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Empowering Citizens for Environmental Action

D4.2 Initial Roadmap and monitoring plan for the activities and actions at the Case Studies – Updated M18

WP4 Case Studies Coordination and Implementation: Living Labs setup and Co-creation and Co-design with Citizens and stakeholders

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Author(s): Dimitris Kofinas, Nikos Mellios (AMRN), Sofia Gourgouliani, Chrysi Laspidou (UTH), Lucie Greyl, Sara Vegni, Ana Berti Suman (ASUD), Mirabela Marin, Ionut Mihai Hapa, Cezar Ungurean, Nicu Tudose (NIRDF), Florentina Nanu (BDG), Michalis Probonas, Christos Georgiadis (UoC), Vanessa-Sarah Salvo, Jaume Piera (ICM-CSIC), Linda See (IIASA), Francis Rowney, Nicola Rogers, Annabel Martin (Westcountry Rivers Trust), Finley Gibson, Albert Chen Lydia Vamvakeridou-Lyroudia, (UNEXE), Lorenzo Labellarte, Francesco Notarangelo (IAMB), Nehizena Osagie (Waag Futurelab), Isayvani Naicker (EviSights), Sofie Thijs, Ifigeneia Tsakalogianni (HU), Spela Zalokar (ENOLL), Sotiris Asprafkathos, Stamatia Rizou (SL), Leon Wiesner, Leo Mensel, Paul Sorrel (ECSA), Weronika Borejko (EARSC), Lisa Pourcher,Nina Olivier, Svetlana Klessova (GAC)

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Authors	Dimitris Kofinas, Nikos Mellios (AMRN), Sofia Gourgouliani, Chrysi Laspidou (UTH), Lucie Greyl, Sara Vegni, Ana Berti Suman (ASUD), Mirabela Marin, Ionut Mihai Hapa, Cezar Ungurean, Nicu Tudose (NIRDF), Florentina Nanu (BDG), Michalis Probonas, Christos Georgiadis (UoC), Vanessa-Sarah Salvo, Jaume Piera (ICM-CSIC), Linda See (IIASA), Francis Rowney, Nicola Rogers, Annabel Martin (Westcountry Rivers Trust), Finley Gibson, Albert Chen Lydia Vamvakeridou-Lyroudia, (UNEXE), Lorenzo Labellarte, Francesco Notarangelo (IAMB), Nehizena Osagie (Waag Futurelab), Isayvani Naicker (EviSights), Sofie Thijs, Ifigeneia Tsakalogianni (HU), Spela Zalokar (ENOLL), Sotiris Asprafkathos, Stamatia Rizou (SL), Leon Wiesner, Leo Mensel, Paul Sorrel (ECSA), Weronika Borejko (EARSC), Lisa Pourcher,Nina Olivier, Svetlana Klessova (GAC)
Primary Contact and Email	Dimitris Kofinas, dimitristheokofinas@gmail.com Nikos Mellios, nikosmellios@gmail.com
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Deliverable Abstract
Deliverable D4.2 presents the updated roadmap and monitoring plan for the eight ENFORCE Case Studies at Month 18. Building on the initial roadmap defined at M9 and which combined methodological directions emerging from Work Packages 2, 3, 5 and 6 and described how these have informed the preliminary planning at the Case Study level, this deliverable consolidates the operationalisation of case-specific actions, the activation of stakeholder engagement structures, and the refinement of data-driven compliance pathways across diverse environmental domains. The report documents the structured deployment of Living Labs aligned with ENoLL principles, the advancement of legal and policy assessments, and the progressive integration of institutional data, citizen science inputs, and Earth Observation (EO) technologies. It further outlines interoperability requirements and tool development processes linked to ENFORCE digital components, while introducing preparatory steps toward the Environmental Compliance – Data Readiness Level (EC-DRL) framework. D4.2 establishes a coordinated implementation agenda across all Case Studies, supported by monitoring mechanisms and KPI tracking. The deliverable strengthens the foundation for forthcoming validation and scalability phases by consolidating co-created, data-informed compliance mechanisms tailored to different regulatory and governance contexts.

Keywords
Environmental Compliance; Case Studies; Monitoring Plan; ENFORCE

Project Summary
Assuring environmental compliance requires a strong network of stakeholders, from citizens and researchers to governments and environmental organisations. Through creative toolkits and protocols, ENFORCE aims to tackle the frequent mismatch between the environmental data gathered by citizens and what authorities require for enforcement purposes. The project will address the challenges in data reporting coming from both the citizens side and the authorities' side for the obtained data to be usable for environmental enforcement. In this line, ENFORCE introduces the concept of Data Readiness Level (DRL) to assess the maturity of data to be used as evidence in environmental compliance cases. In addition, the project will capitalize on the use of geo-spatial intelligence and AI-enhanced tools, strengthening their capacities, promoting good practices and preparing an inventory on geo-spatial intelligence and AI use. The proposed

solution will ensure alignment with the Green Deal Data Space to ensure trustworthy data exchange among the relevant stakeholders. The project encompasses 8 case studies that involve all relevant actors including grassroots organizations, local and regional authorities and a diverse group of experienced researchers forming a scientifically robust interdisciplinary team. The lessons learnt and evaluation results from the case studies will feed the replication guidelines that will be promoted through the ENFORCE capacity building programme and associated policy recommendations to create a multiplier effect for the adoption of citizen science data to support environmental compliance.

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Table 1: List of abbreviations

Abbreviations	Meaning
AI	Artificial Intelligence
COST	European Cooperation in Science and Technology
CS	Case Study
DRL	Data Readiness Level
EO	Earth Observation
EU	European Union
GDPR	General Data Protection Regulation
IT	Information Technology
KPI	Key Performance Indicator
LL	Living Lab

M	Month
NGO	Non-Governmental Organisation
SDG	Sustainable Development Goal
SME	Small and Medium-sized Enterprises
TBD	To be defined
WP	Work Package

Executive Summary

ENFORCE Deliverable D4.2 presents the Month 18 update of the Initial Roadmap and Monitoring Plan for the eight ENFORCE Case Studies (CSs), building on the preparatory coordination, common methodological framework, and structured planning reported in Deliverable D4.1 (Month 9). While D4.1 established the baseline roadmap and coordination architecture under Task 4.1 (T4.1), D4.2 reflects the transition from planning to implementation and early validation (Months 10–18), consolidating progress achieved across all pilots.

The deliverable outlines developments across the Case Studies in relation to policy and regulatory context, stakeholder engagement processes within the Living Labs, data collection strategies, and the integration of tools into the ENFORCE Plaza (Data, Citizens, Knowledge, and Tools sub-plazas). It documents refinements in legislative mapping, clearer definition of enforcement pathways, structured stakeholder roles, and strengthened co-creation mechanisms. Furthermore, it captures updates in data interoperability planning, validation steps for citizen science data, and alignment with methodological outputs developed under WPs 2, 3, 5, and 6.

A central component of D4.2 is the operationalisation of monitoring mechanisms. The deliverable details the activation of Case Study-specific KPIs, the consolidation of baseline data, and the establishment of structured tracking procedures. It further introduces progress toward the Environmental Compliance – Data Readiness Level (EC-DRL) assessment, supporting a systematic evaluation of each CS's maturity, operational readiness, and capacity to generate compliance-relevant evidence.

Through the revision and expansion of structured inputs across the four ENFORCE roadmaps – Legislation and Policy, Living Labs, Data and Tools, and Impact and Capacity Building – D4.2 captures more detailed and operationally relevant information while maintaining comparability across Case Studies. This includes refined indicators, updated data sources, clarified validation procedures, stakeholder engagement pathways, and strengthened communication and impact strategies, all aligned with the project's conceptual framework (Deliverable 2.1) and the defined target tier of environmental compliance.

Overall, through the consolidation of co-created compliance processes, the support of cross-WP coordination, and the advancement of data interoperability across the eight pilots, D4.2 provides a practical and structured framework for the next phase of field activities. It supports the systematic validation of ENFORCE tools and methodologies, enhances their scalability across diverse regulatory contexts, and strengthens the long-term sustainability and policy relevance of ENFORCE approaches at EU level.

1. Introduction

1.1 Aim of the Deliverable

ENFORCE addresses the challenge of improving environmental compliance assurance standards through the introduction of an open innovation framework that tests the integration of environmental citizen science data and technological solutions for environmental reporting, auditing, and compliance. To achieve this aim, ENFORCE implements a comprehensive and integrated approach centered on the development of the ENFORCE Plaza – a one-stop digital hub designed to facilitate stakeholder engagement, data certification, knowledge transfer, and tool accessibility. The Plaza hosts four interconnected sub-plazas (data, citizens, knowledge, and tools). These components are being piloted and progressively validated across eight diverse Case Studies (CSs) in seven countries, each representing a distinct environmental, legal, and social context.

The implementation of CS activities is organised in ENFORCE through Work Package 4 (WP4). The objectives of WP4 are: to develop and update a roadmap of actions for all CSs; to establish Living Labs (LLs) and co-create solutions with citizens and stakeholders throughout the project; to coordinate activities and actions across all CSs; to develop and monitor KPIs; to develop and coordinate validation procedures for ENFORCE solutions in all CSs; and to provide evidence-based knowledge and recommendations at EU level.

Building on the initial rollout and coordination agenda developed under Task 4.1 (T4.1) and reported in D4.1, this deliverable (D4.2) presents the updated roadmap and monitoring plan for activities related to the ENFORCE eight CSs. While D4.1 provided the initial roadmap at Month 9, D4.2 reflects the progress achieved and refinements introduced up to Month 18. It consolidates learning from implementation, stakeholder engagement, and technical development, and updates the planned monitoring pathways accordingly. The document remains structured around the interconnection between the methodological frameworks for environmental compliance (developed through Work Packages 2, 3, 5, and 6) and the context-specific priorities and constraints of each CS.

To support this update, CS leaders were assigned to revise and expand the structured case study inputs across the four ENFORCE roadmaps: the legislation and policy roadmap, the living labs roadmap, the data and tools roadmap, and the impact and capacity building roadmap. In addition to updating the questions used in D4.1, they were also asked to respond to newly introduced questions under each roadmap to reflect the project's progression from initial planning to implementation. This process ensured that D4.2 captures more detailed, operationally relevant information – such as refined variables and indicators, updated data sources and validation steps, stakeholder roles and engagement mechanisms, and clearer communication and evidence pathways – while maintaining comparability across case studies. The process also ensured that the collection and revision of information were undertaken in accordance with the project's conceptual framework (Deliverable 2.1), thereby supporting the clear definition of the target tier of environmental compliance.

A central focus of D4.2 is the updated assessment of each CS's maturity and operational readiness, including refinements to the strategic approach, legal and policy context, data collection and validation plans, and expected impact pathways. The deliverable presents the methodological framework and provides updated analytical profiles of the CSs, reflecting developments since the initial roadmap. The document is grounded in regular coordination with CS leaders and WP partners, desk research, and ongoing exchanges with local stakeholders. It functions as a shared reference framework to guide each CS through the next stages of co-creation and implementation, from citizen science data collection and integration into the ENFORCE Plaza to the generation of evidence suitable for compliance support and policy-relevant outcomes over the remainder of the project.

1.2 Structure of the Deliverable

The Deliverable begins with a methodological section describing the common framework agreed for the organization of CSs work. This section, initially presented in Deliverable 4.1, has been revised to reflect the current state of progress and the methodological activities planned for implementation. The next part provides individual profiles for each CS, including their general information, policy challenges, stakeholder mapping engagement actions, data collection and tools relevance as well as impact and capacity building assessment. The final section presents a summary of planned activities, monitoring KPIs, and considerations for CSs tailored plans. Supporting material and in particular the weekly meeting minutes, are included in the annex.

2. Methodology

2.1 ENFORCE Case Studies

At the core of the ENFORCE project lie eight diverse CSs designed to test, validate, and refine the project's methodologies, tools, and engagement strategies in real-world conditions. The aim of these CSs is twofold:

- To evaluate the effectiveness and adaptability of the ENFORCE tools and protocols in different regulatory and environmental contexts.
- To generate practical insights and lessons that will inform the project's policy recommendations and capacity-building actions, ensuring their relevance, realism, and replicability across Europe.

During the first nine months of the ENFORCE project (September 2024 – May 2025), important preparatory actions and coordination efforts were undertaken towards laying the foundation for the CS implementation. These activities were organised into two main categories:

1. **Overarching Organisation, Communication, and Coordination (T4.1):** Under T4.1, significant focus was placed on the cross-cutting organisation and communication processes necessary for the coherent rollout of the CSs. These included regular coordination meetings, shared planning documents, and the establishment of communication protocols among partners to streamline implementation timelines and ensure consistency across all pilots.
2. **Strategic Alignment with Methodological WPs:** Parallel to the organisational efforts, targeted exchanges were held with the leaders of WPs 2, 3, 5, and 6 to ensure that CS activities are fully informed by the methodologies, tools, and protocols under development. This alignment was critical to guide the design of data strategies, stakeholder engagement approaches, and monitoring frameworks within each CS.

Using the initial methodological framework as guidance, Months 10–18 (June 2025 – February 2026) marked the start of the implementation of the Case Study action plans. The agreed target tier of environmental compliance was operationalised through context-specific activities within the Living Labs. Engagement with regulatory and institutional stakeholders was further strengthened to ensure alignment with enforcement pathways. The monitoring framework and CS-specific KPIs were activated, with baseline data consolidated and initial tracking undertaken. In parallel, continuous coordination across WPs supported methodological consistency and iterative refinement of activities.

Image 1: ENFORCE Case Studies

2.2 Ongoing Activities for Monitoring the Roadmap Implementation

From the start of the ENFORCE project, a structured coordination mechanism was established to ensure the effective integration of CS activities with the methodological developments across WPs. This coordination structure continued and was further consolidated during Months 9–18, supporting the transition from preparatory planning to active implementation.

A central component of this mechanism has been the organisation of regular coordination meetings bringing together CS leaders and WP leaders. Initially held on a weekly basis (every Friday at 12:00 CET), these meetings continued after Month 12 on a bi-weekly basis, reflecting the maturing implementation phase while maintaining systematic oversight. The meetings function as a structured space for progress reporting, methodological alignment, KPI monitoring, and cross-case exchange, combining formal monitoring elements with open technical discussion.

Participation is expected from at least one representative per CS and per WP on a bi-weekly basis, ensuring a continuous feedback loop between field-level implementation and methodological development. This structure reinforces coherence across pilots, supports iterative refinement of tools and protocols, and ensures alignment with the project's environmental compliance objectives. To promote transparency and collective accountability, detailed meeting minutes are recorded in a live online document and stored in a shared SharePoint repository accessible to all partners.

To operationalise collaboration between Case Studies and methodological WPs, a conceptual activity framework was developed during the initial phase and further refined for the M9–18 period. The framework structures CS activities around four core thematic pillars:

- Policy and legal context;
- Stakeholder engagement through Living Labs;
- Data and tools integration;
- Impact generation and capacity building.

These pillars are explicitly linked to the methodological outputs of WPs 2, 3, 5, and 6, ensuring that implementation activities remain anchored in the project's compliance assurance framework. Following Month 9, the framework was updated to reflect WP developments, evolving CS needs, and the operationalisation of monitoring mechanisms.

Accordingly, this updated roadmap deliverable (M9–18) maintains the original architectural structure while refining its content. It first presents the consolidated methodological basis and cross-WP alignment, and subsequently details how these methodological directions are translated into tailored implementation plans at the CS level. Each CS section begins with a concise CS description to ensure a shared understanding of its environmental compliance priority and regulatory focus, followed by updated implementation plans outlining both completed activities (Months 9–18) and planned next steps.

Overall, D4.2 deliverable updates and further operationalises the original roadmap by incorporating revised, implementation-driven information from all CSs, while preserving the common framework and ensuring comparability, methodological coherence, and strategic alignment across the project.

2.3 Key Performance Indicators (KPIs) for monitoring CSs progress

To ensure consistent monitoring, evaluation and comparability across the ENFORCE CSs, a set of Key Performance Indicators (KPIs) was initially selected based on the project's objectives, the nature of environmental compliance challenges, and the specific activities foreseen at the CS level. This set of KPIs has been updated following activities implemented until M18 at the CS level.

Table 2: KPIs specifically developed for monitoring the progress of each CS

KPI	Description	Measurement Method	Baseline/ Target Value	CSs monitoring plan dimension	Status (M18)
Identification of links between environmental compliance and socio	Number of existing laws, policies, strategies, foundational concepts, analysis of	Texts identified	50+	Legislation and Policy	**Achieved Continuous Update** All CSs completed legal and policy mapping (68 refs). Regulatory

technical innovation-	results from 'perception analysis' questionnaire, number of best practices gathered, analysis of expert interviews				frameworks identified. Review will be updated if needed.
Diversity of case-study related admissible court evidence	Tracks the number of jurisprudence and legal cases collected per CS	Jurisprudence and legal cases identified	20+	Legislation and Policy	**Continuous Update Context-dependent.** Jurisprudence reviewed in several CSs (23 refs). Some CSs focus primarily on administrative compliance rather than litigation. Legal case mapping completed where relevant; admissibility frameworks analysed.
Diversity of case-study related legal issues	Tracks the number of specific environmental issues tackled per CS aiming to utilise citizen science data in order to promote environmental compliance	Issues identified	20+	Legislation and Policy	26 refs.
Number of Stakeholders involved in	Tracks the number and representation	Stakeholder lists	10+	LLs Roadmap	173+

LLs in different spatial levels	of stakeholders on each CS				
Frequency of Engagement Activities on each CS	Measures the frequency of activities in which stakeholders are engaged	Log of LL sessions	At least 1 per year	LLs Roadmap	On track. See table 6.
Stakeholder feedback on each CS	Ensures that stakeholders insights are recorded and fed back into the process	Inclusion of feedback synthesis in LL activity reports	On each co-creation action	LLs Roadmap	On track. See table 6.
Data Quality and Readiness Level (DRL) Achievement Rate	Percentage of collected citizen science data that meets the required DRL for regulatory use.	CSs monitoring activities	80% of data reaching a DRL sufficient for use in legal or policy contexts by the mid-point of the project	Data and Tools	TBD
Tool Integration and Interoperability Score	Number of data collection tools successfully integrated into the ENFORCE digital ecosystem, including compatibility with existing regulatory data platforms and	CSs monitoring activities	Integration of at least 75% of CS-specific tools by the second project phase	Data and Tools	TBD

	the ENFORCE Plaza Toolkit.				
Stakeholder Engagement and Training Metrics	Number of stakeholders trained in data collection, validation, and interpretation, including citizens, scientists, and regulators	CSs monitoring activities	500 trained participants across all CSs by the end of the project, with at least 80% reporting increased confidence in using the tools.	Data and Tools	TBD
Stakeholder Engagement Coverage Index	Percentage of identified key stakeholder groups (e.g. citizens, legal professionals, NGOs, policymakers) actively participating in project activities (workshops, co-creation sessions, training, etc.) across all CSs.	CSs monitoring activities	≥ 80% of mapped stakeholder categories engaged in at least one structured activity by Month 24	Impact, Exploitation, Dissemination and Communication and Capacity building	On track. See Table 6.
Citizen Science Uptake for Environmental Compliance	Proportion of citizen-generated environmental data integrated into official	CSs monitoring activities	≥ 60% of CSs demonstrate formal use or	Impact, Exploitation, Dissemination and Communication and	TBD

	reporting or regulatory processes across CSs		recognition of citizen data in institutional frameworks by project end.	Capacity building	
Capacity Building Effectiveness Score	Percentage of trained stakeholders (citizens, NGOs, legal actors) who report improved understanding and confidence in using project tools and frameworks (e.g., ENFORCE Plaza, DRL, apps)	Case studies monitoring activities	≥ 80% of respondents rate training and materials as "effective" or higher in post-training assessments across CSs	Impact, Exploitation, Dissemination and Communication and Capacity building	TBD

2.4 Case Studies specific Sustainable Development Goal KPIs

Each CS will determine which specific Sustainable Development Goal (SDG) KPIs are most directly supported or advanced by the activities and outcomes of the project. The ENFORCE project will take responsibility for systematically monitoring and reporting on these KPIs. Where possible, ENFORCE will also provide quantitative assessments to illustrate the extent to which each KPI has been positively impacted or improved through the project's interventions. Following qualitative progress on CSs Environmental Compliance Objective, the priority for the upcoming reporting period will shift from framework development to strengthening the robustness, reliability, and governance integration of CS monitoring while formally integrating SDGs–aligned KPIs into the monitoring and reporting architecture.

3. Case Studies Horizontal Action Plans

To ensure effective implementation and monitoring across CSs four horizontal action plans were initially developed under the topics: **Law and Policy; Living Labs Implementation; Data and Tools; Impact, Exploitation, Dissemination, Communication & Capacity Building**. Each thematic plan was structured according to a phased logic encompassing preparatory activities, development processes, and validation/assessment steps. This structure was designed to facilitate the integration of methodologies and knowledge generated under the different ENFORCE Work Packages into concrete co-creation and implementation activities at CS level.

The allocation of tasks under these four themes ensured that methodological outputs from WPs 2, 3, 5, and 6 were systematically translated into operational pathways within the CSs. In this way, the horizontal action plans created a common framework while enabling each CS to develop its own tailored implementation roadmap aligned with its specific environmental compliance objective, regulatory context, stakeholder ecosystem, and data landscape. The development of these plans was based on structured exchanges with WP and Task leaders and iterative discussions within WP4 coordination meetings.

