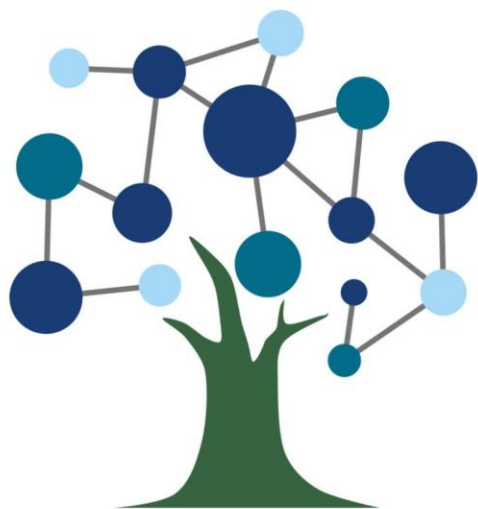




EGDC Case study – gaiasense: Precision Agriculture for Sustainable Olive Farming

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**EUROPEAN GREEN
DIGITAL COALITION**



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1 Introduction

The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions on all other sectors.

The main aim of the EGDC is to maximise the sustainability benefits of digitalisation within the ICT sector, while supporting sustainability goals of other key sectors such as energy, transport, agriculture, and construction. The Coalition recognises the need for science-based methods to estimate the reduction and avoidance of greenhouse gas (GHG) emissions by specific ICT solutions across sectors. This will accelerate the sustainability and circular transitions of these sectors while contributing to an innovative, inclusive, and resilient society.

To support the EGDC, a set of case study calculators are developed to provide a practical example of calculating the net carbon impact of a green digital solution in line with the European Green Digital Coalition (EGDC) methodology. This work aims to support the members of the EGDC with Action 2 of the [EGDC Declaration](#).

This case study methodology accompanies the ‘NEUROPUBLIC – giasense’ case study calculator and provides further details, additional context and transparency around the case study calculator to ensure the outcomes of the case study are interpreted and used correctly.



Disclaimer for European Parliament Pilot Project – European Green Digital Coalition (EGDC) Case Studies

The following disclaimer is intended to provide clarity and context for the case studies prepared as part of the EP Pilot Project, which have showcased the net carbon impact of specific digital solutions using the EGDC ICT Methodology developed during the project:

1. Purpose of the Case Studies:

The case studies served multiple purposes, including:

- **Development of the Methodology:** They contributed to the development of the EGDC ICT Methodology. These case studies were conducted concurrently with the methodology's creation and served as a valuable testing ground for its initial formulation.
- **Application Examples:** They provided practical examples of how the methodology can be applied to real-life use cases. These case studies were essential in demonstrating the practicality and effectiveness of the methodology when applied to concrete situations.
- **Identification of Improvement Areas:** By conducting these case studies, we aimed to highlight parts of the calculation in need of improvement. They shed light on the challenges and limitations inherent in using available data and indicated the necessary steps to move towards best practices in assessing net carbon impacts.

2. Data Quality as a Key Determinant:

It is imperative to emphasize that data quality is a fundamental determinant of the quality and reliability of the case studies. The accuracy and completeness of the data used significantly influence the outcomes and findings of these case studies.

It is essential to acknowledge that the data available for each case study may differ in terms of accuracy, granularity, and coverage. As a result, the case studies may not necessarily represent the best practice application of the EGDC ICT Methodology. Instead, they reflect the application of the methodology at various stages of data availability.

3. Liability for Errors/Omissions:

While reasonable steps have been taken to ensure that the information contained within the case studies is correct, the EGDC gives no warranty and makes no representation as to its accuracy. We accept no liability for any errors or omissions that may be present in the case studies, methodology, or related information. Users and readers are advised to exercise their judgment and seek further clarification if needed, as the information provided may evolve over time and depend on external factors beyond our control.

4. Appropriate Use of the Case Study Calculators:

The case study calculators are intended for educational and informational purposes. They rely on certain assumptions and input data to generate results.

The results of the calculators are specific to the implementation of the ICT solution and may not be representative for other implementation contexts.

As such, it is imperative for users to refrain from directly extrapolating these results to ICT solutions or implementation contexts that may seem conceptually similar.

Instead, users are advised to use the calculators as a means to understand the practical application of the EGDC ICT Methodology, thereby equipping themselves with the knowledge required to develop customized calculators specifically tailored to their unique ICT solutions and implementation circumstances.