For the M9–18 period, these horizontal action plans were updated to reflect the transition from preparatory coordination to active implementation. The processes described in the following sections – supported by the respective figures – focus on highlighting the methodological steps and actions completed or in progress by M18, including Living Lab activation, stakeholder engagement intensification, KPI operationalisation, data pathway refinement, and initial steps toward validation and Environmental Compliance – Data Readiness Level (EC-DRL) alignment. **This section enables a thorough reading of CSs activities and achievement presented in Section 4.**

The implementation of the ENFORCE methodological framework across the Case Studies during this period has generated important insights regarding its practical applicability and adaptability. Core assumptions underpinning the Living Lab approach – particularly the value of co-creation, iterative stakeholder engagement, and the combination of value coming from citizen-generated and institutional data – have been addressed in practice. This has been especially evident in contexts where early trust-building with stakeholders was achieved and where clear compliance-relevant use cases for data integration were identified.

At the same time, implementation experience has revealed the need to recalibrate certain initial work hypotheses. Case Studies have not progressed uniformly, and the shift from preparatory phases to operational activities proved more dependent than initially anticipated on differentiated Environmental Compliance Objectives, local institutional readiness, data accessibility constraints, and legal or procedural requirements. Variations in enforcement cultures, administrative capacity, and data governance conditions influenced the pace and sequencing of activities.

In response, the methodological framework has been applied with increased flexibility during M9–18 ensuring in parallel certain milestones were achieved. Case Studies were enabled to adjust timelines, refine data collection and validation pathways, and tailor Living Lab formats to local

capacities and stakeholder dynamics, while preserving alignment with the overarching ENFORCE compliance framework and monitoring structure. This adaptive approach strengthens methodological robustness without compromising comparability across CSs.

Consequently, the roadmap is reaffirmed as a living operational instrument rather than a static planning document. It is continuously monitored, revised, and updated through structured coordination meetings and stakeholder feedback mechanisms, ensuring responsiveness to real-world implementation conditions, incorporation of lessons learned, and alignment with the evolving objectives and achievements of the project.

3.1 Legislation and Policy Roadmap

Based on the aforementioned, the first working thread relates to legislation and policy. As a work of line and a subject tackled by the project, it runs through the whole project and is constantly monitored. Thus, the horizontal roadmap dedicated to legislation and policy prepared identifies and visualises the separate tasks related to legislation and policy issues, but at the same time aims to stress out that legislation and policy are dimensions that cover the whole project and in which CSs are actively contributing towards the co-creation of the ENFORCE approach.

Phase A: Law and policy grounding of environmental compliance (M1-M12 Completed)

The first phase identified was the grounding of environmental compliance by collecting diverse relevant law and policy documents (laws, regulations, policies, scientific papers, grey literature etc.) and of exploring the theory linking the use of citizen science in compliance assurance. It was addressed by T2.1, T2.2 and T2.3 and completed on M16.

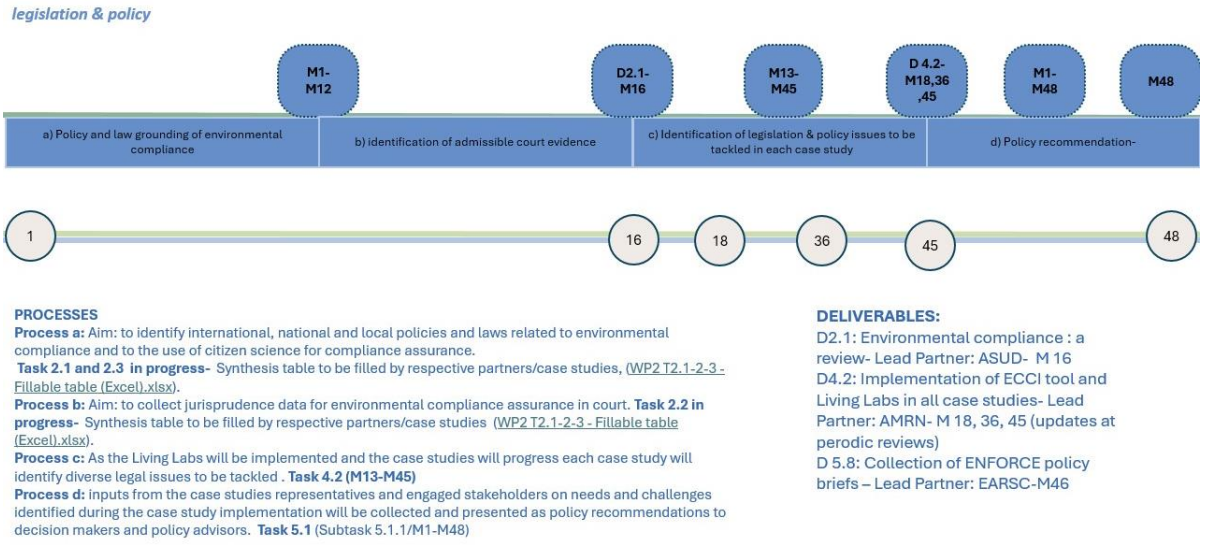


Figure 1: Legislation and Policy Roadmap

Phase A was implemented as a twofold process combining desk-based legal and policy analysis with qualitative stakeholder research, generating complementary outputs that informed subsequent methodological and Case Study activities.

On the one hand, a systematic examination was conducted of existing international, EU, national, and local laws, policies, strategies, and foundational concepts related to environmental compliance. This review also covered innovations emerging from research projects and documented in grey literature, academic publications, and relevant media sources. The analysis positioned environmental regulation within broader environmental protection research, recognising its increasing prominence as a primary regulatory instrument in response to accelerating environmental degradation and strengthened multilevel governance efforts.

Particular emphasis was placed on identifying the theoretical evolution of the notion of compliance, exploring linkages between compliance and socio-technical innovations, and analysing how such innovations can influence regulatory development and policy transformation. Special attention was given to the three thematic pillars of ENFORCE – pollution, biodiversity, and illegal deforestation – while also addressing cross-cutting and extended issues highlighted by partners, such as illegal logging within broader land-use dynamics, national and local enforcement practices, and effective compliance strategies at both policy and operational levels. The analysis incorporated an intersectional perspective across geographical scales (national, EU, and international) and environmental compliance domains, clarifying key innovative concepts and processes.

A further outcome of this phase was the consolidation of shared terminology across disciplines involved in environmental compliance. Key definitions and concepts were aligned and integrated into the project glossary (developed under T2.1), establishing a common language to support coherence across Work Packages and Case Studies.

On the other hand, qualitative methods were deployed to complement the desk research. A perception analysis questionnaire was designed and implemented to identify both actual and perceived barriers to the use of citizen science in compliance assurance. Existing datasets and documented practices in the priority areas of biodiversity, pollution, and agriculture were reviewed, and best practices were systematically collected and assessed.

To validate and enrich these findings, expert interviews (T2.3) were conducted drawing on partner networks and national stakeholder ecosystems across consortium countries. Stakeholder mapping exercises were also carried out to identify relevant actors and institutional dynamics. Together, these activities enabled a deeper understanding of the challenges faced by citizens, authorities, legal experts, and innovators working on smart compliance solutions. The results of Phase A provided the analytical basis for defining international and national legal and policy frameworks and for informing case-specific intervention pathways in subsequent phases.

Phase B – Identification of Admissible Court Evidence (M1–M12 Completed)

Phase B focused on the legal operability of compliance-related data and was implemented under Task 2.2. Building on the analytical groundwork of Phase A, this phase concentrated on identifying and systematising admissible court evidence in environmental compliance cases.

A structured collection of jurisprudence and legal cases was undertaken, covering civil, administrative, and criminal proceedings relevant to environmental compliance. Based on EU legislation and the national legal frameworks of participating Case Study countries, a list of admissible forms of evidence was developed. Each participating Case Study conducted baseline research under its national procedural law, coordinated by the respective CS leader. This research examined applicable procedural frameworks, evidentiary standards, and relevant case law, resulting in country-specific reports outlining admissibility criteria and judicial practice.

In parallel, a targeted study explored how evidence generated through citizen science can be structured, documented, and transmitted to environmental auditors, prosecutors, and judicial authorities in a legally robust manner. This analysis assessed procedural requirements, chain-of-custody considerations, and validation mechanisms necessary to enhance the legal credibility of citizen-generated data.

Together, Phases A and B established the conceptual, legal, and operational foundations for integrating citizen science into environmental compliance assurance, providing a validated basis for subsequent implementation and pilot activities within the ENFORCE Case Studies. Key results of this phase have been reported in D2.1. Although the defined phases have been completed, the objective remains open to ensure continued monitoring of regulatory developments within the field. Ongoing scanning will be conducted to identify emerging requirements, best practices, evolving standards, and innovation opportunities that may necessitate enhancement of the existing framework.

Phase C: Identification of legislation and policy issues to be tackled by each case study (M13-M45 In progress)

The third phase, initiated in Month 13 and currently in progress, focuses on the case-specific operationalisation of legal and policy dimensions within each Case Study (CS). Implemented under Task 4.2 (T4.2), this phase marks the transition from horizontal legal mapping to targeted, context-driven application at pilot level.

Under this phase, each CS addresses its own distinct environmental compliance objective and regulatory environment, identifying and responding to specific legal, procedural, and institutional challenges linked to its line of work. Given the diversity of environmental domains covered – aligned with the ENFORCE pillars of pollution, biodiversity, and illegal deforestation – each CS develops tailored modelling activities and deploys case-specific tools to support the integration of citizen science data into compliance assurance processes.

The implementation of Phase C encompasses:

- The adaptation of methodological outputs to local legal frameworks;
- Collaboration with competent authorities to align citizen-generated data with mandatory reporting systems;
- Clarification of procedural pathways for data validation and potential admissibility in administrative or judicial proceedings;
- Assessment of institutional readiness and enforcement workflows;
- Documentation of modelling activities and operational adjustments within each CS.

As each CS operates within a different legal, administrative, and environmental governance context, the treatment of these issues varies according to local capacities, regulatory maturity, stakeholder engagement levels, and data governance conditions. The phase therefore adopts a flexible yet structured approach, allowing CSs to tailor legal and policy integration pathways while remaining aligned with the overarching ENFORCE compliance framework.

Initial findings and implementation-based insights emerging from this phase have been partially reported in D4.4. Ongoing activities continue to refine the interaction between citizen science, technological tools, and compliance assurance mechanisms, progressively strengthening the legal operability and institutional integration of ENFORCE solutions across pilots.

Phase D: Policy recommendation (M01-M46 In progress)

The fourth phase will come as a complement to the third process concerning the legal and policy issues identified during the CS implementation and will develop in a two-fold way, both benefiting the CS and letting them benefit from relevant stakeholders.

Thus, following a thorough mapping, the partners will make use of their network with the "EEEs" and other EU bodies interested, such as the European Parliament, Council of Regions and "EUSPA" to initiate a fruitful dialogue on the issues tackled by ENFORCE. The stakeholders' diverse needs and challenges will be collected and shared with the CSs in order to enrich their outputs and broaden their research horizons.

Moreover, the CS representatives and involved stakeholders, based on the law and policy issues encountered, will collect, develop and present CS specific policy briefs to decision makers and policy advisors. This step is crucial for reinforcing the partners' transnational collaboration as emerging regulatory framework for global environmental governance comprises an almost endless variety of forms of novel transnational regulatory activity (Mclntyre, 2018). The policy recommendation process derives from the implementation of the CSs, which will be, this way, given the opportunity both to set the foundation for further research and action. CS will be thus able to share the challenges that they encountered with relevant stakeholders as a paradigm and sustainable legacy for a future intervention agenda.

Conclusion: Law and policy as an "umbrella" for the ENFORCE project

The ENFORCE project aims to evolve into a true agent of change regarding the fruitful use of citizen science data towards environmental compliance. The procedure analysed above is based on four different processes, approaches environmental compliance, both in a theoretical and in a practical way, aiming to tackle diverse environmental issues and, ultimately, act as a prototype for the handling of relevant subjects in future endeavors. Thus, legislation and policy are not just a one-off subject for the ENFORCE project but an "umbrella" running through its whole implementation aiming to bring true and meaningful change on the crucial issue of environmental compliance and to enhance the purposeful contribution of citizen science towards this goal.

With the completion of Phases A and B, the ENFORCE has established a solid legal and policy foundation underpinning its approach to environmental compliance. Through the systematic mapping of regulatory frameworks, conceptual developments, socio-technical innovations, admissible court evidence, and procedural requirements across jurisdictions, the project has clarified both the theoretical and operational dimensions of compliance assurance. In this way, subsequent CS implementation (Phase C) builds upon validated legal principles and admissibility criteria.

3.2 Living Labs Roadmap

The ENFORCE project applies the LL approach, led by ENoLL, to co-create environmentally compliant, citizen-centered innovations. This is being implemented through four participatory co-creation phases: perceive, co-design, realize, and evaluate. These phases align with the Living Lab Integrative Process, a framework rooted in design thinking methodology developed by Mastelic (2019). This process provides a structured roadmap for the actions required at each stage:

- **Perceive** – Phase A: Case studies focus on empathizing; selecting a specific practice and engaging stakeholders as well as defining–uncovering existing barriers.
- **Co-design** – Phase B: This is the ideation stage, where a collaborative plan is developed with the stakeholders.
- **Realise** – Phase B : This phase shifts into action, focusing on the piloting of the developed plan.
- **Evaluate** – Phase B: The final included phase involves assessing the overall performance and outcomes.
- The Living Lab Integrative Process identifies two additional stages, Implement and Scale Up, which focus on broader solution development. However, these are beyond the scope of the ENFORCE project. However, in case CSs wish to continue the actions initiated under ENFORCE, building on the stakeholder maturity developed throughout the project, consultative support can be provided.

The project has initiated engagement of a range of stakeholders from the Quintuple Helix (citizens, government, industry, academia, and civil society) civil society/public, government, industry,

academia and natural environment in eight CS across seven European countries. LLs facilitate the development of real-world solutions, integrating research and innovation within local communities ; thus serving as the ENFORCE Citizens sub-plaza. Two iterative cycles, including workshops, will ensure continuous feedback and refinement of innovations. The project will focus on a multi-level approach (micro, meso, macro) to drive sustainable, evidence-based solutions (Beaudoin et al., 2022; Engez et al., 2021). The design and assessment of the Living Labs in the 8 CSs is organised around the activities of T2.4 and Task 4.3 while activities around T4.1/T4.2 will focus on implementation while ensuring alignment with CSs Plaza Development specificities.

Phase A (Preparatory Phase M01-M12 Completed

The primary objective of Phase A was to ensure that all Case Studies (CSs) developed a clear understanding of the LL methodology, while enabling ENoLL to gain in-depth insight into the specific characteristics, institutional contexts, and operational capacities of each pilot site. This mutual understanding supported the co-design of the implementation phase and informed the prioritisation and contextual deployment of the ENFORCE Plaza tools.

The first activity under this phase consisted of a structured survey designed to capture the specificities of each CS in relation to Living Lab implementation. The survey was conducted by ENoLL under Task 2.4 and completed by Month 3 (M3). The results provided a baseline mapping of stakeholder ecosystems, governance structures, and LL readiness levels across the pilots. Subsequently, a self-evaluation home assignment was designed and distributed by ENoLL to all CSs. This exercise aimed to assess key components of their Living Lab processes, including maturity, stakeholder engagement mechanisms, co-creation practices, and governance arrangements. The evaluation of these submissions informed the identification of gaps, capacity-building needs, and tailored follow-up actions. This assessment process has been completed for all CSs.

The second activity comprised a series of internal training sessions delivered by ENoLL in collaboration with the CSs under Task 2.4. These sessions, completed by Month 6 (M6), focused on core Living Lab principles, stakeholder engagement strategies, panel management techniques, governance models, and practical take-away exercises. The trainings strengthened the methodological coherence of LL implementation across Case Studies. Following the training phase, an initial LL self-assessment framework and monitoring strategy were designed and implemented. In parallel, action plans were co-developed through close collaboration between Tasks 2.4 and 4.1, finalised by Month 9 (M9). This process was supported by recurring WP4 coordination meetings and bilateral exchanges with WP and Task leaders, ensuring alignment, shared understanding, and integration of methodological guidance into CS-level planning.

Overall, Phase A established a structured methodological baseline, strengthened LL capacities across all Case Studies, and laid the groundwork for coherent and context-sensitive implementation in subsequent phases.

Phase B (Implementation Phase M13-M45 In progress)

Phase B, initiated in Month 13 and currently in progress, focuses on the operational implementation of Living Labs (LLs) across the Case Studies (CSs). This phase moves beyond preparatory alignment and capacity building, concentrating on the execution of engagement activities, timeline management, and the active involvement of local stakeholders in co-creation processes. The first step of Phase B involved the analysis of the initial LL self-assessment framework by ENoLL under Task 2.4. This analysis identified maturity levels, governance gaps, and priority areas for strengthening LL structures in each CS. Based on these findings, targeted internal training was delivered by ENoLL (T2.4), with outputs to be documented in Deliverable D2.2.

A central methodological instrument deployed during this phase is the **LL Mapping Canvas**, a tool developed by ENoLL to systematically guide CSs in structuring and refining their Living Labs. Through the mapping of key components, such as stakeholder ecosystem, governance model, value proposition, engagement mechanisms, and impact pathways, the Canvas enables CSs to identify knowledge gaps and operational weaknesses. This structured reflection supports the development of Macro-level Living Labs capable of sustaining long-term co-creation and compliance-oriented innovation.

In addition, a dedicated workshop was organised by ENoLL during the 2025 General Assembly (GA) under Task 2.4 (to be reported in D2.2), reinforcing alignment across CSs and fostering peer learning. Further training activities will continue in subsequent phases to ensure sustained methodological coherence and progressive refinement of LL implementation.

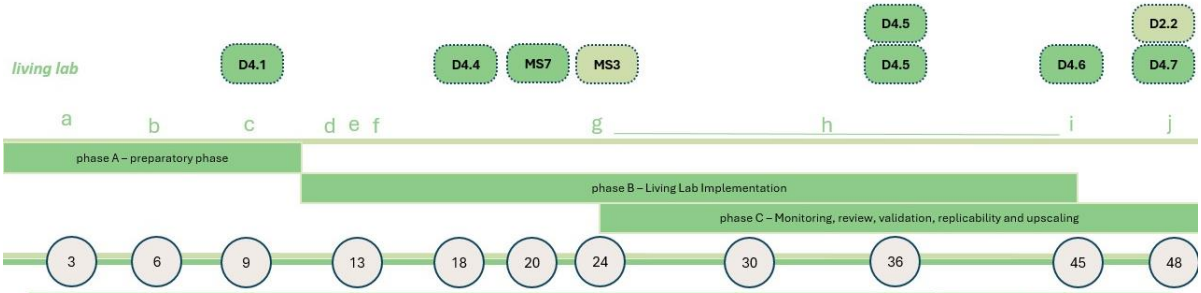
By the conclusion of Phase B, the Living Labs are expected to be fully operational and aligned with defined Key Performance Indicators (KPIs). The planned engagement structure includes:

- 4 workshops per CS across 2 iterative cycles, resulting in a total of 32 workshops realizing the Living Lab Integrative Process framework in each CS;
- **1 physical user uptake workshop per CS** (8 workshops in total), linked to WP5 activities;
- **added online workshops** dedicated to training CS leaders on LL methodology if needed;
- 3 internal and 2 external co-creation and exploitation workshops, totalling 5 workshops (linked to WP6).

Through these structured engagement activities, Phase B strengthens stakeholder ownership and operationalises co-creation processes through the Case Studies' Living Labs, ensuring that stakeholder needs, emerging from the broader objectives and developments of the project, are systematically integrated into implementation. This way, the Living Labs function as structured interfaces between citizen engagement, institutional actors, and methodological outputs.

The iterative workshop cycles, combined with established monitoring mechanisms and KPI tracking, ensure that Living Lab implementation remains aligned with ENFORCE methodological

standards, while allowing for contextual adaptation to the legal, institutional, and operational realities of each Case Study.



Activity	Description	Partner leading and Task
a	Survey to understand the CSs specificities in relation to LLs implementation	EnoLL/ T2.4
b	Internal Trainings to CSs and take away exercise by CSs on Living Lab fundamentals, Stakeholder engagement & Panel management, and Governance models	EnoLL/ CSs T2.4
c	1st Living Lab self-assessment framework defined and monitoring plan (input from 2.4 to T4.3) and definition of action plans together with T4.1	EnoLL/ T2.4 & AMRN/ T4.1
d	Analysis of self-assessment framework by EnoLL (T2.4)	EnoLL/ T2.4
e	Internal training by EnoLL (T2.4)	EnoLL/ D2.2
f	WS in the next GA by EnoLL (T2.4)	EnoLL/ D2.2
g	Evaluation and monitoring methodology for LLs – final decision on KPIs i) & ii)*	EnoLL/ D2.2
h	Regular feedback loop during implementation – position of WSs frequency during implementation to be confirmed	EnoLL/ T4.2 and CSs
i	Completion of Living Lab WSs	EnoLL/ T4.2 and CSs
j	Evaluation and upscaling results from LLs	EnoLL/ T2.4 & 4.3

Figure 2: Living Labs Roadmap

Phase C (Monitoring and Validation Phase M24-M48 Planned)

In the middle of the implementation, Phase C will begin, focusing on monitoring, review, validation, and assessing the replicability of the initiatives. This phase will start with the finalisation of the evaluation and monitoring methodology for LLs (T4.3). In this context, there will be a regular feedback loop in parallel with the rest of the implementation phase, with the position and frequency of workshops to be confirmed, managed by ENoLL in collaboration with the CSs under T4.2. Finally, the evaluation and upscaling results from the LLs will be carried out by ENoLL under T4.3.