In conclusion, these case studies provide valuable insights into the calculation of the net carbon impact of digital solutions through the practical application of the EGDC ICT Methodology. However, it is vital to exercise caution when interpreting the results, considering the variances in data quality and the evolving nature of the methodology. The findings are indicative of the methodology's potential and its room for refinement as we work towards more accurate and comprehensive assessments of net carbon impacts.



2 Methodology

ICT Solution and assessment overview		Organisational contribution
<p>gaiasense, NEUROPUBLIC’s precision agriculture platform allows for data driven farming.</p> <p>Without this solution, farmers follow traditional practices which often involve suboptimal use of fertilisers, plant protective products and water. This also leads to higher spend in fertilisers, and numerous environmental consequences to the surrounding area such as leaching and volatilisation of nitrous oxides due overapplication of fertilisers.</p> <p>This case study is an ex-post assessment carried out in Crete, Greece for olive cultivation. Data has been collected in 2022 and 2024 for 9-month cultivation cycles on the same land.</p>		<p>NEUROPUBLIC worked to innovate, develop, and deploy the solution. This aligns with A-level classification as defined by ITU-T L.1480 (contribution of the integrated solution or the innovation of the solution).</p>
		Other identified impacts
		<p>Reduction in fertiliser use leads to significant cost savings for the farmer.</p> <p>However, NEUROPUBLIC is exploring measures to ensure that cost savings are re-invested in ways that further reduce emissions rather than increase them.</p>
		<p>Reduced fertiliser use can also deliver benefits:</p> <ul style="list-style-type: none"> • Reduced run-off improves local water quality and reduces eutrophication that cause algal blooms and kills aquatic life. • Nutrient pollution can disrupt the natural flora communities favouring the fast-growing species, creating consequences for both flora and fauna. • Improved soil health, decreased acidification and salinisation as well as increase organic matter retention. Which relates to healthier ecosystems.
Quantified impacts		
Assessment period:	9 months	
Net carbon impact range:	-1.7 to -2.5 tCO ₂ e	
Net carbon impact:	-2.1 tCO ₂ e	
Net impact per kg product:	-0.56 kgCO ₂ e/kg	



Discussion of results

The range of results shows a relatively low uncertainty demonstrating the quality of the data collection. An alternative source of uncertainty that is not captured in the uncertainty range is the effect of the change in yield. The calculation may overestimate the emissions avoided by assuming that the change in yield occurs due to the solution alone. If the impact of the increased yield is removed, the results show 7% lower avoided emissions demonstrating a lower bound in the unlikely event that none of the yield change occurred due to the solution. Yield variations may also be influenced by seasonal conditions, and longer-term observations could provide additional context for interpreting these effects.

Glossary of terms

Term / Acronym	Description
ICT	Information and Communication Technologies
DSNZ	UK Government - Department for Energy Security and Net Zero
CO ₂ e	Carbon dioxide equivalent
N ₂ O	Nitrous oxide
gaiasense	NEUROPUBLIC's integrated smart farming solution for precision agriculture
gaiaTron	Telemetric agrometeorological station used within the gaiasense system
Earth Observation	Satellite-based environmental and agricultural monitoring data
Proxy data	Substitute or estimated data used when primary data are not available
Cradle-to-grave	A full lifecycle perspective that assesses the environmental impacts of a product or system from raw material extraction



	(“cradle”) to end-of-life disposal (“grave”).
For further clarification of terms, please refer to the EGDC Net Carbon Impact Methodology for ICT Solutions (EGDC - ICT Methodology)	

Name of solution - gaiasense	
Assessment Objective	<p>The purpose of this assessment is to quantify the avoided emissions from NEUROPUBLIC’s gaiasense advanced smart farming system. gaiasense is designed to support farmers in making better decisions for crop cultivators through real-time data collection and analysis. It combines information from field-installed sensors, satellite images, meteorological models, and agronomic knowledge, providing users with accurate and location-specific advice on irrigation, fertilisation, and plant protection.</p> <p>This case study will focus specifically on the use of the digital solution to transition from uniform, resource-heavy farming to smart, sustainable agriculture. The output of the assessment will demonstrate the solution’s impact on reduced consumption of fuel, electricity, water, and chemical use.</p> <p>This assessment focused on one implementation context in Crete, Greece, with data collected based on the crop harvesting season for olives.</p> <p>The assessment is based on primary data collected from farmers participating. While reasonable efforts were made to use the most reliable data available, certain field-level data are dependent on information provided by third parties.</p>
Solution Description	<p>NEUROPUBLIC’s gaiasense precision agriculture platform allows for data driven farming. Without the use of the solution, farmers typically rely on conventional practices, which may result in less optimised use of inputs such as fertilisers, plant protection products and water. This can result in leaching and volatilisation of nitrous oxides due to overlapping fertilisers and oversaturation of the soil.</p> <p>The gaiaTron system includes a station which contains different elements used to monitor and detect various items such as water soil moisture, solar radiation. Based on the feedback that is</p>