3.3 Data and Tools Roadmap

The ENFORCE action plan, which focuses on data and tools for environmental compliance, is structured into three distinct phases to ensure a comprehensive and systematic approach. Each phase is designed to build upon the previous one, progressively advancing the project's objectives and methodologies. Since the submission of Deliverable D4.1, the Data and Tools roadmap has progressed from conceptual alignment to early implementation and testing across several case studies. As detailed in Deliverable D4.4, case studies have advanced in refining data pathways and modeling activities, identifying indicators, testing citizen science and Earth Observation tools, and assessing interoperability and Data Readiness Levels. The roadmap presented below therefore remains

structurally valid, while its phases should be read as partially completed or ongoing, rather than purely prospective.

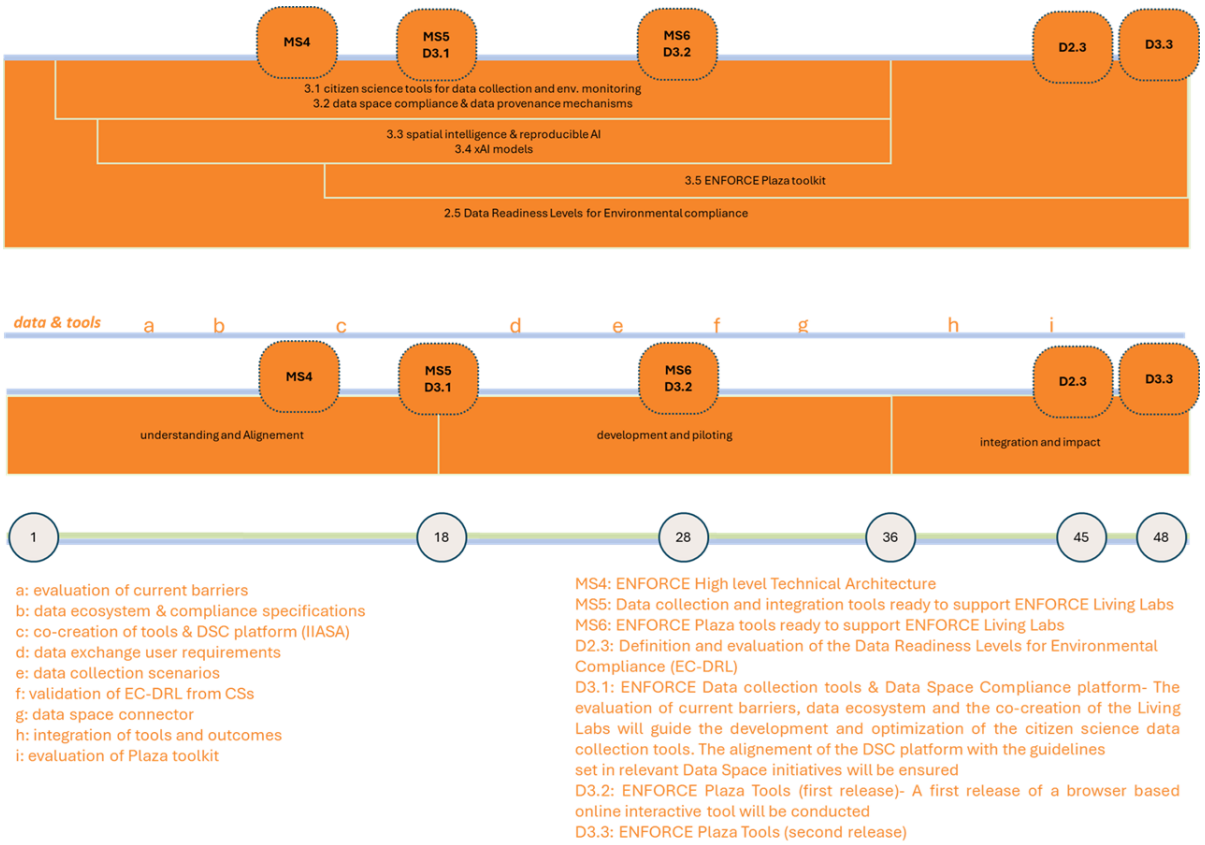


Figure 3: Data and Tools Roadmap

Phase A: Understanding and Alignment (M01-M18 Completed)

During the initial phase, the project lays the groundwork by defining the scope and objectives of various tasks. This involves high-level activities such as literature reviews, barrier specifications, and the first draft of Data Readiness Level for Environmental Compliance (EC-DRL) in terms of baseline and structure and the scale related to. The focus is on understanding the initial data collection processes and setting up frameworks for validating citizen initiatives in association with the specific use. CSs play a crucial role in this phase, helping to align the project's objectives with real-world environmental compliance needs. The analysis will be done not only for the initial process of data (or data collection), but for the whole data flow process to understand how to build a standardized tool to assess the validity and/or maturity of the citizen science data for the specific application, in other words from a fit to purpose perspective. That is totally different

concept that the data validation or quality of the data that is intrinsic at each type of data collected by CS due to it depends by the data syntax, format, granularity and protocol used. The scope of Phase A will be to capture the user needs from the CS's perspective and translate into concrete user and technical requirements that will guide the ENFORCE Plaza tools design. Figure 4 shows a schematic representation of the co-creation methodology to be followed during this stage to ensure continuous feedback and alignment with the CSs.

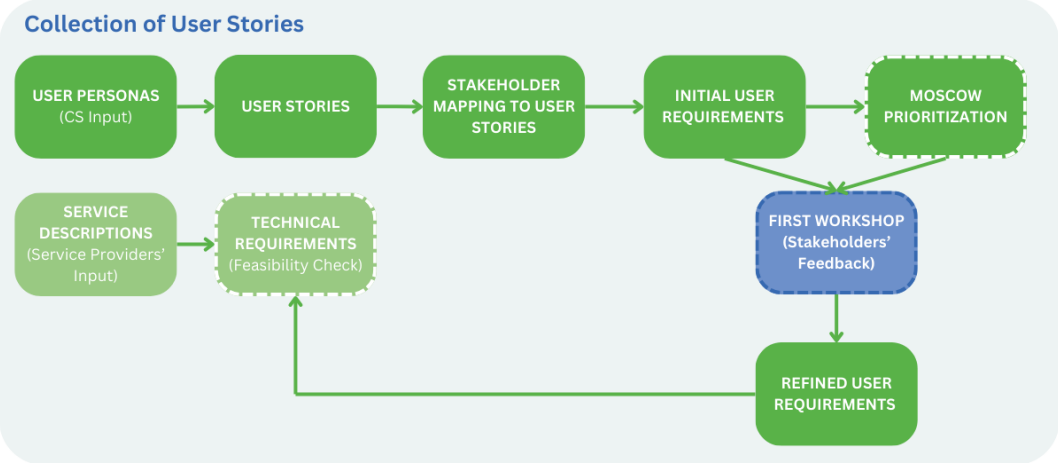


Figure 4: Co-creation methodology for tools design during Phase A

For T2.5: Data Readiness Levels for environmental compliance, this phase has focused on the identification and refinement of the scope and objectives of the EC-DRL framework. This has included defining the EC-DRLs and clarifying the characteristics required for data and information at each level from a fit-for-purpose perspective. The work has concentrated on understanding the criteria required and steps for data robustness and validity across the dataflow, and on establishing a framework for trustworthy citizen initiatives by linking maturity levels with potential uses in environmental compliance contexts (Haklay, 2015). The EC-DRL maturity levels are aligned with a fit-for-purpose approach to data usability.

During this reporting period, T2.5 has remained primarily high-level and conceptual, building on literature review, the specification of barriers, and the definition of EC-DRL scales in relation to environmental compliance needs and legislative baselines. After the literature review and the primary conceptualization, the process to set up the EC-DRL involved the communities of interest in building the framework of the scale for the maturity model. Actions like a survey, workshops and roundtables defined a year-long discussion building consensus together with scientists, jurists, experts in participatory science and citizen science project. In terms of case study involvement, T2.5 has continued to rely on feedback from T3.1 (see below), notably through the scoping of case-specific environmental compliance objectives and the characterization of existing or emerging datasets and tool ecosystems.

For T3.1: Citizen science tools for data collection and environmental monitoring, this phase has focused on laying the groundwork for the development, testing, and early operationalisation of citizen science tools across the case studies. It has involved evaluating current barriers and the existing data ecosystem (T2.3) in order to understand challenges and opportunities along the dataflow generated by citizen science activities. In parallel, Living Labs (T2.4) have functioned as collaborative environments for the co-creation, adaptation, and early testing of tools and methodologies in real or near-real contexts.

The Data Readiness Level (DRL) framework is not applied solely at the data collection stage, but across the entire data pathway. It provides a structured set of ordered criteria to describe data maturity and fitness-for-purpose (Schade et al., 2017), reflecting how well data meets the requirements of different potential uses. These criteria integrate multiple dimensions, including data science requirements (such as metadata standards, data analysis procedures, and validation thresholds), adherence to FAIR (Findable, Accessible, Interoperable, Reusable) and CARE (Collective Benefit, Authority to Control, Responsibility, Ethics) principles, as well as legislative requirements related to regulatory frameworks, data protocols, monitoring programmes, and legal compliance. Social dimensions are also incorporated, including participatory approaches, inclusivity, and stakeholder engagement in data generation and use.

Experience gained during this reporting period has reinforced the importance of applying the DRL concept as an assessment of the entire data pathway rather than focusing exclusively on initial data collection. This pathway-based approach supports the progressive validation, integration, and use of citizen-generated data in ways that are aligned with technical, legal, and social requirements, as evidenced by early tool testing and data pathway exploration reported in D4.4.

The action points of this task for this phase are to:

- Consolidate and refine the needs of the case studies in relation to their environmental compliance objectives defined in WP2.
- Analyse and update the understanding of the current data ecosystem, including existing datasets, tools, gaps, and barriers affecting citizen science data flows.
- Critically analyse criteria, gaps, and needs influencing the effective use of citizen science data along the data-to-policy pathway, following a fit-for-purpose approach.
- Operationalise Living Labs as collaborative environments for innovation, co-creation, and early testing of citizen science tools and methodologies.
- Define and refine goals and objectives for the valorisation of existing tools and the development or adaptation of new citizen science tools.

For T3.2: Data space compliance and data governance mechanisms, this phase has focused on evaluating current barriers, reviewing relevant guidelines, and clarifying objectives in relation to emerging European Data Space initiatives such as IDSA and GAIA-X. While this task remains largely horizontal in nature, it has been informed by targeted inputs from the case studies,

particularly in relation to data access, data sharing practices, and role differentiation among stakeholders involved in data generation, management, and use. Case study involvement at this stage has primarily contributed to the mapping of user roles per CS, supporting a clearer understanding of governance needs and constraints across different environmental compliance contexts.

For T3.3: Spatial Intelligence and reproducible AI, this phase has focused on scanning the case studies to identify those that can provide a clear, evidence-based narrative on how spatial intelligence can be derived from the combination of existing and emerging data ecosystems with AI techniques. Building on progress reported in D4.4, the UK case study (East Devon Catchment) has emerged as the frontrunner, demonstrating a mature multi-source data pathway that combines citizen science monitoring, regulatory datasets, meteorological context, and Earth Observation products (e.g., Copernicus accessed through the OpenEO API) to support analysis of targeted variables such as phosphates, turbidity, and land use/erosion-risk proxies.

In this frontrunner context, xAI is being explored as a means to enhance transparency and trust in analytical outputs by addressing key objectives such as: (a) assessing and improving intelligence: citizen science provides high spatial/temporal density and responsiveness, while regulatory monitoring offers accredited baselines, and EO-derived indicators strengthen catchment-scale interpretation between sampling points. These complementary sources also enable early work on data fusion and reproducible modelling pipelines, supported by defined validation workflows (e.g., review/approval processes for citizen submissions) and planned capacity-building actions such as QA/QC-focused workshops. In parallel, a general framework for establishing a comprehensive approach to spatial intelligence and reproducible AI is being consolidated to ensure transparency, methodological rigour, and reusability of analytical outputs for environmental compliance monitoring.

This involves the following action points:

- Confirm and document the spatial intelligence scope and objectives for the frontrunner CS (UK), based on the targeted variables and multi-source data pathway already defined.
- Consolidate the methodological framework for spatial intelligence and reproducible AI, building on early modelling/analysis plans and validation approaches emerging from the frontrunner.
- Formalise the data types to be analysed (e.g., citizen science measurements and observations, regulatory water quality baselines, meteorological/rainfall context, and EO products from Copernicus services via OpenEO).
- Set up and document the necessary infrastructure and reproducibility guidelines for data handling, analysis, and sharing (including clear QA/QC steps and transparent workflows).
- Identify and onboard at least a second CS with a sufficiently mature data pathway to act as a comparative implementation site for the same reproducible approach.

At the time of this update, Phase A outputs for T3.3 are consolidated and Phase B implementation has been initiated in the frontrunner CS.

For T3.4: explainable AI (xAI) models, this phase has focused on identifying the scope and types of data relevant for the application of xAI methods in environmental compliance contexts. This has included clarifying objectives, determining suitable data types, and outlining a framework through which xAI can support improvements in data quality, interpretability, and decision-making. Building on progress reported in D4.4, the UK case study (East Devon Catchment) has emerged as the frontrunner, offering a coherent and data quality, (b) guiding attention to the most relevant variables and observations, (c) supporting the categorisation of events and anomalies, (d) aligning observations with agreed semantic frameworks, (e) identifying and interpreting counterfactual or anomalous patterns, and (f) analysing feature relevance within modelling workflows. These objectives are being considered in relation to heterogeneous data streams, including citizen science measurements, regulatory monitoring data, and contextual environmental information, with the aim of ensuring that AI-supported analyses remain interpretable, reproducible, and usable for environmental compliance purposes.

In parallel, a generic framework for the application of xAI across case studies is being consolidated, drawing on insights from the frontrunner while remaining adaptable to other environmental domains and data ecosystems as additional case studies progress.

This involves the following action points:

- Confirm the frontrunner case study (UK) and refine the scope and objectives for the application of xAI models in an environmental compliance context.
- Consolidate the methodological framework for the frontrunner, building on existing analytical workflows and identified needs for interpretability, transparency, and decision support.
- Formalise the data types to be analysed, including citizen science observations, regulatory monitoring data, contextual environmental variables, and, where relevant, Earth Observation datasets from Copernicus services.
- Set up and document the necessary infrastructure and guidelines to support reproducible, interpretable xAI analysis, including data preparation, model selection, validation, and explanation workflows.
- Identify and engage at least a second case study with sufficient data maturity to act as a comparative implementation site for the xAI framework.

For T3.5: ENFORCE Plaza toolkit, this phase has focused on preparatory and exploratory work aimed at shaping the overall concept, scope, and ambition of the Plaza toolkit. Initial activities have moved beyond abstract brainstorming to incorporate structured inputs from the case studies, as reported in D4.4. In particular, case study reporting incident typologies, target

audiences, user roles, and visualisation and communication requirements has provided concrete guidance for defining the toolkit's intended functionalities and user experience.

These inputs have helped clarify how the Plaza toolkit should support different stages of the data-to-policy pathway, including incident reporting, data interpretation, and communication with diverse stakeholders such as citizens, regulators, legal actors, and journalists. While the ENFORCE Plaza remains under conceptual development, this early feedback has begun to inform the shared understanding of its role as an integrative environment for accessing tools, visualising data, and supporting environmental compliance workflows across heterogeneous case studies.

This involves the following action points:

- Provide structured feedback on the aspirations and intended use of the ENFORCE Plaza toolkit, informed by case study experience with incident reporting, target audiences, and communication needs.
- Contribute to the definition of the high-level architecture of the Plaza toolkit, taking into account user roles, data flows, and interoperability requirements identified through case study reporting.
- Draft and refine initial user requirements, including functional, visualisation, and usability needs, based on concrete case study practices and expectations emerging during the reporting period.

Phase A activities have been largely completed across the case studies, resulting in consolidated user requirements, initial data pathway mappings, and early applications of the EC-DRL concept, which now inform tool prototyping and testing activities in subsequent phases. During the last reporting period, substantial progress has been achieved across the Data and Tools workstream, with most Phase A action points under Tasks T3.1 to T3.5 either completed or actively initiated, as documented in Deliverable D4.4. Case studies have consolidated and refined their environmental compliance objectives, analysed their data ecosystems, and identified key gaps and barriers affecting citizen science data flows and data-to-policy pathways. Detailed reporting on incident typologies, target audiences, user roles, and visualisation requirements has provided concrete inputs to horizontal tasks on data governance and the conceptualisation of the ENFORCE Plaza toolkit. Living Labs have been operationalised in several case studies, supporting co-creation, early tool testing, and methodological refinement. In parallel, the identification of frontrunner case studies – most notably the UK case study – has enabled early implementation of spatial intelligence and explainable AI approaches, including the definition of relevant data types, analytical objectives, and validation workflows. While some actions, such as the formal consolidation of shared frameworks and the onboarding of additional case studies as comparative implementations, remain ongoing, the evidence from D4.4 demonstrates a clear transition from preparatory scoping to grounded, practice-informed development across the Data and Tools tasks.

Phase B: Development and Piloting (M19-M36 In Progress):

At the time of this update, Phase B activities have been initiated for selected tasks and case studies, building directly on Phase A outputs, while full implementation and scaling remain ongoing and dependent on local readiness.

In the second phase, the project shifts towards the development and implementation of data analysis methods and tools. This includes the assessment of different data collection, analysis and validation processes of each CS applying methods to improve the reliability of information collected by volunteers, developing methodologies to ensure data quality and compliance, and implementing tools to support large-scale data collection and validation. The involvement of LL and CS is essential. The validation of the data is possible only within the CS and the validation system is different for each case considering that it depends on the protocol used, the system for the validation and so on. DRL will establish the minimum criteria applicable and requirement to get trustful data along the dataflow but is not a system for the data validation. During the second phase, the design of user-friendly environments and the user flow diagrams for the Plaza Toolkit will be conducted. Further feedback on the interaction of the end users will be received during the Living Labs from each CS. During these Social Labs, both technical stakeholders and other end users could be involved.

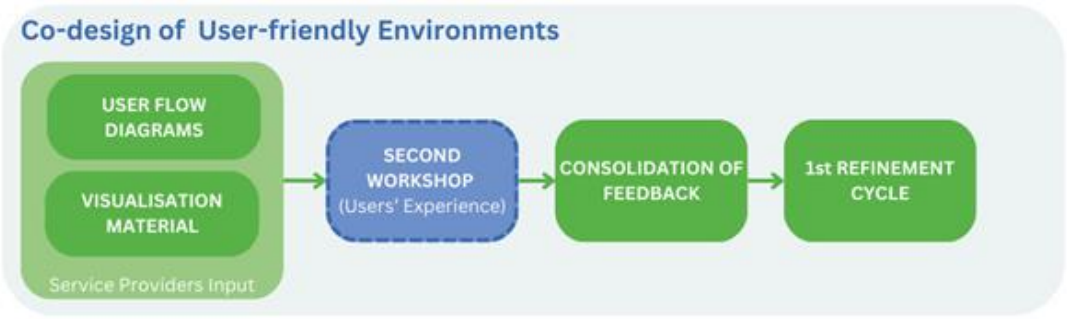


Figure 5: Co-design of user-friendly environments during Phase B

For T2.5: Data Readiness Levels for environmental compliance, this phase focuses on the development and implementation of data science methods and tools to support the EC-DRL levels. It includes work that concentrates on the application of the EC-DRL to CS. The task also involves a) applying different data science methods to progressively improve the reliability of information from the big data set collected by volunteers (synergies with T3.1), b) developing and refining methodologies to connect the data maturity to the usability in term of fit-to purpose for compliance with environmental legislation (synergies with T3.4), and c) implementing tools and processes to support the recognition of the criteria needed to establish the quality levels on the basis of Data science requirements (standards and metadata needs, data analysis and validation minima, FAIR principles, Open science etc.), legal requirements (standards requirements as protocols, monitoring programmes and alignment GDPR, etc.) and social requirements (participation, inclusion, etc.) related to data pathways for data to policy. Given that each type of analysis, whether terrestrial, satellite, biodiversity, or water contaminants, has distinct

requirements for protocols and data quality systems, it is not feasible to standardize protocols within the DRL framework. Instead, the DRL should be designed as a standard process with a set of requirements that can be applied universally, providing a consistent approach to data readiness without imposing specific, context-dependent validation and quality procedures. This means that while the DRL can define the minimum requirements for general data quality and validation, it should not attempt to prescribe the detailed processes for validation and quality control, which will necessarily vary based on the type of data and the specific scientific or operational context in which it is used. Specifically, the CS's action points relevant to this task will involve:

- mapping the criteria associated with data pathways of the data generated in terms of quality minimum r for each CS to include these in the potential criteria set for the DRL level in order to design data fit to purpose in the framework of regulatory and environmental directives.

For T3.1: Citizen science tools for data collection and environmental monitoring, in this phase, the focus shifts to the development and optimization of citizen science data collection tools (Wiggins & Crowston, 2011). F. Building on the insights from T2.3 and T2.4, existing technologies will be extended to meet data acquisition and compliance specifications for each ENFORCE LL. This phase includes:

- Developing and enhancing applications for data collection by citizens.
- Ensuring tools are user-friendly and promote engagement and collaborative participation.
- Refining case-based protocols and embedding them in relevant technologies.
- Creating narratives that highlight the importance of environmental stewardship and citizen participation.

For T3.2: Data space compliance and data governance mechanisms, this phase focuses on developing mechanisms for log-in requirements, user contracts, and identity management. It includes implementing a Data Space Connector (European Commission, 2021), creating secure log-in systems, developing user contracts, tracking data provenance with blockchain technologies, enhancing connectivity, linking to established platforms, and applying semantic models. The action point for CSs, relevant to this task is to :

- conduct tests, validate and give feedback for the developed mechanisms for compliance and secure data exchange among stakeholders.

For T3.3: Spatial Intelligence and reproducible AI, this phase focuses on the implementation of data fusion, combination, and intelligence at least two CSs. It includes:

- Applying ML algorithms (deep neural networks, k-nearest neighbour, random forest) to analyse the identified data sets.

- Implementing data fusion techniques using CNN-based, RNN-based, or canonical correlation analysis (CCA) for multimodal data from IoT sensors, CCTV, citizens, and EO.
- Complementing ML approaches with analytical methodologies such as hydrogeological analysis, contaminant fingerprinting, and chemical fate and transport modelling.
- Ensuring the methodologies, model training, and software environment are published in open access journals.
- Sharing training data, tools, and codes via frameworks like TensorFlow Hub, Model Zoo, or Model Hub to ensure transparency and reproducibility.

For T3.4: xAI models, this phase focuses on implementing data fusion, combination, and intelligence. It involves works such as developing interpretable xAI models, applying feature relevance methods, dimensionality reduction techniques, and linking model representations to knowledge graphs (van Noordwijk & Lane, 2021). The action point for the at least two CSs is:

- Implement of xAI models aiming better data quality and informed decision-making based on the characteristics of each CS

For T3.5: ENFORCE Plaza toolkit, this phase focuses on developing the ENFORCE Plaza Toolkit, an online interactive visualization tool. It includes the following action points for the CSs:

- Leading the LL co-creation activities for an informative tool for citizens to display environmental damages, handle different types of evidence, and enable selection and ranking.
- Guiding the development of advanced features for end -users (particularly journalists and NGOs) to investigate incidents, identify causes, and make meaningful associations with relevant information.
- Supporting the implementation of geospatial and timeline displays of environmental stress points and associating them with various data sources.
- Providing different types of evidence, such as written reports, videos, satellite imagery, and sensor data to support the implementation of the tool.
- Providing and validating user narratives

Phase C: Integration and Impact (M37-end of the project Planned):

Phase C remains prospective at this stage of the project, with its activities and objectives informed by early lessons emerging from Phase B but scheduled for later stages of implementation.

This final phase focuses on integrating, validating, and evaluating the developed frameworks and tools. This involves establishing comprehensive systems for trustworthy citizen initiatives and supporting environmental compliance through certified data sets fit for purpose. The ENFORCE Plaza toolkit is integrated into the platform, and its effectiveness is evaluated. CS continue to support this phase by testing and evaluating the developed mechanisms, ensuring that they meet regulatory and environmental directives and are ready for real-world application. During the Phase C the demo version of the Plaza Toolkit will be available for stakeholders to test. Additionally, a short assessment will be developed to refine the tool and its usability to the end users.

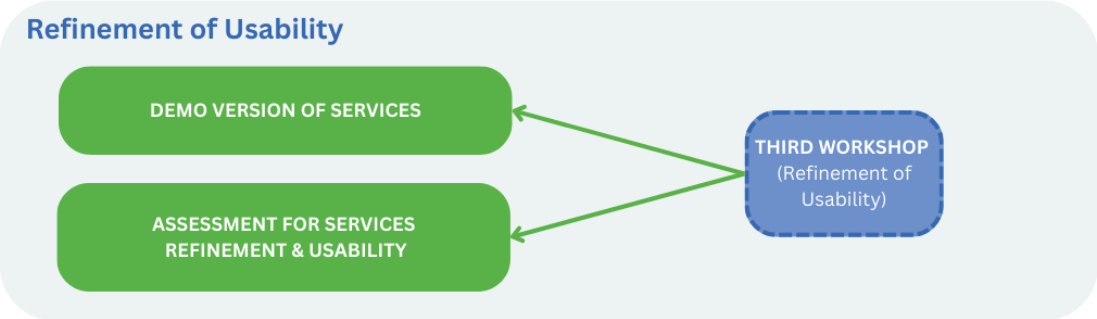


Figure 6: Refinement of Usability during Phase C

For T2.5: Data Readiness Levels for environmental compliance, this phase involves the integration, validation and evaluation of the EC-DRL. The task aims to establish a comprehensive framework for citizen initiatives and supporting environmental compliance through standardized maturity level model for certified datasets for the specific use. The CS are supporting this task through the following action points:

- testing and evaluating the EC-DRL scale analysing the response of maturity and usability of the Cs projects in the CS in order to understand the capability of the DRL system
- application of works following the task framework for the improvement of the EC-DRL
- co-development of guidelines for the improvement of the EC-DRL in a CS.

Verification of results, comparing the EC-DRL levels obtained together with competent bodies/entities in order to establish the efficiency of the EC-DRL in describing the level of maturity of data and information generated by citizens with based on the EC-DRL scale.). Before moving to validation by means the of the fit-to-purpose of data, it is essential to first validate the effectiveness of the DRL scale. This requires testing the scale in real-world scenarios to assess its functionality and relevance. Once initial results confirm that the scale is working as intended, the process of formal validation of the projects can begin, ensuring that the DRL criteria are robust, reliable, and fit for purpose.

For T3.5: ENFORCE Plaza toolkit, this phase involves integrating the developed toolkit into the ENFORCE platform and evaluating its effectiveness. The task aims to develop and integrate a comprehensive toolkit that supports various stakeholders in environmental monitoring and enforcement. The action points for the CSs include:

- Final version of the Plaza Toolkit launching
- Evaluation of the visualization implementation of end-to-end data provenance
- Evaluation of safe communication channels for witnesses with prosecutors' privilege.
- Guiding the link of the toolkit with other tools developed in WP5, such as the success stories registry, training hub, and legal guidance toolkit.
- Plaza toolkit integration with other ENFORCE Plaza components

3.4 Impact and Capacity Building Roadmap

The ENFORCE project unfolds across four interconnected phases, each designed to progressively build strategic capacity, stakeholder engagement, and measurable impact in environmental enforcement. Throughout the project lifecycle, nine thematic processes (a–i) are activated at different moments to structure activities and ensure continuity of the "Impact & Capacity building" framework (Figure 7).

Phase A: Strategic Foundation & Early Engagement (M1–M12 Completed)

The first phase of ENFORCE has been successfully completed, establishing a solid strategic and operational foundation for subsequent implementation phases. A key priority during this period was the development of the project's visibility, coherence, and shared vision through the early formulation and activation of a comprehensive communication strategy. This included the establishment of the project's branding identity, the launch of digital platforms, and the initiation of targeted outreach activities. Together, these actions laid the groundwork for a structured, long-term engagement approach designed to support stakeholder mobilisation, knowledge dissemination, and impact generation throughout the project lifecycle.

In parallel, a systematic stakeholder mapping exercise was conducted to identify and analyse key actors within the ENFORCE ecosystem. This mapping covered citizen science communities, NGOs, environmental regulators, public authorities, legal experts, research institutions, and other relevant actors across governance levels. The objective was to understand roles, interests, influence dynamics, and collaboration potential within the broader environmental compliance landscape in which ENFORCE operates.

This foundational work aligned with collaborative and multi-actor innovation principles described in Living Lab literature (e.g., Veeckman et al., 2013), ensuring that ENFORCE's implementation would be grounded in structured stakeholder engagement and ecosystem-based innovation from the outset.

Throughout this completed phase, the project prioritised strong internal coordination and strategic alignment across the consortium. Governance structures were formalised, ethical compliance procedures were activated, and quality assurance mechanisms were established to ensure methodological robustness and transparency. In parallel, systems for tracking project progress and collecting relevant operational and performance data were put in place, creating a structured basis for monitoring implementation.

Crucially, impact indicators and Key Performance Indicators (KPIs) were defined at an early stage, enabling the project to adopt an outcome-oriented monitoring approach from the outset. The early establishment of measurable impact metrics reflects best practices in structured, results-driven project planning frameworks (European Commission, 2020) and ensures that progress can be systematically assessed throughout the project lifecycle.

Collectively, these actions strengthened communication and visibility, initiated structured engagement with future co-creators and data users, and ensured strategic coherence across Work Packages. This early investment in governance clarity, shared vision, and trust-building has created the institutional and operational conditions necessary for the effective implementation of subsequent phases.

Phase B: Implementation & Active Engagement (M13–M24 In progress)

With its foundations laid, ENFORCE transitions into a phase of real-world activation. The eight LLs – ENFORCE's core testing environments – have been launched across diverse CS regions. These LLs serve as collaborative spaces where communities, institutions, and legal actors co-design environmental monitoring activities, pilot digital tools, and explore how citizen-generated data can be legally and practically integrated into enforcement systems – an approach increasingly supported by research on the legal relevance and community value of citizen science (Haklay, 2015; Conrad & Hilchey, 2011).

At the same time, initial actions for capacity-building programs have been introduced setting the foundation for planned actions including workshops, training materials, and e-learning resources aimed at empowering local stakeholders with the skills needed to use ENFORCE tools and understand the legal implications of data collection. This participatory approach reflects capacity-building models in LLs, where stakeholder co-creation and localized learning have proven effective in driving sustainability transitions (Voytenko et al., 2016). The content is tailored to reflect regional differences in environmental challenges, legal frameworks, and institutional readiness.

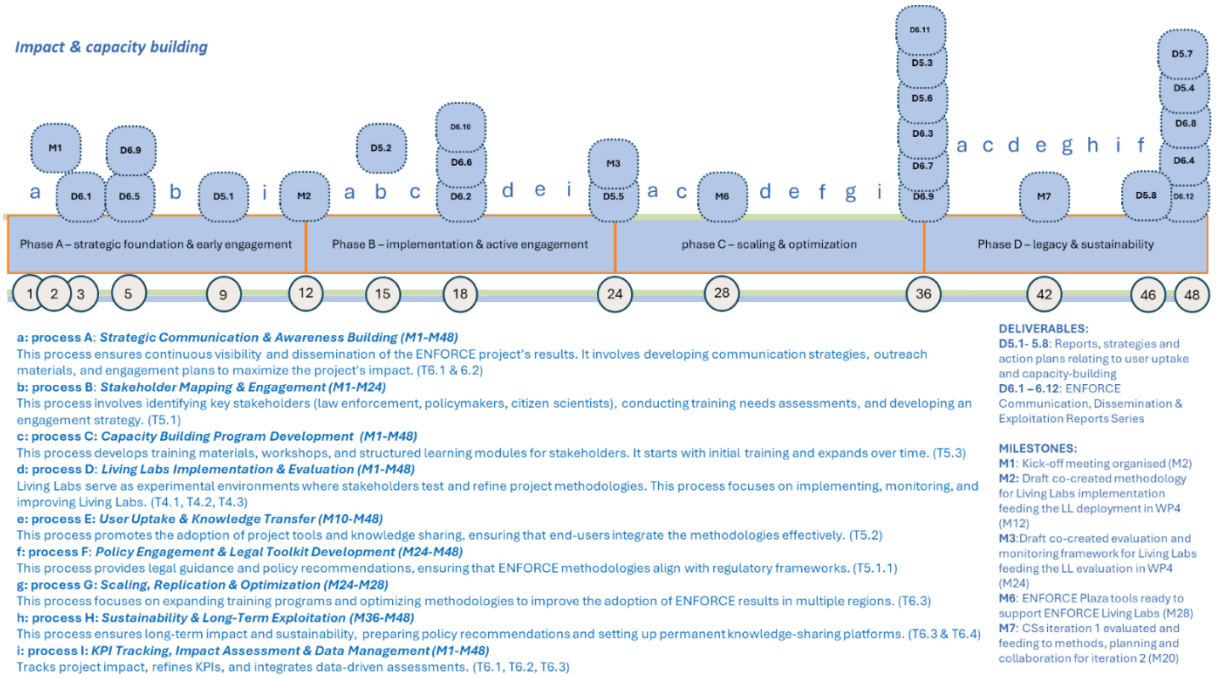


Figure 7: The ENFORCE roadmap phased approach to "impact & capacity building" over the extent of the project. It outlines four project phases (A–D) and nine parallel processes (a–i), highlighting key milestones and deliverables.

This phase also sees the beginning of broader knowledge transfer. Identification of success stories and lessons from the LLs has been initiated and will be shared with external stakeholders who may be interested in applying ENFORCE methodologies in their own contexts. The communication strategy shifts from awareness to interaction – using targeted campaigns and on-the-ground engagement to bring in new voices and broaden participation. Knowledge co-creation in LLs accelerates innovation by creating feedback-rich environments for experimentation and learning (Schuurman et al., 2016).

All activities are continuously monitored and evaluated, with user feedback and data quality assessments helping to fine-tune the tools, training content, and engagement approaches. By the end of Phase B, ENFORCE will establish a functioning ecosystem of communities, tools, legal frameworks, and learning pathways that form the backbone of its innovation model.

Phase C: Scaling & Optimization (M25–M36 Planned)

Building on the insights gained from the first implementation cycle, Phase C focuses on refining the project's approaches and preparing them for replication. The LLs enter a second phase, now optimized with feedback from evaluations. Improved methodologies are introduced, while new co-creation cycles test refined workflows that reflect adaptive innovation frameworks designed to support iterative development and stakeholder feedback (Bergvall-Kåreborn et al., 2009), ensuring the tools and processes are both robust and adaptable.

Regarding capacity building, more advanced training sessions are delivered, and the learning materials are revised to include CS results and legal best practices. Toolkits are developed not just for direct use, but also for training multipliers–actors who can pass on knowledge within their own institutions or networks.

At this stage, ENFORCE also formalises its legal and policy contributions. Practical toolkits and guidance materials are co-created with legal experts and policymakers to ensure that citizen-generated data can be effectively used in environmental compliance across different jurisdictions. These efforts echo best practices for integrating citizen data into legal regimes, echoing recommendations for structuring citizen science contributions to environmental compliance (Pocock et al., 2018). Parallel efforts begin by preparing policy recommendations and replicable models that can be shared with other cities and countries.

Efforts to communicate results are stepped up, focusing on visibility and credibility. The success stories from the LLs are used to demonstrate real-world value and to position ENFORCE as a model for participatory compliance. This strategic framing echoes the concept of "urban laboratories"; for low-carbon innovation (Evans & Karvonen, 2014). Underlying all of this, performance indicators and feedback loops remain active, helping the team assess not just whether tools are used, but how well they work in varied regulatory and social environments. By the end of this phase, ENFORCE is no longer a pilot–it is a mature, replicable, and policy-aware framework for environmental enforcement.

Phase D: Legacy & Sustainability (M37–M48 Planned)

The final phase of ENFORCE Impact and Capacity Building Roadmap is focused on ensuring that the project's results endure well beyond its formal conclusion. Now that tools, methods, law and policy guidance have been validated and refined, the emphasis shifts toward sustainability, replication, and policy integration.

All remaining training content is finalized, including multilingual toolkits, recorded modules, and trainer guides. These are disseminated through permanent platforms like the ENFORCE Plaza and the EO Wiki, ensuring open and long-term access. Stakeholders are supported in adapting and reusing these resources independently, reinforcing decentralized governance models as seen in experimental urban sustainability efforts (Bulkeley & Castán Broto, 2013), and thus the project's vision of decentralizing environmental enforcement capacity.

ENFORCE's law and policy contributions are also consolidated and shared widely here. Final toolkits and briefs are presented to European and local institutions, offering actionable guidance on how citizen-generated environmental data can be integrated into formal compliance systems. These resources reflect the project's close collaboration with legal experts and policy stakeholders throughout its lifetime.

Efforts to replicate ENFORCE's methodology beyond the original CSs are also scaled up. The project shares concrete models for adoption, tailored to different regional contexts and legal systems. To ensure ongoing engagement, strategic partnerships are formed, and options for licensing, IPR management, and business models are explored–an approach supported by

transition management theory as a means to institutionalize innovation (Loorbach, 2010). These measures help guarantee that ENFORCE's outputs remain useful and supported in the future.

Throughout this phase, impact is closely monitored, and success stories are collected and showcased. Communication now centers on legacy – ensuring that the project's story, value, and potential continue to resonate across the environmental, civic, and policy-making landscapes.

Conclusion: A Phased and Purposeful Path to Impact

From its outset, ENFORCE has been designed not only as a research initiative, but also a pathway to lasting change. Its roadmap is carefully phased to align activities with stakeholder readiness, data maturity, legal validity, and political momentum.

Impact is cultivated from the beginning, through clear communication, stakeholder trust-building, and strategic monitoring. It deepens through participatory testing and learning in the LLs, expands through capacity-building and policy engagement, and is solidified through tools, partnerships, and legal frameworks that make ENFORCE usable and replicable well beyond the life of the project. Capacity building is not a standalone activity, but it is embedded in every phase. From initial stakeholder training to full-scale toolkits for independent use, ENFORCE equips its users to take action and sustain that action. Impact is not an afterthought – it is monitored, measured, and refined continuously through feedback, evaluation, and adaptation.

By the end of the project, ENFORCE will create next to the suite of tools and methods a community of trained actors, an open infrastructure for replication, and a proven model for connecting citizen science with environmental law. Citizen science is increasingly recognized for its policy relevance, as emphasized in recent frameworks advocating for citizen science as a credible source of regulatory insight and civic engagement (Eitzel et al., 2017; Hecker et al., 2018). Through this structured and process-driven journey, ENFORCE transforms awareness into action, data into evidence, and participation into policy influence.

4. Customization of action plans for each case study

This section explains which actions have been implemented so far (M18) by the CSs and as a result how the four horizontal action plans are being adapted to fit the specific needs of each CS until the next action plan update (D4.2 - M18). The process is ongoing and tracked in a living document, which will be updated regularly.

4.1 Valle Galeria, Rome, IT, Lead: ASUD, Participants: Waag, EVI.

4.1.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your Case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal.

An in-depth legal mapping at the European, national, and regional levels to understand the regulatory context governing the environmental remediation of the Malagrotta landfill was carried out. Key references include the EU Waste Framework Directive, the Water and Air Quality Directives, the Corporate Sustainability Due Diligence Directive (CSDDD), and the Aarhus Convention. At the national level, the CS considered the Italian Code on the Environment and the relevant regional legislation of Lazio.

Describe your Case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.).

Legislative documents and case law regarding the admissibility and recognition of data collected through citizen science in environmental monitoring and enforcement procedures were reviewed. This includes research outcomes from the Sensing for Justice project and analysis of FOIA practices and civic interventions in Lazio. Identified barriers include the lack of a legal standard for civic data, the absence of institutional mechanisms for integrating such data, and difficulties in establishing its scientific validity.

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to the case study.

The team collected examples of past legal actions involving civic data, including those submitted to the TAR Lazio and other authorities. The CS studied how residents and civic organizations have attempted to introduce air quality data, photographic documentation, and incident reports as

supporting evidence in lawsuits or complaints. This includes work with legal professionals to ensure alignment with admissibility criteria.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence identified.

The team is in the process of defining quality standards for civic data to be recognized in legal contexts. This includes ensuring full metadata, traceability, and geolocation, and exploring third-party certification mechanisms with the support of environmental scientists and lawyers.

Phase C: The legislation and policy issues faced by the case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)? .

The team observed major gaps in transparency, public access to data, and institutional responsiveness. Although the remediation process involves a large-scale public contract, there is no mechanism for community monitoring or structured consultation. The fragmented responsibility among institutions further complicates accountability.

Have you identified policy issues to be encountered throughout the implementation of your case study?

The CS anticipates barriers in achieving institutional recognition of civic data, as well as in accessing technical documentation on the progress and quality of the remediation works. There is also concern about the lack of oversight mechanisms and communication failures between citizens and local/national institutions.

Have you foreseen any actions (e.g., obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

Work ongoing to co-design legal and policy advocacy tools, including the development of formal complaints, public statements, and policy briefs through participatory processes. These include Policy Labs coordinated with the Environmental Council of the XII District of Rome, leveraging both legal expertise and civic engagement.

Have you now clearly identified the environmental compliance objective of your case study?

The compliance objective is to improve environmental quality through active monitoring of key parameters (air pollution and fires, water quality, soil contamination), utilizing citizen-collected data to strengthen enforcement actions and local environmental management policies. The team also aims for a relationship of collaboration and pressure on institutions to remedy the pollution in case levels of pollutants are proven to be over the maximum permitted, to publish regular

transparent reports on the area, and eventually compensation to specific citizens/business owners.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

Based on the court cases collected so far, court action is not the primary objective of the Valle Galeria case study. The main aim is to generate robust, well-documented data that can support environmental enforcement and policy action, while keeping the option of judicial action open if deemed necessary by the community.