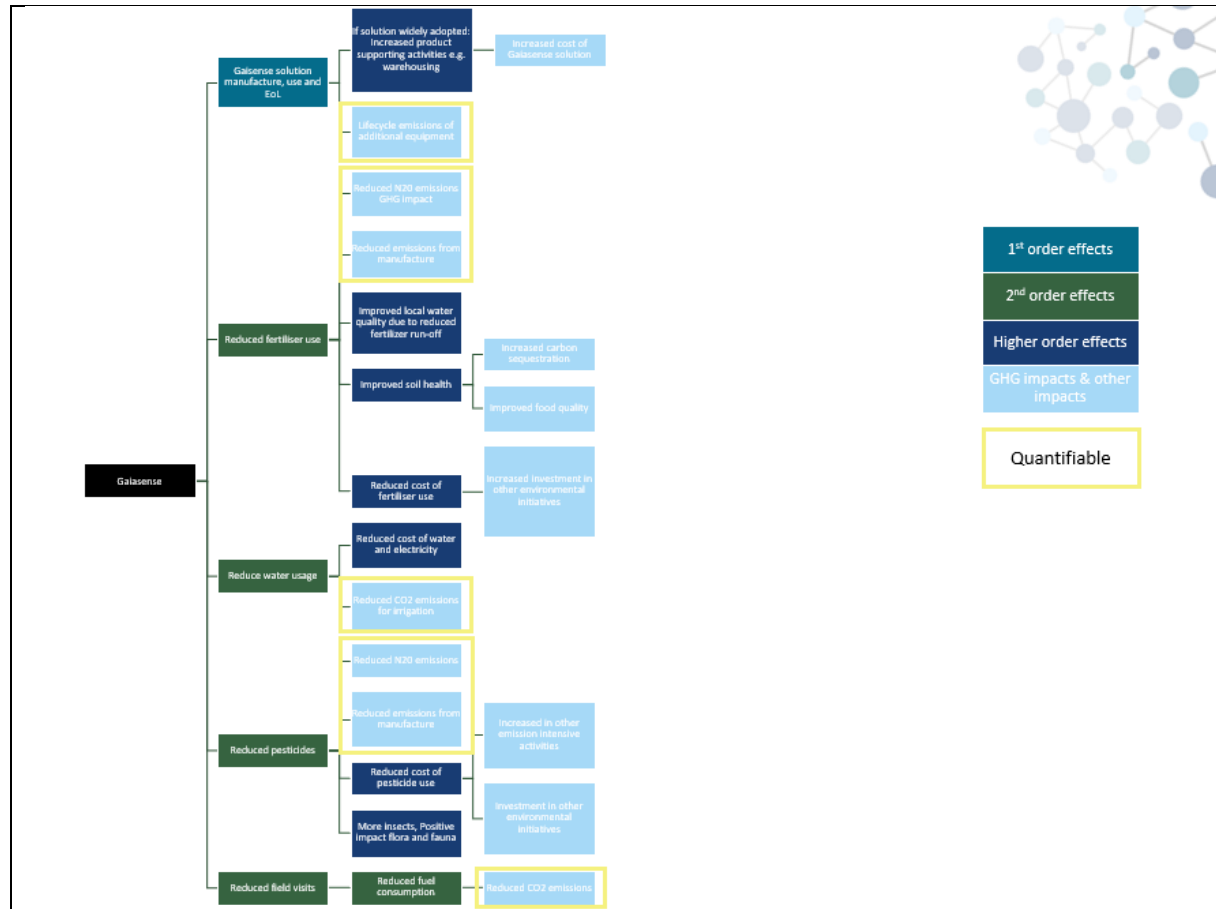
	received from the sensors allowing precise use and application of fertilisers, plant protective agents and water per hectare.
Solution Boundary	<p>gaiasense is currently deployed in an olive farm in Crete, Greece. The solution consists of the following digital components:</p> <ul style="list-style-type: none"> • gaiaTron station • Solar Radiation Sensor • Atmospheric Sensor • Leaf Sensor • Soil Multi-sensor • IoT Gateway • Weather Monitoring System (integrated gaiaTron) • Satellite Imagery (Earth Observation) • Cloud Processing & Storage • Network Infrastructure for Data Transfer
Functional Unit	<p>CO₂e emissions per kg of product</p> <p>This functional unit was selected as reporting emissions on a per-kg of product basis is considered most appropriate for these types of case studies. This reflects the primary objective of the solution, which is to reduce input use while maintaining yields. By contrast, reporting emissions on a per-hectare basis could potentially overestimate the benefit of the solution if the field size decreases in the solution scenario but total fertiliser use remains unchanged. Therefore, the CO₂e emissions per kg of product is most suitable to provide a consistent basis for comparison between the scenarios.</p>
Calculation Boundary	<p>The calculation represents the farming period of olives of 9 months.</p> <p>The geographic boundary of the solution is limited to Crete, Greece, where the grove implementing the solution is located.</p> <p>The lifecycle boundary of the assessment is cradle to grave.</p>
Reference scenario	<p>In the reference scenario, Agriculture practices follow conventional farming methods. Farmers rely on fixed schedules or previous experience to determine irrigation, use of fertiliser or application of pesticides. Farm management relies on field visits.</p>