To date, the reviewed cases show that in Valle Galeria there have been no judicial proceedings based exclusively on citizen science data However, citizen-generated data can play a relevant role in alerting law enforcement authorities and public prosecutors by triggering inspections and formal investigations.

Within ENFORCE, data are therefore being prepared to reach a level of quality and traceability that would make them usable in court if required, without assuming litigation as an automatic or immediate outcome. Importantly, the Valle Galeria citizens' committee has already demonstrated legal readiness: it has previously supported civil actions including a collective claim related to a fire in June 2022, and remains prepared to pursue a potential class action should environmental and health impacts persist and institutional responses prove inadequate.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

The case study has highlighted several additional policy issues that affect the achievement of the environmental compliance objective.

First, there are significant barriers to accessing public information in an integrated and usable way. Environmental, health, and administrative data are often fragmented across different authorities, published in non-interoperable formats, or not proactively disclosed. This limits the effective implementation of open access and transparency policies, despite their formal existence, and hampers citizens' ability to understand cumulative environmental and health impacts.

Second, the case study has revealed structural difficulties in interacting with policy actors in the epidemiological and public health domain. Access to health-related data and meaningful dialogue with competent authorities remains limited, making it challenging to link environmental exposure data with health outcomes and to support evidence-based prevention measures.

Finally, the monitoring activities point to a low level of effectiveness in biodiversity protection policies in the area. Existing regulations and plans show weak enforcement, limited monitoring, and insufficient consideration of cumulative pressures, resulting in poor protection outcomes despite formal policy commitments.

To address these issues, the case study foresees:

- strengthening data integration and interoperability through citizen-generated data and ENFORCE tools;
- using documented evidence to support formal requests for information and institutional accountability;
- facilitating structured dialogue with environmental and health authorities where possible;
- producing policy-oriented outputs to highlight enforcement gaps in biodiversity protection and transparency, contributing to recommendations at local and higher governance levels.

These actions aim to improve compliance and accountability primarily through policy and institutional channels, while maintaining the possibility of escalation if needed.

4.1.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Activities Aligned with the ENoLL Methodology

During the initial phase, the case study team actively participated in training sessions organized under the ENoLL methodology and completed related self-assessment exercises. They conducted a review of local participatory tools to assess their compatibility with Living Lab principles such as open innovation, real-life experimentation, and co-creation. This preparatory work also included collaborative planning meetings with local stakeholders to establish a shared understanding and vision for the Living Lab.

Stakeholder Engagement Actions

The team initiated stakeholder engagement by collaborating closely with the Environmental Council of Rome's XII District, where the local committee plays a central and facilitating role. This institutional platform was identified as a key enabler of participatory governance and was selected as a foundational structure for the Living Lab. Additional efforts were made to involve local residents, environmental NGOs, and technical experts, ensuring a diverse and inclusive stakeholder base.

Planned Future Activities

In the following months, the case study plans to implement a series of participatory "Policy Labs." These events will bring together citizens, experts, and local authorities to co-design requests for policy and enforcement actions. A central focus will be on interpreting civic-collected

environmental data and translating it into actionable formal outputs such as petitions, legal complaints, and policy recommendations. These labs aim to strengthen the role of community-led initiatives in environmental compliance and advocacy.

ENoLL Trainings Attended, Skills and Competencies Acquired, Preparatory Outputs Produced (e.g. Stakeholder Mapping, Guidelines, Background Documents), Their Use in Living Lab Activities, Capacity Gaps Identified for Phase B, and Availability of Analytical or Supporting Documentation

ENoLL trainings:

- first online training fall 2024
- February 2025 training
- 09/10/25 GA Crete Development of Living Labs on the macro level and overview of missing key components

Preparatory outputs:

- stakeholder mapping
- Living Lab mapping canvas (mission, vision, objectives and context)

Challenges were observed in fully applying the Living Lab methodology to the specific context of Valle Galeria. The local community is a well-established, grassroots-driven group that existed prior to ENFORCE and has developed its own forms of organization, priorities, and modes of action over time.

In this context, the Living Lab approach requires careful adaptation, as the community's focus is oriented more toward long-standing social and environmental concerns than toward technology-driven processes. Rather than reflecting a lack of engagement, these dynamics highlight the need for a flexible and context-sensitive implementation of the methodology, one that builds on existing community structures, knowledge, and practices, while gradually integrating ENFORCE tools in a way that is meaningful and complementary to local needs.

Phase B – Implementation of First Workshop

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

During 2025, the Valle Galeria case study implemented a first cycle of Living Lab activities aimed at consolidating an existing community structure and progressively introducing ENFORCE tools, data and methodologies. Rather than starting from scratch, the Living Lab was embedded within

the ongoing work of the Valle Galeria Committee, a long-standing grassroots organisation active on environmental health, pollution monitoring and institutional accountability.

The following Living Lab–related meetings and activities were carried out in 2025:

- 09/01/2025 – Committee meeting
- 31/01/2025 – Committee meeting
- 11/02/2025 – Casal Selce Committee meeting
- 05/03/2025 – Committee meeting
- 17/04/2025 – Technical meeting with Prof. Valentini on satellite surveys
- 20/05/2025 – Committee meeting
- 14/06/2025 – Living Lab workshop on satellite imagery and environmental priorities
- 30/06/2025 - Meeting with Bruna Gumiero River ecologist
- 09/07/2025 - Meeting with Antonello Ciervo, lawyer
- 15/07/2025 - Meeting with Luigi Marini, former Judge
- 18/09/2025 – Committee follow-up meeting
- 21/10/2025 – Meeting with lichenologists (biodiversity and air-quality bio-indicators)

Although not all meetings were formally minuted, they played an important role in consolidating relationships, fostering shared problem framing, and progressively aligning community concerns with ENFORCE's data-driven environmental compliance approach. These preparatory exchanges laid the groundwork for more structured Living Lab activities.

Structure and facilitation of the first Living Lab workshop

The first structured Living Lab workshop took place on 14 June 2025 and represented a key milestone in WP4 .

Duration: 3 hours

Facilitation: A Sud team members, with technical inputs from ENFORCE experts

Methodology: Plenary discussion combined with guided co-design and collective prioritisation

The workshop was structured as follows:

- Introduction and expectations round, to align participants and surface community priorities.
- Presentation of the ENFORCE project, including the concepts of Data Readiness Level (DRL) and Living Labs, and the role of the Valle Galeria Committee within the European framework.
- Presentation of satellite-based environmental analysis, focusing on Copernicus open-source data (Sentinel-2 and Sentinel-5P) and their application to Malagrotta (vegetation, soil moisture, water bodies, air pollutants, fire risk)
- Plenary discussion and prioritisation, linking satellite evidence with lived experience (miasmas, water pollution, fires, lack of institutional response).
- Co-design of a first action plan (WP4 – Task 4.2.1), defining priority actions, responsibilities, data needs and expected outputs.
- Wrap-up and next steps, reinforcing the Living Lab as an ongoing process rather than a one-off event.

Participants to these meetings (workshop and others) mainly included:

- Members of the Valle Galeria Committee and local sub-groups (including Casal Selce);
- A Sud facilitators and researchers;
- ENFORCE technical experts (EO and satellite data);
- Observers and contributors connected to environmental monitoring, health and advocacy.
- Institutional actors were not directly involved in this first workshop, by design: the initial phase focused on consolidating community capacity and shared evidence before engaging duty-bearers.

Objectives and key outcomes

Main objectives:

- Introduce ENFORCE tools and the Living Lab approach in an accessible way;
- Translate satellite data into actionable knowledge for the community;
- Identify and prioritise environmental compliance issues;
- Co-design a first, realistic action plan aligned with WP4.

Key outcomes

- Increased community understanding of how satellite data can support environmental monitoring and enforcement claims;
- Identification of priority areas for action (air quality and miasmas, water contamination, fires, data gaps in official monitoring);
- Agreement on the need to transform informal reports and citizen complaints into structured, reusable datasets;
- Initial discussion on creating a local, multi-dimensional "living observatory" integrating environmental, health and biodiversity data.

Challenges and lessons learned

- Embedding vs. imposing: the Valle Galeria Living Lab had to adapt to an already active, non-technological community rather than imposing a predefined Living Lab model. This required flexibility and trust-building.
- Data overload vs. capacity: while many data sources exist (citizen reports, ARPA data, satellite imagery), the main bottleneck is analytical capacity and institutional uptake.
- Institutional asymmetries: limited transparency, fragmented responsibilities and restricted access to official data remain key barriers, reinforcing the importance of citizen-generated evidence.
- Living Lab as a process: the experience confirmed that Living Labs work best as iterative, long-term processes rooted in existing community struggles, not as isolated workshops.
- These insights have been used to recalibrate subsequent activities, including tool testing, biodiversity monitoring, and interactions with enforcement and research actors.

Availability of analytical reports

Not all meetings have been reported, we have started reporting our meeting in a more structured way since the second half of the year.

A detailed report of the 14/06/2025 workshop and committee meeting is available and can be shared internally

A follow-up report of the 18/09/2025 meeting documents progress, emerging institutional dynamics, and next steps in data integration and platform testing.

Presentation materials on satellite analysis used during the Living Lab are available.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

The plan for upcoming Living Lab workshops is currently under development and has not yet been formally finalized. Following the inputs received from ENoLL and EARSC during the General Assembly in Crete in December, the team has internally completed the Living Lab Mapping Canvas and clarified the mission, vision, and core objectives of the case study.

By the end of the month, a dedicated meeting is scheduled with the Valle Galeria Libera citizens' committee. This meeting is expected to define a shared roadmap for the next steps, including priority themes, methods, and the organization of future Living Lab activities. The outcomes of this process will then inform how results are documented, shared, and connected to analytical documentation for stakeholders within the ENFORCE framework.

4.1.3 Data and Tools Action Plan

The needs of the case study:

The case study requires comprehensive environmental data on air and water quality, soil contamination, gas emissions, and the status of ongoing remediation efforts. This data is essential for ensuring civic oversight, raising community awareness, and supporting potential legal actions against polluters. Specifically, accurate, real-time data is needed to monitor air pollutants, track the spread of soil contaminants, assess the effectiveness of cleanup measures, and evaluate the health impacts on local residents. These insights will also be critical for building legal cases, as well as informing public health interventions and policy reforms aimed at reducing environmental harm.

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem includes a mix of low-cost sensors deployed by A Sud and local committees, as well as academic research collaborations and institutional data from ARPA Lazio. However, these sources present several limitations. Official data from ARPA Lazio is often outdated, incomplete, or difficult to access, making it challenging to establish a consistent and reliable baseline for monitoring. Furthermore, data from different sources is rarely standardized, leading to compatibility issues that hinder comprehensive analysis. In addition, civic data is typically less precise than institutional measurements, requiring significant effort to validate and integrate into formal decision-making processes.

The barriers to effective data collection and usage:

Barriers to effective data collection include a lack of open data infrastructure, which limits the ability to share and integrate data across different stakeholders. The fragmentation of data

sources, ranging from citizen science initiatives to academic studies and institutional records, complicates the creation of a unified, actionable dataset. Moreover, the absence of standardized protocols for integrating citizen-generated data into institutional workflows poses significant challenges. Additionally, there is a critical need for user-friendly tools that can effectively communicate complex data to non-technical audiences, ensuring that community members can fully engage with and act upon the information collected.

The Living Labs as collaborative environments for innovation:

The project aims to transform the Environmental Council and local civic forums into Living Labs– collaborative spaces where different forms of knowledge, including scientific, civic, and legal, can intersect and co-evolve. These spaces will support experimentation with innovative tools, capacity building for community members, and the development of new methodologies for data collection and analysis. By bridging the gap between communities and institutions, these Living Labs will foster a more inclusive approach to environmental monitoring and decision-making, empowering residents to take an active role in managing their local environments.

The valorisation of existing and the development of new citizen science tools:

The project will build on existing air and water monitoring efforts, while also exploring new data collection methods, such as satellite and thermal imaging for detecting biogas leaks. In addition, a user-friendly dashboard will be developed to consolidate and visualize data from multiple sources, making it easier for communities to interpret and act on the information collected. Integration with ENFORCE tools and methodologies is also being considered, allowing for more precise tracking of environmental impacts and better alignment with institutional data standards. This approach will enhance the credibility and usability of citizen science data in both community and regulatory contexts.

The goals for the use of data in relevance to environmental compliance:

The ultimate goal is to ensure that data generated by citizens can be effectively used in institutional contexts, particularly for enforcement and legal action. This requires not only improving the quality and reliability of the data but also building community capacity to collect, interpret, and mobilize this information for advocacy and justice. By making civic-generated data more compatible with regulatory requirements, the project aims to strengthen community oversight, support transparent decision-making, and promote more responsive environmental governance.

Key potential users and user requirements:

Key potential users of the data include local activists, residents, lawyers, journalists, and public officials. Each of these groups has specific requirements in terms of data accuracy, accessibility, and usability. For example, activists and residents need easily understandable, real-time data to mobilize their communities, while lawyers require legally admissible evidence that can withstand courtroom scrutiny. Journalists often prioritize data that can be clearly communicated

to a broader audience, while public officials need reliable, comprehensive datasets to inform policy decisions and regulatory enforcement.

Exploring whether this CS could be testbed for 3.3 and 3.4:

The Valle Galeria case presents a strong opportunity for integration with spatial intelligence and explainable AI frameworks, given the complex, multi-layered nature of the environmental, legal, and civic data involved. This makes it an ideal testbed for ENFORCE tools, which could be used to automate the detection of illegal dumping, generate predictive pollution maps, and aggregate evidence for legal cases. These technologies could significantly enhance the efficiency and impact of local environmental monitoring efforts, providing a powerful toolset for both community activists and institutional stakeholders.

Progress on Data Pathways, Indicators, and DRL Preparation: Update on progress made regarding the definition or refinement of the Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for datasets (if any)?

Water pollution

Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD)

Chromium, Hexavalent Chromium (Cr VI), Cadmium, Nickel, Lead, Copper, Zinc, Aluminium, Iron, Arsenic, Barium, Boron, Manganese, Mercury, Selenium, and Tin

Ammoniacal nitrogen

Escherichia coli

PFAS

HFPO dimer acid (GenX), cC6O4, ADONA, 6:2 fluorotelomer sulfonic acid (6:2 FTS)

Air pollution

PM2.5, PM10

Fires (through committee's platform and app)

Duration, position, intensity, smoke characteristics

Miasmas (through committee's platform and app)

Position, type, intensity

Soil contamination

Arsenic (As), Cadmium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb), Zinc (Zn), Iron (Fe), Manganese (Mn), Calcium (Ca), Magnesium (Mg), Potassium (K), Phosphorus (P), and Sulfur (S), soil pH

Third party datasets

Rio Galeria surface water quality monitoring database available until December 2024 with two sampling stations

https://sira.arpalazio.it/banche-dati/visualizzazione/acqua#/

AROMATIC COMPOUNDS, PHYTOSANITARY PRODUCTS AND DERIVATIVES, METALS, ORGANIC LOAD, MICROBIOLOGICAL LOAD, FIELD MEASUREMENTS, WATER CHARACTERIZATION, DIOXINS, FURANS, PCBs, BIOLOGICAL PARAMETERS, ALIPHATIC COMPOUNDS, SOLVENTS, BIOCIDES, TOXINS, PARTICLES, PERFLUOROALKYL SUBSTANCES, SURFACTANTS, QUANTITATIVE MEASUREMENTS

Air quality dataset, control unit no. 53 Malagrotta, particulate matter data (PM 2.5, PM10)

https://sira.arpalazio.it/web/guest/banche-dati/visualizzazione/aria#/

Progress on Tool Requirements, Prototyping, and Integration Needs: Developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for the Case Study?

The GeoQuest tool developed by IIASA is currently under testing for the reporting of miasma events and fire-related incidents, with a focus on usability and responsiveness in real-world conditions.

An important development concerns integration needs. GeoQuest is being assessed for interoperability with the Valle Galeria citizens' committee digital platform, Athena, with the aim of ensuring continuity with existing community tools rather than introducing parallel systems.

Additional functional insights have emerged regarding potential extensions. There is interest in integrating biodiversity monitoring functionalities, potentially through interoperability with Minka, to allow community members to report and document species observations alongside pollution-related data. Furthermore, the case study is exploring the integration of Earth Observation–based fire detection, which could trigger notifications to app users and invite on-the-ground verification and reporting, strengthening the link between EO data and citizen validation.

4.1.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In Valle Galeria, a community historically affected by pollution and mistrust toward institutions, the project focuses on supporting civic advocacy, raising environmental health awareness, and building legal empowerment. Phase A includes Process a (Strategic Communication & Awareness

Building), Process b (Stakeholder Mapping & Engagement), and Process (KPI Tracking, Impact Assessment & Data Management).

What are the communication objectives in Valle Galeria during Phase A?

The communication goals were to raise awareness about environmental health risks and civic rights in a respectful, careful way, recognizing the community's long-standing frustration. Public events, such as the Italian Citizen Science Association's annual conference, were used to increase visibility around local environmental challenges and civic actions. The WP6 communication toolkit was applied and carefully adapted to fit the local context.

Who are the priority audiences and why?

The priority audiences include local residents, grassroots movements like Comitato Valle Galeria Libera, environmental associations, and local health and environmental authorities. These groups play essential roles in giving legitimacy to civic-generated data, supporting advocacy efforts, and helping translate citizen science into institutional action.

Which communication tools and formats are most appropriate for this context?

Effective communication in this context relies on simple, accessible channels such as local social media platforms, printed leaflets, WhatsApp messages, and posters in town halls or community spaces. The ENFORCE branding (D6.5) was localized, and materials were translated into everyday, easy-to-understand language so they could reach a wide audience, not just experts.

What kind of support is required from WP6 to reach these audiences?

Support is needed from WP6 to co-create visual materials that are clear and culturally adapted, translate complex legal information into straightforward Italian infographics, and frame messages around key local concerns such as health, environmental cleanup, and community empowerment.

Who are the key stakeholders in this case study and why are they important?

The key stakeholders include Comitato Valle Galeria Libera, local residents, the Municipality of Rome, the Lazio Regional Government, ARPA Lazio, ISPRA, companies involved in waste and fuel storage, journalists, lawyers, scientists, public health advocates, and local schools. Each group plays a vital role in shaping the local landscape and ensuring that citizen science efforts contribute to compliance monitoring and accountability.

How were these stakeholders identified and mapped?

Stakeholders were identified through long-standing presence and knowledge of the local context, as well as by drawing on A Sud's broad network of environmental justice actors. This combined approach helped build a detailed and accurate stakeholder map.

What engagement activities were initiated in Phase A?

Phase A included a range of engagement activities, such as community trust-building meetings, expert discussions, Miro brainstorming sessions, informal meetups at the citizen science premises, and public outreach events. These efforts aimed to strengthen local networks and encourage open dialogue.

What capacity gaps have been observed among stakeholders?

Observed capacity gaps include low legal awareness among residents, mistrust in institutions, and limited methodological skills for using tools like Earth Observation (EO) or citizen science for monitoring. Addressing these gaps will require capacity-building efforts, particularly through WP5's planned initiatives.

What data has been collected during Phase B, and why?

Data collected includes the number of citizens engaged, formal and informal complaints submitted both to institutions and through the local reporting platform at https://www.vallegalerialibera.it/segnalazionigenerali/, and participation in legal and policy sessions. These data points are important for assessing early progress, measuring civic engagement, and tracking impact in this legal and justice-focused setting.

What KPIs make sense for this case study?

Relevant KPIs include the number of citizen reports filed through the platform at https://www.vallegalerialibera.it/segnalazionigenerali/, the percentage of complaints acknowledged or acted upon by authorities, increases in legal literacy among residents (such as the ability to follow legal and judicial processes), and strengthened capacity to use EO and citizen science methods for monitoring landfill security. These indicators align with deliverable D6.9 and support the project's early exploitation goals.

How is data collected, validated, and shared with WP6?

Currently, data is gathered and monitored through the community platform at https://www.vallegalerialibera.it/segnalazionigenerali/, where reports, event logs, feedback, and complaint records are tracked. To improve coordination, support is needed to integrate this system with A Sud's broader monitoring processes and ensure smooth data transfer into the KPI dashboard (MS2) for project-wide tracking and reporting

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

Since Phase A, capacity-building activities in the Valle Galeria case study have been limited and targeted. The main activity implemented so far was the workshop on satellite images and environmental monitoring (June 2025).

The workshop involved a small group of participants, specifically members of the Valle Galeria Committee, and did not target a broad range of stakeholders. This choice reflected the local

context: an already organised grassroots group with strong advocacy experience but limited familiarity with satellite-based data.

The activity strengthened participants' understanding of how EO and satellite data can support local monitoring and compliance-related claims, and helped link technical data to issues already monitored by the community (air quality, miasmas, water pollution, fires).

Concrete changes observed include increased confidence in discussing satellite evidence, greater awareness of the need to structure citizen observations as reusable data, and a more strategic approach to prioritising monitoring actions. The impact so far is therefore focused on strengthening a core community group, laying the groundwork for broader stakeholder engagement in later phases.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study ?

At this stage, it is still premature to determine.

4.2 Brasov, Central RO, Lead: NIRDF, Participants: BDG, UNIBI

4.2.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

In the initial stage of the case study, a series of actions were undertaken to identify relevant legislation and policy documents addressing the environmental compliance objectives. A comprehensive desk research activity was conducted, consisting primarily of an extensive literature review. This included the analysis of both peer-reviewed articles and grey literature (such as reports, nationally indexed articles, and online publications). Additionally, informal consultations with experts in legislative and policy analysis were carried out to obtain targeted insights and validate the preliminary findings relevant to the case study's focus.

The team also participated in two major events to strengthen its understanding of the current legislative framework. The first was a national conference on environmental law, organized by the leading juridical information portal in cooperation with the Ecologic University of Bucharest, which centered on discussions about Romania's recently adopted Forest Code. The second event took place within the context of the Common Agricultural Policy and addressed the use of financial instruments for afforestation as a greening measure.

Both events provided critical perspectives on the challenges associated with the legal and institutional governance of forests in Romania under the new legislative and financing frameworks. Participation in these events also allowed the case study team to engage with key stakeholders across the Quadruple Helix categories (academia, industry, government, and civil society), thus contributing to the development and refinement of the stakeholder inventory. These activities collectively guided the next steps of the research process within the ENFORCE project context.

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

In the last step of phase 1, the activities conducted were especially desk research through an extended literature review focused on citizen science (or sensing) for environmental compliance. Furthermore, the first stakeholders' workshop complemented the research tackling in an interactive dialogue the main policy elements perceived as barriers by the citizens as well as preliminary ideas for overcoming them.

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

To identify legal cases that involved or were influenced by citizen science activities in the field of environmental compliance, the case study team conducted targeted research using the "Lege5" platform. Although "Lege5" is managed by the private entity Indaco Systems, it provides comprehensive access to Romanian court rulings and functions as a key legislative documentation tool.

The research involved a detailed analysis of jurisprudence, focusing on cases of illegal forest activities that were brought to public attention, often through citizen involvement in law enforcement processes. Particular attention was given to cases where media exposure, supported by citizen initiatives, played a critical role in highlighting illegal actions and influencing judicial outcomes.

Moreover, insights gained from ongoing legal debates regarding the Forestry Code revealed several vulnerabilities in the new legislative framework, particularly due to discrepancies between sector-specific terminology and legal taxonomy. These findings opened further avenues for investigation, which will be explored in subsequent project activities and through engagements with various stakeholder groups.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

Similar to the first step in phase 2, valuable information on citizen science based evidence use in court was collected when conducting the interviews within the frame of WP2. The knowledge acquired will substantiate future actions on qualitative data collection, especially through workshops/interviews, since local experience and wisdom based on taking action in the specific national context has proven to lead to increased reliability of the collected data than the traditional sources.

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

The first stakeholders workshop revealed the complexity of legislation and its formulation, the different challenges encountered in the elaboration and implementation processes of relevant public policies (including the real impact of the public debate procedures), along with the excessive bureaucracy for compliance, and bottlenecks in the communication from and with the authorities. The workshop also revealed the impact of the obligation to use expert advice for the elaboration of environmental approval documents required by the national legislation resulting in additional financial burden and delaying processes.

Have you identified policy issues to be encountered throughout the implementation of your case study?

Same as in above.

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

No specific action is yet defined. The participation conferences and symposiums regarding either forestry or agriculture or both, as well as joining events of citizen based initiatives contribute tono other actions have been carried out yet. Preliminary findings of the first workshop will be used for further adjusting communication with stakeholders to identify specific needs for overcoming policy issues of relevance in the local context, in parallel with selecting and adapting Enforce strategies as part of an engagement plan to ensure continuity in communication and action for citizen empowerment.

Have you now clearly identified the environmental compliance objective of your case study?

The environmental compliance in our case study is sustainable forest management with a particular focus on illegal activities, especially logging.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

All court cases identified are in the first stage of the process which involves gathering evidence. In all cases, the first level of proof required to signal such a law indictment are the license plate, time and place as Romania has a traceability tool called "SUMAL". Whether the case study requires court action to achieve its environmental compliance objective is up to competent authorities. Depending on the nature and circumstances of the event, the competent authorities decide to initiate legal actions as required, due to either forest manager or citizens signaling the indictment. Besides the first level of proof required, the evidence could consist of statements, property documents and a damage calculation sheet.

Nevertheless, through the mobile application that is currently developed at the case study level, it is intended to support forest managers to be informed in a timely manner about the occurrence of various events (tree falling, drying trees, damaged roads and so on). Pictures loaded in the application can provide details on the nature and magnitude of the reported event. For instance, in the case of tree falling that is not part of a silvicultural plans, the forest managers can promptly react and mitigate any further damages.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

The case study has identified significant policy issues arising from the controversial use of Emergency Ordinances to modify the new Forestry Code (Law no. 331/2024). A primary concern is the proposed restructuring of RNP ROMSILVA management toward 'mandate contracts,' which critics argue may violate constitutional rights to professional stability and bypass parliamentary oversight. Additionally, while the Code mandates new technological solutions – such as GPS tracking for the forest fleet–there remains a lack of clear legal procedures regarding data responsibility and administrative implementation. To address these issues, the project is utilizing Living Labs to foster dialogue and developing the EC-DRL framework to ensure that digital evidence meets the high technical and legal standards required by Romanian courts.

4.2.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Implementation of the ENoLL Methodology:

During the preparatory phase, the team participated in Living Lab training sessions and completed the corresponding home assignment survey to support the implementation of the methodology. These activities helped frame the approach to be followed and provided a foundation for the contextualization of Living Lab principles within the case study.

Stakeholder Engagement Actions:

Initial stakeholder engagement efforts began with the identification and classification of potential stakeholders according to the Quadruple Helix model. This led to the organization and execution of a dedicated stakeholder engagement workshop within the selected case study area. The workshop served as a platform to introduce the ENFORCE project, outline its objectives, and explain the role of Case Study #2. The response from participants was highly positive - discussions were constructive, and many stakeholders expressed strong interest in remaining actively involved in future activities. Supporting documentation and materials from this workshop will be shared in the Teams workspace to ensure open communication and transparency.

Planned Activities:

Although specific dates have not yet been set, the team plans to organize bilateral meetings, workshops, and surveys as part of the continuing stakeholder engagement process. These future actions will be aligned with the overarching ENFORCE stakeholder engagement plan and the project's general timeline.

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

The case study team attended the ENoLL 1st Training on Living Labs fundamentals on 22nd January 2025, an event that improved knowledge on Living Lab concept, stakeholder engagement process, and governance models for a successful LL. Another event that the case study team attended was the Stakeholder Value Mapping exercise, held on 9th October 2025. Herein, the team mapped stakeholders by role to achieve our case study objective. At the case study level, the Case Study team had developed a stakeholder database of potential stakeholders to be involved in the case study activities (workshop organisation, bilateral meetings, surveys, and so on). The file will be updated throughout the project's lifetime.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available?

Within the framework of WP4 – Case Studies Coordination and Implementation: Living Labs Setup and Co-creation and Co-design with Citizens and Stakeholders – the Case Study team conducted its first stakeholder workshop. The primary objective of this workshop was to provide a comprehensive presentation of the ENFORCE project and to address knowledge gaps among local communities, public authorities, practitioners, NGOs, and market representatives. The aim was to foster awareness, mutual understanding, and collaborative pathways for improved forest management. Participants represented almost all Quadruple Helix categories, ensuring broad cross-sectoral engagement.

The discussions highlighted the complexity of the legislative framework and the challenges associated with both policy formulation and implementation. Particular emphasis was placed on the practical impact of public consultation procedures, the administrative burden linked to compliance requirements, limited access to subsidies, and communication bottlenecks between stakeholders and competent authorities. Furthermore, the workshop revealed concerns regarding the mandatory reliance on specialised expert consultancy for the preparation of environmental approval documentation, which often entails significant financial costs. These findings provided valuable insights into structural barriers affecting environmental compliance and informed subsequent Living Lab co-design activities.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

At this stage, the Case Study team is awaiting further guidance from ENoLL regarding the KPI framework and its alignment with the Sustainable Development Goals (SDGs), which is planned to be included as a dedicated item on the agenda of the second stakeholder workshop.

Looking ahead, the forthcoming Living Lab workshops are expected to prioritise citizen science themes related to forest governance, reporting mechanisms, and transparency. These sessions will apply participatory co-creation and validation methodologies, ensuring structured stakeholder input. The outcomes will be systematically documented and consolidated in analytical reports to support traceability, learning, and alignment with the ENFORCE methodological framework.

4.2.3 Data and Tools Action Plan

The needs of the case study:

The primary environmental compliance objective for this case study is to ensure sustainable forest management within the context of climate resilience, biodiversity conservation, water management, agriculture, and local economic development. This aligns with the broader goals of the Romanian National Forestry Strategy 2030 and the Forestry Code (Law no. 331/2024), as well as Government Decision No. 497/2020, which mandates the use of an Integrated Information System for Wood Tracking to comply with European Regulation 995/2010 on timber legality.

To support these objectives, a wide range of data is required, including core datasets from the National Forest Inventory (NFI), which provide critical insights into forest composition, health, and biomass. Complementary data from the National Institute of Statistics (NIS) is also essential, as it offers context on regional economic activities, land use patterns, and population dynamics, all of which influence sustainable forestry practices.

Additionally, data on wood exploitation periods is a critical component of compliance. These periods are defined by national legislation, but flexibility is often provided through forest management plans, which allow for the postponement of harvesting based on economic viability or environmental considerations. This flexibility, commonly used by private forest owners and associations, highlights the need for precise, up-to-date data to ensure that harvesting practices remain within legal limits while supporting broader conservation and climate resilience goals.

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem for this case study relies primarily on the SUMAL system, Romania's national forestry management and tracking platform, which is designed to monitor the entire wood management supply chain and reduce illegal logging. SUMAL 2.0, the latest version, enables real-time monitoring and accountability by requiring forestry operators to log all harvesting and transport activities. It integrates data from multiple sources, including transport permits, wood valuation documents (APVs), forest management maps, and the boundaries of protected natural areas. This system also includes the Forest Inspector application, a mobile and web tool accessible to the general public, which provides real-time information on timber harvesting and transport activities. Although the Forest Inspector is a useful tool for tracking the movement of timber on public roads, it is not designed to also allow monitoring of illegal activities inside the forest.

SUMAL's data includes inputs from economic operators, forestry authorities, and forest administrators, capturing critical information at various points in the supply chain, such as wood loading events and transport details. It also includes datasets like the catalogue of old-growth forests and protected area boundaries, which are maintained and updated by public forestry authorities.

In addition to these established systems, the case study has engaged with stakeholders to assess the potential role of citizen science in enhancing forest monitoring. During the first stakeholder workshop, participants provided insights into the perceived benefits and challenges of citizen involvement in environmental monitoring, as well as the potential utility of a decision-support system for wood traceability at both national and international levels, particularly in light of upcoming EU Deforestation Regulation (EUDR) requirements.

The barriers to effective data collection and usage:

The main barriers to effective data collection and usage in the forestry sector include a lack of communication and transparency among authorities, private entities, and the public. This disconnect often leads to inconsistencies in reported data, with different sources providing conflicting figures for the same elements or activities, creating confusion and reducing data reliability. For instance, variations in reported timber volumes or forest cover can arise from differences in measurement methods, data collection intervals, or reporting standards, undermining efforts to create a unified, accurate dataset.

To address these issues, there is a critical need for a standardized, nationally and internationally accepted data framework, which would improve data comparability and reliability across different sources. Additionally, enhancing data quality and representativeness will require

significant investments in digitalization and advanced technologies, such as remote sensing, IoT-enabled ground sensors, and real-time data processing platforms. These improvements will not only streamline data collection but also support better decision-making, more effective enforcement, and increased public trust in the system.

The Living Labs as collaborative environments for innovation

The Living Lab (LL) for this case study has not yet been formally established. However, the first steps toward creating this collaborative environment were taken during a stakeholder workshop held in mid-April. During this initial meeting, valuable insights were gathered from a diverse group of participants, including forestry professionals, government representatives, and community members. These insights will help shape the design and implementation of the Living Lab, ensuring it effectively supports data collection, knowledge exchange, and collaborative problem-solving.

As the LL develops, it will aim to integrate a wide range of data sources, including satellite imagery, ground sensors, citizen science inputs, and institutional databases, creating a comprehensive platform for monitoring and managing forest resources. This collaborative approach is expected to enhance stakeholder engagement, improve data quality, and support more effective, data-driven decision-making in the forestry sector.

The valorisation of existing and the development of new citizen science tools:

For this case study, the primary citizen science tool will be the SUMAL (Forest Inspector) application, which is already widely used for real-time wood tracking and forest management in Romania. To enhance its capabilities, the project plans to integrate Earth observation-derived geo-information services provided by the European Association of Remote Sensing Companies (EARSC). This integration will allow for more precise monitoring of forest cover, logging activities, and land use changes, providing a more comprehensive picture of forest health and compliance.

Additionally, this approach will enable better cross-referencing of citizen-reported data with institutional records, improving the overall quality and reliability of the data collected. Future developments may include expanding the functionality of the Forest Inspector app to incorporate features like automated alerts for illegal logging, enhanced map overlays for protected areas, and real-time ecosystem health indicators, creating a more powerful tool for both professional foresters and engaged citizens.

The goals for the use of data in relevance to environmental compliance:

The primary goal for data use in this case study is to improve the clarity and effectiveness of environmental legislation and compliance processes, particularly in the context of sustainable forestry and wood tracking. This involves enhancing the functionality and usability of existing

tools like the SUMAL (Forest Inspector) system, which is critical for monitoring the entire wood supply chain, from harvesting to transport.

To achieve this, efforts will focus on integrating more precise and comprehensive data sources, including Earth observation and remote sensing inputs, to provide a clearer picture of forest health and logging activities. This will help ensure that forestry operations remain within legal limits and comply with both national and EU regulations. Additionally, the project aims to improve data quality through better validation processes, potentially incorporating real-time sensor data, automated anomaly detection, and user-friendly interfaces to increase uptake by both professional foresters and citizen scientists.

Key potential users and user requirements:

Key potential users include citizens, who need accessible, anonymized data for community monitoring; public authorities, who require accurate, secure data for enforcement and policy decisions; and private entities and NGOs, who rely on high-quality data for advocacy, impact assessments, and public awareness.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

Regarding the Data Pathways and Indicators, the logical sequence is the criteria at hand which presumably is Forest law enforcement effectiveness which could be assessed through the Number of reported suspected illegal timber transports. Moreover, the variables are complex; however, the total number of citizen alerts per county per month/year could act as a proxy for citizen sensing or enforcement impact. The data sources could come from the Policy alert department (STS) and forest managers implication through legal documents.

Preliminary steps towards assessing Data Readiness Levels have focused on reviewing data completeness, structure, and accessibility, and on distinguishing between raw administrative data and analytically processed datasets. Further refinement of indicators and formal DRL assessment will be undertaken in future tasks according to the project.

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

Progress on Tool Requirements, Prototyping, and Integration are scarce mainly due to technical (Mobile application under development) and user requirements concerns, early testing activities will require additional measures such as active engagement of all actors involved so far (or new ones). A prototype for the mobile application has been developed so far, but its functionality needs to be complemented with additional functionalities related to reporting and communication

between citizens and forest managers. These functionalities will be developed and finalized following stakeholder consultation and internal testing of the prototype.

Overall, initial progress has been made in defining the data pathways for the case study which facilitates the progress on ENFORCE Plaza tool and integration. Key indicators related to forest governance and enforcement, such as the volume and spatial distribution of citizen-reported alerts, have been identified, along with corresponding variables, proxies, and data sources, including administrative records, survey data, and Living Lab outputs. All these aspects will support the functionality and integration of the overall tool.

4.2.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In the mountainous areas of Brașov, the protection of forests and the fight against illegal logging involve multiple layers of complexity. These include legal challenges, the need for effective decision support systems (DSS), and the active participation of local communities, forest agencies, and other institutional actors. Phase A focuses on three main processes: Process a (Strategic Communication & Awareness Building), Process b (Stakeholder Mapping & Engagement), and Process i (KPI Tracking, Impact Assessment & Data Management) – all of which lay the groundwork for long-term success.

What are the communication objectives in Brașov during Phase B?

The communication efforts aim to raise public awareness about the dangers and consequences of illegal logging, stressing why forest monitoring matters and how community members can contribute by reporting violations when they see them. Another important focus is to increase general understanding of the different types of forests, the specific treatments they require, and the principles of sustainable logging – making sure people understand not only the threats but also the best practices. Improving communication between citizens, researchers, and private-sector actors is a key goal, as this collaboration is seen as central to improving overall environmental compliance and ensuring a shared sense of responsibility.

Who are the priority audiences and why?

The primary audiences for these communication efforts are representatives from civil society, industry, government, and academia at both the local and regional levels. These groups play crucial roles in the forest management landscape, as they are directly involved in efforts to prevent illegal logging, detect forest irregularities, and contribute to effective reporting and enforcement processes. Engaging these audiences is essential to ensure that all relevant perspectives and responsibilities are aligned toward the project's objectives.

Which communication tools and formats are most appropriate for this context?

A combination of communication tools and formats is considered most suitable, including workshops that bring people together for direct discussion, bilateral meetings that allow focused

dialogue between specific actors, printed materials to ensure information reaches even those with limited digital access, and social media posts to share updates and progress reports from CS#2 with a wider audience. These channels were selected to meet the varied needs of the stakeholders involved and to ensure messages are delivered effectively across multiple platforms.

What kind of support is required from WP6 to reach these audiences?

Support from WP6 is needed to help translate and design the communication materials so they are easy to understand, visually clear, and culturally appropriate. This includes making sure that complex technical or legal content is presented in a way that can be understood by non-experts, ensuring that outreach materials are accessible and effective in reaching the target groups.

Who are the key stakeholders in this case study and why are they important?

The key stakeholders identified are the Forestry Guard, the Agency for Environmental Protection, the Forest Districts, NGOs, and forest owners. These actors are central because they hold critical roles in the management, oversight, and protection of forests in the region. Each group brings different resources, expertise, and responsibilities to the table, making their engagement essential to the project's success and its ability to drive meaningful change.

How were these stakeholders identified and mapped?

Stakeholders were identified through the project team's previous collaborations and interactions with local actors, as well as through careful desk research into the institutions and organizations at the local and regional levels that have the potential to support the project's objectives in CS#2. This combined approach ensured a well-rounded and informed stakeholder map that reflects the realities of the local context.

What engagement activities were initiated in Phase A?

The first stakeholder workshop, organized on April 10, 2025, served as the initial engagement activity, bringing together key actors for an introductory meeting. This workshop provided an opportunity to open lines of communication, share information about the project, and start building the relationships needed for future collaboration and action.

What capacity gaps have been observed among stakeholders?

No specific capacity gaps have been identified so far. However, some signs of tension and distrust were observed during the first workshop, particularly between the representatives of forest owners and the representatives of participating NGOs. These differing perspectives and the underlying concerns behind them will be explored further in the upcoming activities under the ENF project and may be incorporated as a thematic focus in the planned Living Lab (LL) activities.

What data has been collected during Phase A, and why?

The data collected so far includes detailed records of stakeholder attendance and the feedback gathered after the first engagement workshop. This information is valuable for establishing a

baseline understanding of participation levels and gauging initial reactions and perceptions, which are important for shaping the next steps of the project.

What KPIs make sense for this case study?

The key performance indicators (KPIs) selected for this case study are KPI 1, KPI 2, KPI 4, and KPI 5. These indicators have been chosen because they directly align with the project's goals and offer measurable ways to track progress and impact over time.

How is data collected, validated, and shared with WP6?

Data is collected by tracking the number of stakeholders who participate in various engagement activities, including workshops, bilateral meetings, and surveys. This data is compiled and delivered in Excel files, while more detailed summaries and reflections from meetings are provided as Word documents. These materials are then shared with WP6 to support the project's overall monitoring framework and to ensure that key results are integrated into the KPI dashboard.

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

Besides the first stakeholder workshop, we have contributed to the dissemination of surveys developed under WP2 namely T2.3 survey and related interview as well as the T2.5 survey.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

The impact of T2.3. survey and related interviews that emerged since Phase A is yet to be assessed as the analysis of its results requires cumulative effort from all partners inside the project. Presumably, the barriers and opportunities of Brasov CSA are similar to the South-east Europe type of forest management practices and implication towards enforcing environmental compliance.

4.3 Crete, EL, Lead: UoC, Participants: HBA, IIASA

4.3.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

Our work together with the HBA at the LIFE Natura Themis Project has been studied as an initial point and expanded further. The reports from the Law Observatory of East Crete that include the

area of interest for our project were also studied. We implemented several actions to identify legislation and policy texts related to our environmental compliance goals. We have conducted desk research & legal review of EU and national environmental legislation and studied the outcomes of judicial proceedings as well as relevant journals and publications. We have commenced personal visits to judicial authorities and administrative authorities and stakeholders.

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

To identify legislation and policy texts related to the use of citizen science for environmental compliance we implemented the actions mentioned at Q1 with a special focus on identifying the connection between legal actions and citizen science data. We have organized several meetings with representatives from the Bar Association of Heraklion in order to discuss about Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, that is connected with the use of application for smart devices and the visualization of the data to be collected.