<p>Description of 1st order effects</p>	<p>The first-order effects of NEUROPUBLIC's gaiasense solution are related to the direct environmental impacts arising from the deployment and operation of the system's components. These include the embodied emissions, use-phase emissions, and end-of-life emissions of the solution components:</p> <p>1) Hardware components (only embodied and end-of-life emissions are considered since the sensors are battery powered)</p> <ul style="list-style-type: none"> • gaiaTron Station Incl. battery • Solar Radiation Sensor • Atmospheric Sensor • Leaf Sensor • Soil Multi-Sensor • IoT Gateway – excluded as this is part of gaiaTron station • Weather Monitoring System – excluded as this is part of gaiaTron station <p>2) Network and data transmission</p> <ul style="list-style-type: none"> • Network Infrastructure for Data transfer – excluded due to limited availability • Cloud Processing & Storage – excluded due to limited data availability <p>3) Software</p> <ul style="list-style-type: none"> • Satellite Imagery (Earth Observation) – excluded due to limited data availability <p>Exclusions: Elements such as cloud computing, data transfer infrastructure and satellite imagery have not been included in the assessment due to data limitations and the shared nature of these infrastructures. While their inclusion could further improve the completeness of the assessment, their contribution is expected to be relatively low and unlikely to significantly influence the overall results.</p>
<p>Description of 2nd order effects</p>	<p>The second order effects of the solution are decrease in emissions due to reduced fertiliser use, plant protective products, irrigation, electricity and fuel emissions within the olive farms.</p> <p>More specifically:</p> <ol style="list-style-type: none"> 1. Reduces direct and indirect N₂O emissions by avoiding unnecessary applications of fertiliser and pesticides in nitrogen-rich areas 2. Reduce indirect CO₂ emissions from the production of urea 3. Reduces upstream CO₂ emissions by reducing resource consumption of pesticides



	<ol style="list-style-type: none"> 4. Reduces CO2 emissions by reducing energy consumption required by mechanised operations such as spraying, tillage or irrigation 5. Reduces CO2 emissions by reducing fuel consumption required for regular farmer visits <p>This is due to the optimisation of all these inputs applied to each designated zone.</p>
<p>Description of higher order effects</p>	<p>Reducing the volume of fertiliser and plant protection agent could have several indirect impacts including:</p> <ul style="list-style-type: none"> • Improved local water quality through reduced contamination and nutrient runoff from fertilisers and plant protection products, helping to mitigate eutrophication and related effects such as algal blooms. • Nutrient pollution can disrupt the natural flora communities favouring the fast-growing species, creating consequences for both flora and fauna. • Improved soil health, balancing the microbial ecosystems within the soil which in place support plant growth. It can decrease acidification and salinization as well as increase organic matter retention. Which relates all to the point above of healthier ecosystems. • Reduced pressure on surrounding ecosystems and agricultural biodiversity. <p>NEUROPUBLIC has observed yield increases and reduced operational costs associated with the use of the solution, although these effects may also be influenced by seasonal and external factors. As with many agricultural optimisation practices, some environmental and operational benefits may become more evident through longer-term implementation across multiple growing seasons.</p>
<p>Mapping of all effects</p>	





Description of calculation

1st Order Effects

The solution emissions are calculated by summing the annualised embodied emissions, annual use-phase emissions, and annualised end-of-life emissions of all hardware, as well as emissions related to the use of gaiasense.