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

To identify legal cases based on the use of citizen science data for environmental compliance we have implemented a range of field and desk research actions, with a strong focus on systematic data collection, stakeholder cooperation, and innovative tools. We will be using the data from the smart devices application through which citizens will submit environmental complaints. The reports will include geo-referenced data and photos and we will forward them to the competent authorities anonymously. Cases linked to environmental damage, including those arising from citizen-submitted evidence, will be entered into the project's GIS crime map, which will serve both as a legal data visualization tool and a reference for enforcement agencies.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

We have gone through an extensive study of the Greek procedural law, CSs and scientific literature for identifying the admissible citizen science court evidence. We have gained significant knowledge through our meetings with administrative authorities, prosecutors and judges that were held to discuss and evaluate the role of public reporting and how citizen-sourced evidence could be incorporated into case files during the operation of the LIFE Natura Themis application. We are updating our knowledge through new rounds of meetings with experts and authorities.

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

There are significant policy issues we have already identified. First of all, there is lack of cohesive environmental legislation which can create problems. The Greek legal framework is on many occasions a fragmented "mosaic of laws" without codification, which can make enforcement difficult and inconsistent. There is weak administrative implementation as the competent authorities are many times understaffed and there is overlap of responsibilities in many occasions. Moreover, there is absence of systematic recording of environmental violations. Additionally, authorities many times fail to act on environmental crimes unless directly pressured and there are occasions where public complaints are often ignored or inadequately processed. An additional challenge is to activate citizens who avoid reporting fearing that they could be personally involved if a case comes up.

Have you identified policy issues to be encountered throughout the implementation of your case study?

Same as above.

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

Some actions that would be beneficial to deal with the policy issues to be encountered are the following:

- Environmental compliance training: Local municipalities often lack expertise.
- Joint training sessions with environmental authorities, police, and prosecutors can close that gap and create a common understanding of how to act on reports. Institutional advocacy: The project could engage with ministries and legislators to promote structural reforms and improve the administrative weaknesses.
- Education of citizens: Informing the citizens more about environmental matters and the importance of citizen science could encourage their participation in identifying environmental crimes.

Have you now clearly identified the environmental compliance objective of your case study?

The main objectives of our case study include the identifications of land clearing cases in Heraklion prefecture and the collection of environmental complaints from citizens that would lead in identification of activities that are against environmental laws. The participations of citizens raises their environmental awareness and helps environmental compliance as citizens can inform us about incidents that could remain unnoticed otherwise and through us the competent authorities are informed and can take action.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

The environmental compliance objective of our case study includes the notification of competent authorities of activities that seem to be against environmental law that have come to our attention through the environmental complaints that the citizens will submit. The competent authorities will decide the process they will follow afterwards and if they will start a court proceeding. Therefore, court action could happen but it is not required.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

To be defined.

4.3.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Implementation of the ENoLL Methodology:

In preparation for stakeholder engagement and Living Lab implementation, the team translated the ENFORCE questionnaire to ensure accessibility and relevance for local actors. The translated version is finalised and ready for distribution.

Stakeholder Engagement Actions:

Stakeholder engagement efforts began with mapping and establishing contact with relevant local actors. These actions were aimed at raising awareness about the ENFORCE project and introducing the core features of the application developed for smart devices, highlighting its role in supporting environmental compliance efforts.

Planned Activities:

Upcoming planned activities include the organization of a stakeholder workshop and the coordination of the ENFORCE General Assembly, which is scheduled to take place in Crete in October 2025. Additionally, the team plans to update the mobile application, launch a targeted survey, and conduct interviews with key stakeholders to further enhance engagement and co-creation efforts.

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

The team participated in the **"Training on Living Labs Fundamentals"** (22 January 2025) and in the **"Stakeholder Value Mapping Exercise"** organised during the General Assembly in October 2025, both designed and facilitated by ENoLL. Through these sessions, the team strengthened its understanding of the Living Lab concept, the Quadruple Helix Model, and the operational principles required for effective implementation. The training also contributed to a more structured and consistent use of terminology, while increasing awareness of procedural requirements such as obtaining informed consent from engaged stakeholders.

Stakeholder mapping is treated as an ongoing and dynamic process. Continued engagement with initial stakeholders has generated additional recommendations and led to the identification of further relevant institutions and individuals. At the same time, systematic tracking mechanisms have been introduced to monitor participation across different activities. To ensure traceability, the team maintains structured Excel records of stakeholder engagement, covering events such as the first stakeholder meeting, the stakeholder event during the GA 2025 in Crete, and the T2.3 survey process. The team anticipates further guidance on the refined operational framework for Living Lab implementation in order to consolidate methodological alignment and enhance the effectiveness of future co-creation activities.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available?

In June 2025, UoC and HBA organised the first stakeholder meeting under the Living Lab framework. The meeting aimed to introduce the objectives of ENFORCE, present the legal dimensions of environmental crimes related to land clearing, explain the Living Lab methodology (including its definition and core implementation axes), and demonstrate the digital tool used in the Case Study, namely the Themis app for citizen scientists. The preparatory meeting brought together 10 participants representing the Region of Crete, the Fire Department, the Heraklion Forestry Directorate, the company Altsol, and the Natural Environment & Climate Change Agency. Following introductory presentations, an extensive and constructive discussion unfolded, allowing participants to exchange insights and practical experiences from administrative, technical, and enforcement perspectives.

A key conclusion emerging from the dialogue was that effective environmental compliance requires interoperability and stronger networking among competent authorities. A tangible outcome of the meeting was the notification of two land clearing cases previously handled by the Region of Crete, which were identified as potential case studies aligned with ENFORCE objectives. Although no formal analytical report was produced, photographic documentation was collected and presentation materials (.ppt) remain available upon request. The meeting also highlighted the diversity of viewpoints that can arise in multi-actor discussions and highlighted the value of inclusive roundtable exchanges. At the same time, it revealed a structural challenge: sustaining long-term stakeholder engagement. Despite positive in-person feedback and visible enthusiasm

during the meeting, only one of the ten participants responded to a subsequent email requesting structured feedback and additional information on land clearing incidents.

The second Living Lab activity took place on 8 October 2025, during the first day of the General Assembly, in the form of a dedicated "Stakeholder Event." The session attracted 10 participants, including both returning stakeholders from the June meeting and new representatives. Participants included the Region of Crete, the Heraklion Forestry Directorate, Altsol, the Municipality of Hersonissos, the Foundation for Research and Technology–Hellas (FORTH), the Psiloritis UNESCO Global Geopark, and the Natural Environment & Climate Change Agency. A representative of a competent authority delivered a substantive presentation entitled "Environmental Compliance – Dealing Step by Step with Land-Clearing Incidents in the Heraklion Regional Unit." This intervention was closely coordinated with a presentation by an ENFORCE team member on the legal challenges of the Cretan Case Study, resulting in complementary and co-shaped contributions that bridged institutional practice and legal analysis.

A central outcome of this event was the strengthening of linkages between the Cretan Case Study and other ENFORCE Case Studies, as well as the expansion of stakeholder familiarity with additional ENFORCE partners beyond UoC and HBA. This broadened network contributes to cross-case learning and reinforces the institutional embedding of the Living Lab process.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

It is under discussion.

4.3.3 Data and Tools Action Plan

The needs of the case study:

The main environmental compliance objective for this case study is to prevent illegal land clearing in the Regional Unit of Heraklion, Crete, through improved monitoring and enforcement. This requires integrating and updating existing data sets, such as those developed under the LIFE Natura Themis project, which include environmental services registries and anonymous citizen reports. These data sets will be expanded to cover the 2019-2022 period, providing a more complete picture of land degradation in the region. The project also aims to incorporate these data sets into the PLAZA tool, enhancing real-time detection and response capabilities for local authorities. Additionally, the project will focus on raising awareness among at least 500 stakeholders and 1,500 citizens, promoting more effective land management and compliance.

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem for the Crete case study is built around the LIFE Natura Themis mobile application, developed under the LIFE14/GIE/GR/000026 project. This app empowers citizens to report environmental violations within Crete's NATURA 2000 protected areas, providing a critical

source of data for monitoring illegal activities like habitat destruction, wildlife crimes, and unauthorized waste disposal. Available for both Android and iOS, the app supports anonymous, geotagged reporting, allowing users to submit up to four photographs and a written description of each incident, even offline.

Data from the app is reviewed by administrators before being forwarded to relevant authorities for further investigation, creating a direct link between public observations and regulatory enforcement. This approach has already led to the imposition of fines and remediation of environmental damage, demonstrating the app's potential as a powerful tool for civic engagement and environmental protection.

However, a key limitation is the potential for imprecise location data, as observers may not always be able to accurately record the exact location of the reported incidents (e.g. low internet accessibility leading to mistaken geolocation). This can complicate efforts to verify reports and take targeted enforcement actions, highlighting the need for more precise geospatial tools or complementary data sources to improve data accuracy.

The barriers to effective data collection and usage:

Despite the innovative approach of the LIFE Natura Themis mobile application, several barriers have limited its effectiveness as a data collection tool.

First, user awareness and engagement remain significant challenges, as many citizens are either unaware of the app's existence or hesitant to use it due to limited digital literacy or doubts about the impact of their reports. This reduces the overall volume and geographic coverage of the collected data. Second, connectivity issues in rural and mountainous areas can prevent real-time data submission, leading to delays in reporting and requiring manual synchronization, which can reduce the timeliness of enforcement actions. Third, the data verification process is a critical bottleneck. Each submission must be manually reviewed by administrators before being forwarded to the appropriate authorities, delaying response times and potentially reducing the effectiveness of enforcement.

Additionally, the app currently lacks interoperability with public databases and enforcement systems, meaning that collected data cannot directly trigger formal enforcement actions without additional processing, reducing its potential impact on compliance efforts. An extra current limitation could be the pending rebuilt of the application, which makes its not operational. To be clear, as many users of the application have been using the same smartphones since the downloading of the application, they can still record observations. Finally, while the app prioritizes user privacy through anonymous reporting, this also limits the ability to follow up with users for additional information or legal support in serious cases, creating a potential barrier to successful prosecution and long-term deterrence.

The Living Labs as collaborative environments for innovation:

In the context of the LIFE Natura Themis project, the mobile application served as a foundational tool for crowdsourced environmental monitoring within NATURA 2000 areas. However, the full

potential of Living Labs as collaborative environments for innovation was only partially realized. Environmental NGOs and project partners were the primary users of the collected data, analyzing incident reports to identify patterns of environmental degradation and using these insights to support advocacy, awareness campaigns, and environmental justice initiatives. This data played a critical role in shaping their environmental protection strategies, but its impact was often limited by the lack of integration with broader enforcement systems.

Public authorities, such as forestry departments and municipalities, occasionally responded to validated reports, particularly when supported by photo evidence and precise geolocation. However, without formal integration into their existing enforcement workflows, many of these reports remained underutilized, reducing their potential impact on policy and compliance.

Judicial and legal stakeholders also engaged with the data, using it to improve their understanding of the types and geographic distribution of environmental crimes. Some environmental lawyers and judicial officers received training on how to interpret this data, enhancing their ability to build cases. However, the systematic use of this data within formal legal proceedings remains a challenge, as many reports lack the structured, legally admissible evidence needed for prosecution.

Citizens and community groups primarily acted as data contributors rather than active end-users, with limited feedback on how their reports were used. This lack of transparency and engagement reduced long-term participation and trust in the system, despite efforts to address this through educational guides that make legislation more understandable to the public.

In summary, while the app successfully enabled initial data collection and awareness-building, it did not fully function as a true Living Lab, lacking sustained, multi-stakeholder co-creation and real-time collaboration. Future efforts in the ENFORCE framework could address these gaps by creating structured feedback loops, establishing data-sharing agreements, and integrating real-time collaboration platforms to support more effective, continuous engagement.

The valorization of existing and the development of new citizen science tools:

For Case Study #3, the LIFE Natura Themis mobile application will be further improved and adapted for use in the ENFORCE project. This app, which has already proven effective in enabling citizen reporting of environmental violations, will provide a cost-efficient starting point for citizen science data collection. However, a significant technical challenge remains: integrating the Themis app into the PLAZA Tool and the broader Informative Environment of the ENFORCE project.

Currently, the Themis app lacks the built-in capability for seamless data exchange with external platforms, as it was not originally designed to support real-time data sharing or integration with complex decision-making dashboards like those envisioned for PLAZA. This limitation presents a potential barrier to fully leveraging the app's data in real-time enforcement and monitoring workflows.

To address this, preliminary discussions have begun to assess the technical architecture of the Themis app and its compatibility with PLAZA. This includes exploring possible data exchange

formats, such as API development or data export functions, that could enable better interoperability. Direct communication with the PLAZA Tool developers will be critical to co-designing a solution that allows the Themis app to function effectively within the ENFORCE ecosystem, supporting more comprehensive, real-time environmental data collection and analysis. Update (January 2026): After further discussions with legal consultants and WP3 leaders, we suggest that immediate exchange of data between Themis app and PLAZA is not applicable. Data input for PLAZA is available upon request, since data filtered by UoC are going to be visualized, on expose.

The goals for the use of data in relevance to environmental compliance:

The primary goal for the use of data in this case study is to enhance the detection, monitoring, and enforcement of land clearing regulations in the Heraklion Regional Unit. Under the framework of T4.3, existing datasets collected through the LIFE Natura Themis application will be enriched and updated to cover the period from 2019 to 2022. This process will include georeferencing, categorizing incidents by type, severity, and legal status, and analyzing spatial and temporal patterns of land clearing in the pilot area. The aim is to produce a high-quality, actionable dataset that can support early detection of illegal activities and improve the decision-making capabilities of local authorities.

Additionally, this enriched dataset will play a critical role in the co-design of tools under WP3 of the ENFORCE project. This will include the development of risk-assessment components for early incident detection, decision-support dashboards for more efficient responses by forestry services and inspectors, and user-friendly interfaces that empower citizens and community groups to contribute to real-time environmental monitoring. These tools will help bridge the gap between community observations and formal enforcement actions, creating a more integrated approach to environmental compliance.

To improve data quality and increase the uptake of citizen-generated reports, new protocols will be introduced, including verification criteria, photo documentation standards, and metadata requirements. This will ensure that data collected by local users, including citizens, NGOs, and park rangers, meets the evidentiary standards required for administrative and legal proceedings. Legal experts and enforcement authorities will be involved in defining these standards, ensuring the data is both actionable and legally admissible.

Ultimately, these efforts aim to reduce illegal land clearing incidents through faster detection and response, enhance transparency and accountability in enforcement practices, and foster a culture of environmental vigilance and legal empowerment within the local community.

Key potential users and user requirements:

Within the context of **Case Study #3** of the ENFORCE project, the upgraded **LIFE Natura Themis** application is expected to serve several distinct user groups, each with specific needs regarding data accessibility, privacy, and functionality:

1. **Public Environmental Authorities (e.g., Forestry Departments, Environmental Inspectors):** These users require access to geotagged and time-stamped incident reports, complete with photographic evidence, to effectively monitor environmental violations and plan enforcement actions. Their requirements include secure, role-based access to prevent unauthorized data manipulation, as well as dashboard interfaces that support data filtering, prioritization, and export for more efficient incident management.

2. **Legal Professionals and Environmental Prosecutors:** For this group, the primary need is for verified, time-sequenced data that can support legal proceedings. This includes metadata on incident frequency, severity, and location, as well as assurances of data integrity and legal admissibility where applicable. Given the sensitive nature of some reports, the system must also respect the anonymity of whistleblowers, ensuring that their identities remain protected in compliance with legal and ethical standards.

3. **Citizens and Environmental NGOs:** As primary data contributors, these users need simple, intuitive mobile interfaces for reporting incidents, even in offline mode. They also benefit from feedback loops that provide updates on the status of their reports, fostering long-term engagement. Privacy is a critical concern, requiring full GDPR compliance, including the option for complete anonymity and no collection of personal identifying data unless explicitly permitted by the user.

In all cases, the design and future integration of the Themis application within the ENFORCE data environment must ensure compliance with EU data protection legislation, provide role-based access to sensitive data, and support scalable interoperability with other tools, such as the PLAZA platform.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

1. Variables recorded:

Images of the place/land clearing incident

Timestamp (Month-Year)

Short description of the incidents

Geolocation

Protection status of land (inside/outside Natura 2000 Network of Protected Areas)

Progression of report (Competent authorities confirmed or not validity of report, Was an administrative fine imposed? Was the problem restored?

2. Proxies:

All variables mentioned above, worth mentioning though that not the exact location of the incident is going to be used. Instead, a further area (including the spot) is going to be shown on a map.

3. Data sources

Citizen science reporting (LIFE THEMIS app): geo-reference, photos, timestamp

Natura 2000 boundaries (maps)

Earth Observation/satellite data

Hellenic Society for the Protection of Nature (HSPN) reports (HPSN was evaluating citizens' reports the first years the app was being used (until 2021) during the Project LIFE14 GIE/GR/000026 – LIFE NATURA THEMIS)

Competent authorities reporting (after receiving UoC or HPSN reports, they have been evaluating the reported environmental violations)

4. Progress towards assessing Data Readiness Levels

The already collected data from the LIFE THEMIS app satisfies some DRL requirements: Citizen contribution and involvement since the crucial data input is citizens' reports; Task-readiness since data serve enforcement of compliance and active engagement of citizens towards environmental compliance; Legal admissibility since the management of reports includes sending official reports to competent authorities accompanied by a protocol number; Data quality/Faithfulness since multiple level data validation takes place for every report. First, only georeferenced photos can be used for making a report through the app (this serves also legal admissibility). Second, the procedure includes expert involvement (university of Crete – Natural History Museum of Crete). UoC partners filter the citizens' input (using Earth Observation) and forward the report to more experts (competent authorities) who will implement autopsy to ascertain the validity of the report.

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

Case Study is in the process of development regarding the integration of the already collected data via LIFE THEMIS app with the Plaza tool (this data was collected before ENFORCE project initiation). The preparation of an excel file including land clearing reports using specific variables/proxies is already completed. Also, the new version of the app is under development, so that more users can download it (technical rebuilding in order to make it operational, compatible with modern smart devices.

4.3.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In Crete, biodiversity protection and environmental law enforcement are deeply connected to the management of Natura 2000 areas. Building on the LIFE Natura Themis project, the ENFORCE initiative focuses strongly on citizen involvement and legal empowerment, aiming to strengthen environmental compliance and conservation outcomes through strategic partnerships and community action. Phase A covers three core processes: Process a (Strategic Communication & Awareness Building), Process b (Stakeholder Mapping & Engagement), and Process i (KPI Tracking, Impact Assessment & Data Management).

What are the communication objectives in Crete during Phase A?

The communication objectives in Crete during Phase A are focused on four main pillars:

1. Promoting awareness of biodiversity conservation and protected areas: The goal is to raise public understanding of land degradation, habitat loss, and other environmental issues affecting Crete, fostering a stronger sense of environmental responsibility and stewardship within local communities.

2. Informing citizens about their rights and their role in environmental law enforcement: Efforts focus on increasing awareness of citizens' legal rights to report environmental violations and participate in protecting nature. This includes promoting awareness of citizen science tools such as the LIFE Natura Themis mobile application, which offers a practical mechanism for public participation.

3. Encouraging participation in environmental governance: The project aims to build local interest and trust in public systems that allow community members to contribute to environmental monitoring and reporting, emphasizing that citizen contributions can have meaningful impact, especially when integrated into enforcement mechanisms.

4. Supporting the uptake of existing tools and laying groundwork for integration with ENFORCE platforms: Promoting the LIFE Natura Themis app as an established example of citizen participation is a key part of the strategy, while also preparing stakeholders for its enhancement and integration with new tools under ENFORCE and PLAZA, ensuring continuity between past efforts and future developments.

These objectives are aligned with the strategic goals and stakeholder engagement framework outlined in Deliverable D6.1, particularly in relation to mapping and targeting local audiences, developing tailored key messages, building trusted communication channels, and preparing the conditions for long-term behavioral change.

Who are the priority audiences and why?

The priority audiences are:

1. Legal professionals (lawyers, prosecutors, bar associations): These actors are critical for ensuring that environmental violations are addressed within the justice system. Raising their awareness about environmental law and tools like the LIFE Natura Themis App improves legal follow-up, strengthens access to evidence, and integrates environmental law more deeply into legal practice.

2. Law enforcement agencies (police, Coast Guard, environmental crime units: As first responders to citizen-reported violations, these agencies must understand the legal frameworks, the value of citizen-sourced data, and the specific needs of protected areas to ensure effective environmental enforcement.

3. Forestry and environmental authorities (Forestry Services, Regional Environmental Inspectors): These agencies are on the frontline of managing Natura 2000 sites. Their capacity to interpret, validate, and act on reported infractions is key to achieving the project's goals.

4. Local residents and community leaders: Residents near protected areas are well positioned to observe and report environmental harm. Providing them with knowledge about their rights and access to legal and reporting tools empowers them to take an active role in safeguarding local biodiversity.

5. Schools and law students: Raising early awareness among students, particularly those in environmental or legal education, helps shape a new generation of environmentally responsible citizens and professionals.