Use-phase emissions are calculated from the battery consumption of the gaiaTron. A standard battery lifetime 3-5 years has been assumed.

Embodied emissions account for the contributions from materials used in device components.

End-of-life emissions are calculated by multiplying the weight of flow mass controller by the relevant waste emission factor.

Total first-order emissions are obtained by summing up the contributions from all items including embodied, use-phase, and end-of-life emissions.



	<p>2nd Order Effects</p> <p>The second-order effects represent the emissions avoided due to reduced fertiliser use after implementing the solution. They are calculated as the difference between the baseline seasonal embodied, direct and indirect emissions before the solution and seasonal embodied, direct and indirect emissions after the solution is in place. This captures the fertiliser savings achieved by the system.</p> <p>It represents the emissions avoided due to the reduced use of the plant protective agents, water use, electricity use. This is calculated in the same way as the embodied emissions of the fertiliser.</p> <p>Net Carbon Impact</p> <p>Net carbon impact is calculated by subtracting the first-order emissions generated by the solution itself from the 2nd order effects. This ensures that the environmental benefit accounts for the emissions embedded in the solution components, providing a more accurate measure of the net reduction in greenhouse gas emissions.</p>
<p>Net Carbon Saving Impact of the Solution</p>	<p>Net carbon savings of solution -0.56 kgCO₂e per kg product per cultivation cycle.</p>
<p>Uncertainty and sensitivity analysis</p>	<p>The data quality analysis and resulting uncertainty calculation show that for the main second order effects: use of fertilisers, insecticides, fungicides, electricity, water, and fuel, the primary data is high quality yielding a relatively low uncertainty.</p> <p>An alternative source of uncertainty that is not captured in the quantitative analysis is the effect of the change in yield. The yield of a crop is affected by many factors and although the solution acts to improve the yield it may not be the only factor that caused the increase in yield between the reference and solution scenarios. As the calculation considers the change in the total kg of product produced it may overestimate the emissions avoided by assuming that the change in yield occurs due to the solution alone. The assessment has also calculated the change between the scenarios on a per hectare basis without any consideration of the kg of product produced which effectively removes the increased yield impact. These results show 7% lower avoided emissions demonstrating a lower bound in the unlikely event that none of the yield change occurred due to the solution.</p>



<p>Assumptions</p>	<p>Bill of materials and components weights: Have assumed that the first order effects are all equipment used within under the DSNZ IT equipment.</p> <p>Electricity emission factor Unclear whether the emission factor is of full lifecycle, however, it has been assumed that it is. The source is the Greek Ministry of Environment and Energy. These factors are officially recommended for greenhouse gas accounting purposes in Greece and were therefore considered the most appropriate available option for the scope of the assessment.</p> <p>Residue Have assumed that 50% of the residue is made up of dry matter.</p>
<p>Data sources</p>	<p>Data provided by NEUROPUBLIC: Primary data has been provided from NEUROPUBLIC in terms of hectarage, crop yield, amount and type of fertiliser, amount and type of plant protective agent, fuel type and quantity, water quantity, electricity used.</p> <p>Secondary data sources: All secondary data sources used during calculations of the first order effects have been linked within the calculator</p>
<p>Input adjustments and key considerations for usage of results</p>	<p>List of things to consider if using results in other use cases:</p> <ul style="list-style-type: none"> • Country (for the electricity grid) • Field location • Yield of crop • Field size (ha) • Fertilisers used • Nitrogen content • Plant protective agents • Water consumption • Electricity consumption • Fuel consumption • Data period
<p>'Do no harm' criteria</p>	<p>Do not foresee any negative impacts on any of the EU Taxonomy's environmental nor social objectives and strongly supports objective 1.</p> <p>Climate change mitigation. The NEUROPUBLIC's gaisense solution is scalable, while also having the potential to positively impact biodiversity and food quality.</p>



Key areas for improvement

- The reference and solution scenarios relate to different growing seasons (2022 and 2024), which may introduce variability associated with seasonal conditions. However, the use of the same field was considered beneficial for reducing uncertainty related to spatial variability between different agricultural plots. Complementary comparisons across different fields within the same growing season could further contribute to the overall interpretation of the results.
- Quantify the first-order emissions associated with network infrastructure for data transfer, cloud computing (processing and storage), and satellite imagery (Earth observation). These components are currently excluded due to data limitations. Their inclusion would improve completeness, ensuring that all emissions associated with the implementation solution are accounted for.