6. Environmental NGOs and civil society groups: Already active in monitoring and advocacy, these groups can amplify communication efforts, strengthen citizen engagement, and act as intermediaries between communities and institutions.

7. Tourists and visitors: Tourists, as frequent users of natural spaces, need to be informed about the rules and available reporting tools to avoid accidental harm and increase broader awareness.

By engaging these diverse but complementary audiences, the project works to build a multi-level enforcement system that connects legal, institutional, and civic actors in the long-term protection of Crete's Natura 2000 zones.

Which communication tools and formats are most appropriate for this context?

The tools and formats selected include:

1. Public information boards in and near Natura 2000 areas, located at key access points such as protected area entrances and town halls, providing clear, accessible details on environmental rules, protected species, and reporting mechanisms like the LIFE Natura Themis app.

2. Educational workshops designed for different audiences, such as legal professionals (on environmental law and the use of citizen data), forestry staff and law enforcement (on verification procedures), and local residents (on their rights and how to report). These sessions also serve as opportunities to test and improve citizen science tools.

3. Environmental fairs and local events such as village festivals or regional fairs, which offer informal but powerful ways to engage diverse groups through demonstrations of the Themis app, open discussions, and distribution of informational materials.

4. Printed and digital guides that explain, in clear and illustrated terms, what counts as an environmental violation, how to respond safely and legally, and step-by-step instructions on how to use reporting tools. These resources are produced in both physical and digital formats for maximum accessibility.

This mix of formats is designed to maximize outreach, message retention, and consistent reporting behaviour, in line with the communication approaches outlined in Deliverable D6.5.

What kind of support is required from WP6 to reach these audiences?

The project requires support in three key areas:

1. Event communication materials such as banners, posters, leaflets, roll-ups, and templates for interactive activities like quizzes, pledge boards, or participatory maps, to enhance engagement during local events.

2. Storytelling and messaging assets tailored to Crete such as local narratives, testimonials, short videos, or animations that showcase the LIFE Natura Themis app in action and share real-life CSs of successful reporting.

3. Digital dissemination materials including adapted social media visuals, targeted micro-campaigns for specific groups (e.g., schools, legal professionals), and graphics or content blocks for use on municipal or NGO websites and social platforms.

Close collaboration with WP6 will ensure that all communication products are visually coherent, contextually relevant, and aligned with the broader project strategy and the audience segmentation framework set out in D6.1.

Who are the key stakeholders in this case study and why are they important?

Key stakeholders include:

1. Local Park rangers and field wardens who serve as frontline monitors, helping to detect illegal activities, validate citizen reports, and coordinate field responses.

2. Environmental authorities such as Forestry Services and Environmental Inspection Units, which have the legal authority to investigate infractions, conduct inspections, launch administrative or legal actions, and provide feedback on citizen reports.

3. Legal experts and environmental lawyers who ensure that citizen-generated data is legally useful, help advance cases in court, and promote awareness of environmental rights and obligations.

4. Volunteers and students from the LIFE Natura Themis network who bring valuable experience, trust, and local knowledge, acting as multipliers to guide others in reporting and engaging with authorities.

5. Educators and youth groups who contribute to long-term cultural change by teaching and inspiring young people to protect their environment and participate in citizen reporting.

Engaging these stakeholders is essential to building a resilient, community-centred enforcement system that aligns with ENFORCE's goals for participatory compliance and legal empowerment.

How were these stakeholders identified and mapped?

Stakeholders were mapped through:

1. Leveraging the LIFE Natura Themis network which provided a strong baseline of legal experts, judicial contacts, forestry staff, volunteers, educators, and NGOs already engaged in public outreach.

2. Semi-structured interviews and stakeholder dialogues with environmental authorities, park rangers, law enforcement, educational institutions, and youth group leaders, helping to refine the map and understand stakeholder roles and capacities.

3. Using WP5 stakeholder mapping tools including matrix templates and classification criteria from Deliverable D5.1, to categorize stakeholders by influence, interest, and involvement potential, and to visualize relationships across enforcement, education, and civil society.

4. A combination of digital and in-person methods such as online consultations, emails, surveys, face-to-face meetings, and field visits, ensuring broad reach and deep, localized insights in line with the participatory principles of D5.1.

What engagement activities were initiated in Phase A?

Phase A began with a formal introductory letter sent to key stakeholders, including environmental authorities, legal professionals, educators, and civil society organizations. This letter explained the goals of ENFORCE, highlighted its connection to the LIFE Natura Themis project, announced the planned use of the Themis app as a participatory tool, and invited expressions of interest for future collaboration.

What capacity gaps have been observed among stakeholders?

Several gaps have been identified:

1. Limited understanding of Natura 2000 rules and legal frameworks among municipal staff, residents, and even some enforcement agents, leading to confusion about protections, violation definitions, and evidence requirements.

2. Low legal confidence and awareness of citizen rights with many community members hesitating to report due to uncertainty about their standing, fear of retaliation, or lack of trust in authorities.

3. Limited access to or familiarity with reporting channels particularly among older residents, teachers, and volunteers who may be unaware of digital tools or unsure how to document and submit reports correctly.

4. Institutional gaps in handling citizen-generated data with public authorities lacking established protocols, resources, or clarity on how to integrate app submissions into legal and administrative processes.

Addressing these gaps through targeted capacity building – including legal literacy, digital training, and institutional workflow development – is critical for strengthening citizen participation and enforcement outcomes.

What data has been collected during Phase A, and why?

So far, the project has planned for citizen reporting by the end of 2025-beginning of 2026, when the smart device application will be fully operational. Preparatory data includes early stakeholder contacts and confirmations of interest.

What KPIs make sense for this case study?

Relevant KPIs include:

1. Number of downloads of the smart device application.

2. Number of citizen reports submitted using the application.

3. Number of reports that are forwarded to the authorities and evolved (there were re-actions to the report).

4. Number of reports concerning land clearing.

How is data collected, validated, and shared with WP6?

Data is being gathered through records of stakeholder contacts, such as the formal letter sent to a compiled stakeholder list. Two stakeholders – the Regional Development Agency of Heraklion and the Ministry of Environment and Energy – have already responded positively. These records are prepared in list format for sharing, ensuring they can be integrated into the KPI dashboard (MS2) for project monitoring.

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

Capacity-building activities haven't been implemented yet.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

Networking of stakeholders; creation of relationships among different authorities emerged through Phase A. The intimacy that started with the exchange of information and experiences lays the foundation for long-lasting relationships, bonds leading to better workflow of each authority, and a better monitoring of land-clearing violations. Through the above mentioned, environmental compliance should arise more easily and naturally.

4.4 Barcelona Urban Beaches, Barcelona, ES, Lead: CSIC, Participants: BCASA, ECSA

4.4.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

The policy framework has been discussed with the public administration on the basis of the mandatory monitoring programmes to follow the environmental status of the coastal area, taking into account the parameters selected for the LL of Barcelona.

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

The legislation currently under consideration has its own mandatory monitoring programme, but based on the misconception that citizen science data is not trustworthy does not integrate data from citizens, so we would like to implement a follow-up of the regulations selected together with the local administration to demonstrate the feasibility of official monitoring using citizen science data

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

The Barcelona LL conducted desk research on the EU Directives (MSFD and ERP), national environmental regulations, and local ordinances (smoke free beaches), along with stakeholder consultations with environmental authorities and municipal representatives, to identify the legal frameworks governing coastal ecosystem monitoring and determine how citizen science data coul be harmonized to support mandatory compliance obligations.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

The BCN LL will not address court litigation or admissible citizen science evidence; instead, it will focus on environmental compliance monitoring by comparing data from smoke-free and regular beaches to evaluate no-smoking legislation effectiveness, assess wet wipe impact through established protocols and translate findings into information for Extended Producer Responsibility (EPR) frameworks, and collect marine biodiversity data from urban ecosystems to support MSFD (D1 and D2 descriptors) follow up.

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

The BCN LL has held meetings with citizen science stakeholders and local government, who agreed to explore incoporating citizen science data in the monitoring follow-up. Currently, three working groups have been established, each dedicated to one of the three parameters, involving local stakeholders including NGOs, public agencies, research centres, and citizen platforms to discuss implementation issues.

Have you identified policy issues to be encountered throughout the implementation of your case study?

Some legislation lacks clear thresholds, so part of our work is translating data into impact analysis, such as for local no-smoking area regulations, while drawing on experience from other countries like France or other Spanish regions. For wet wipes, the rules focus on producer responsibility and how to translate data into policy, in collaboration with an external working group that includes the Barcelona City Council and representatives from the private sector and technical experts.

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

The BCN LL already is co-coordinate by ICM-CSIC and BCASA, part of Barcelona local council, therefore all permissions needed as well as potential discussions for decision making will be designed with them and the stakeholder part of the three working groups established.

Have you now clearly identified the environmental compliance objective of your case study?

The BNC LL is focus on environmental compliance with monitoring obligations through citizen science data.

1. Follow up of the monitoring obligation for D1, D2 and D10 of the Marine Strategy (MSFD, and it national and regional transposition). Parameters: marine biodiversity (D1 and D2) and marine litter (D10)
2. Improvement of the protocol and definition of thresholds for analysis of the local regulation of no-smoke beaches using CS data. Parameters: items of marine litter - waste associated with smoking (items of marine litter: cigarette butt, lighter, vaping tools, ect)
3. Definition of the protocol for the analysis responding to the ERP directive and the national transposition of the extended responsibility of producers. Parameters: items of marine litter- waste associated with smoking) cigarette butt, lighter, vaping tools, ect) and wet wipes.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

This use case does not focus on court action, but rather on achieving environmental compliance through the implementation and monitoring regulatory requirement; currently, citizen scence data are not used to this purpose, and our objective is to demonstrate that such data can effectively support the follow-up and control of environmental legislation.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

No

4.4.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Implementation of the ENoLL Methodology:

The Barcelona Living Lab (BCN LL) has actively participated in the ENFORCE training programme and has completed the associated self-assessment questionnaire. These initial steps ensured alignment with the ENoLL methodology and set the foundation for the upcoming co-creation activities.

Stakeholder Engagement Actions:

To initiate stakeholder involvement, the team organized an initial workshop designed to inform participants about the project and explore possible collaborations and synergies. This was carried out using a dynamic and participatory approach. After a series of individual follow-up meetings

are being held with key stakeholders to deepen engagement and explore specific areas of interest, currently three active working groups have been defined WG1 Biodiversity, WG- 2 waste associated with smoking and WG3 – Wet wipes In each WG there are several stakeholders involved part of the public sector, private sector, research centre and NGOs or citizen platforms.

Planned Activities:

Ongoing efforts include continuing individual stakeholder meetings. Additionally, the team is considering the formation of a dedicated working group focused on the issue of wet wipes, which would address specific local challenges and support targeted co-creation and policy-oriented activities.

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

Part of the team attended ENoLL trainings, including the introductory training on the basics of Living Labs and the workshop held during the General Assembly in Crete, which strengthened competencies in Living Lab methodology, co-creation processes, stakeholder engagement, and project structuring. As preparatory outputs, the team produced a stakeholder mapping and a working document to advance the project according to the defined parameters; these will be used to guide stakeholder involvement and structure activities within the Living Lab. For Phase B, capacity gaps were identified mainly in advanced impact assessment, data-to-policy translation, and long-term monitoring frameworks. Analytical and supporting documentation is available internally and can be shared upon request.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available?

An initial participatory workshop introduced the project and led to the creation of three thematic working groups, biodiversity, smoking-related waste, and wet wipes, followed by targeted meetings with stakeholders from the public sector, private sector, research, and civil society, with internal summaries and analytical notes available

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

At the beginning of 2026, an internal meeting with experts will be held to define the methodologies and draft a calendar for the actions, which will then be shared with the working groups during the first quarter. Validation workshops will be conducted, and the sampling campaigns will commence according to seasonal timing.

4.4.3 Data and Tools Action Plan

The needs of the case study:

Table 3 shows the environmental compliance for the parameters in the framework of the CS4BCN.

Table 3: Parameters of the User case BCN- Biodiversity and Marine Litter focusing on two different items wet wipes and cigarette butts

Area	Biodiversity	Marine Litter	
Parameter	Marine biodiversity through MINKA	Cigarette butts	Wet Wipes
EU legislation	MSFD - state of art of the descriptors D1 and D2 Waste framework directive	MSFD - state of art of the descriptor D10 Waste framework directive Directive SUP	MSFD - state of art of the descriptor D10 Waste framework directive Packaging and packaging waste Directive SUP
National legislation	Royal Decree 715/2012of 20 April. Interministerial Maritime Strategy Commission	Royal Decree 715/2012, of 20 April. Interministerial Maritime Strategy Commission Royal Decree 1093/2024, of 22 October. Waste management of filtered tobacco products and filters placed on the	Royal Decree 715/2012, of 20 April. Interministerial Maritime Strategy Commission Law 7/2022, of 8 April. Waste and contaminated land for a circular economy. Draft Royal Decree regulating the

		market for use with single-use plastic-containing tobacco products.	management of waste from wet wipes and balloons.(it was in public consultation until June 2025)
Local legislation	Decree Legislative 2/2008, of 15 April. Revised text of the Animal Protection Act	Ordinance Ban on smoking and the use of other nicotine-releasing devices on Barcelona's beaches	Metropolitan Wastewater Discharge Regulation Ordinance Environment Barcelona
Maturity	**High**. Well established and standardized protocol for data collection and upload in MINKA	**Medium**. Protocol for data collection established but not standardised, procedure for data upload not defined in MINKA	**Very low**. No protocols and standards set up and procedures for data upload in MINKA
Description	**Data collection**. Involvement of volunteers in biodiversity data collection in collaboration with local partners - activities in support of the Biomarathon and BioDiverCiutat events using the MINKA observatory	**Protocol with volunteers**. Study to define how to integrate the data into the MINKA Observatory. Definition of a scientific protocol to support the monitoring of the implementation of the rules. of the implementation of the rules	**Pilot analysis**. Study to define how to involve citizens in the collection of harmonised data in order to create a "control/check" system to monitor the application of Extended Producer Responsibility (EPR).

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem for this case study includes a range of databases and citizen science tools focused on marine litter and biodiversity.

Marine Litter: Data is primarily collected through the EDMONet Chemistry (Marine Litter) database, which serves as a central repository for litter data. Community-driven data collection is supported by the MINKA citizen observatory for underwater monitoring, while dry beach litter data is collected using the Marnoba app, with data often managed in Excel before being integrated into EDMONet. And the floating marine litter with JRC Floating Litter Monitoring app. Furthermore, a camara will be located close to the beach to analyse the inflow of litter into the sea from inland. These tools allow for localized, community-driven monitoring, but can present challenges in data standardization and integration.

Biodiversity: Biodiversity data is drawn from multiple sources, including EDMONet Biodiversity, GBIF (Global Biodiversity Information Facility), and the MINKA observatory, which feeds data directly into the GBIF system. These platforms provide comprehensive coverage of both terrestrial and marine species but may face limitations in data completeness, accuracy, and real-time accessibility, depending on the scale and consistency of community contributions.

Overall, while these tools provide valuable datasets for marine litter and biodiversity monitoring, challenges remain in integrating diverse data formats, ensuring data quality, and maintaining up-to-date records across different ecosystems.

The barriers to effective data collection and usage:

A key barrier to effective data collection and usage in this case study is the varying levels of maturity in the protocols and systems used to measure different environmental parameters. As indicated in the reference table, some data streams rely on well-established, standardized methods, while others use emerging or experimental approaches that may lack consistency and comparability. This mismatch in data quality and reliability can create challenges in integrating diverse datasets, reducing the overall effectiveness of environmental monitoring and decision-making.

The barriers to effective data collection and usage:

Barriers to effective data collection include uneven network development across topics, while biodiversity engagement is established, networks for waste and wet wipes are still emerging, initial workshops, follow-up meetings, and three working groups involving public, private, research, and civil society stakeholders, supported by external experiences, are helping build structured collaboration and improve data collection and policy translation. The goal is to establish volunteer groups for each of the 10 beaches included in the Barcelona use case, with each group focusing on a specific environmental parameter, promoting more targeted and effective data collection.

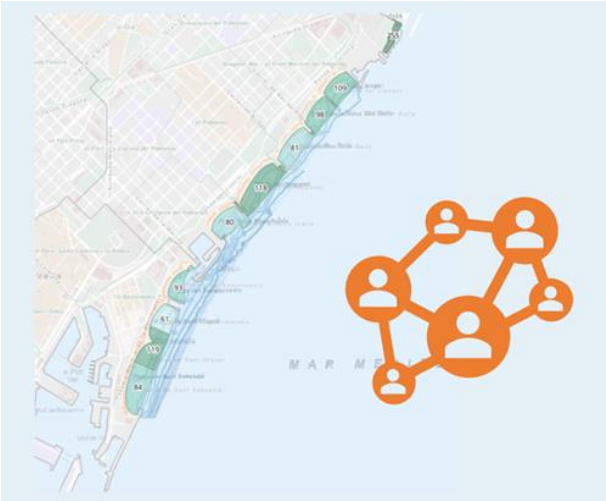


Figure 8: Conceptual framework Living Lab of Barcelona- Network of groups of organizations monitoring in 10 beaches of BCN

The valorization of existing and the development of new citizen science tools

For both biodiversity and marine litter monitoring, the EDMONet database, managed by the European Commission, serves as a central repository for data provided by EU Member States under the Marine Strategy Framework Directive (MSFD). This database supports the collection and analysis of data related to Descriptor 1 (Biodiversity), Descriptor 2 (Non-Indigenous Species), and Descriptor 10 (Marine Litter), aligning citizen science efforts with broader EU environmental monitoring and reporting requirements. By integrating these datasets, the project can enhance data consistency and support evidence-based decision-making for marine conservation.

The goals for the use of data in relevance to environmental compliance:

The primary goal for data use in this case study is to ensure that all collected biodiversity and marine litter data are aligned with established standards, follow the FAIR (Findable, Accessible, Interoperable, Reusable) principles, and are fully interoperable. This will enable effective data sharing and integration across different platforms, ensuring that the information can be reliably used by national and EU administrations for compliance monitoring and reporting under the Marine Strategy Framework Directive (MSFD). This alignment is critical for supporting long-term environmental protection and achieving the directive's goals of good environmental status for marine waters.

Key potential users and user requirements:

The primary users of the tool are citizens, who contribute data through mobile apps and community platforms. The main users of the resulting data include both citizens and public administrations, who rely on this information for environmental monitoring and decision-

making. To ensure privacy and data security, all platforms used, including the EDMONet database managed by the European Commission, are fully aligned with GDPR requirements and follow standardized metadata protocols, ensuring consistent, reliable, and legally compliant data management. Users of the tool: citizens.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

Focusing on data availability, quality, and usability, the occurrence data will be integrated into ongoing platforms with high-quality control and FAIR principles, including Minka-SDG, VertidosCero/Marnoba, and the JRC Floating Litter Monitoring App. All biodiversity data will follow Darwin Core standards. While marine litter datasets will adhere to EMODnet's new guidelines and standards, ensuring both the refinement of data pathways and a robust assessment of dataset readiness. The analysis of marine will follow the Join List of litter categories of JRC,

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

Early prototyping and testing have focused on ensuring compatibility with Minka-SDG, VertidosCero/Marnoba, and the JRC Floating Litter Monitoring App, while aligning biodiversity data with Darwin Core standards and marine litter data with EMODnet guidelines. Key insights indicate the need for functionalities supporting multi-stakeholder data input, standardized reporting, and seamless integration with analytical and visualization tools to facilitate data-driven decision-making and policy translation

4.4.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In Barcelona, urban environmental compliance efforts focus on key issues such as noise, waste, water quality, and artificial lighting, especially in high-profile tourist areas like the city's beaches. The work is supported by active citizen observatories, such as MINKA, which play a central role in engaging residents and visitors alike. Phase A addresses Process a (Strategic Communication & Awareness Building), Process b (Stakeholder Mapping & Engagement), and Process i (KPI Tracking, Impact Assessment & Data Management).

What are the communication objectives in Barcelona during Phase A?

The main communication objectives center on increasing public awareness of environmental issues that directly affect the Barcelona coastline, particularly noise, marine litter, and light pollution. These efforts are closely tied to the BioDiverCity and Biomarathon initiatives, which use social networks and related activities to enhance citizen understanding and engagement with

local biodiversity. Additionally, marine litter clean-ups are planned in collaboration with relevant stakeholders to promote shared responsibility and active participation in environmental compliance. All these activities align with the goals outlined in Deliverable D6.1.

Who are the priority audiences and why?

The priority audiences include beach users (tourists and local residents), local businesses, youth groups, city environmental services, and tourism authorities. These actors are directly involved in or impacted by the environmental quality of the coastline. To engage them, the Living Lab is working with NGOs, local government institutions responsible for coastal or waste management, and private sector entities, especially water sports centers, with the goal of involving citizens in the planned activities and fostering broad-based participation.

Which communication tools and formats are most appropriate for this context?

The most suitable tools and formats identified include social network campaigns linked to key activities (such as the Biomarathon), local events to promote citizen science tools, and physical signs at the beaches promoting initiatives like smoke-free zones. Digital signs at beach entrances, QR codes linking to MINKA tools, multilingual information materials, Instagram stories, and visual dashboards presenting environmental data have also been highlighted, adapting materials where appropriate from Deliverable D6.5.

What kind of support is required from WP6 to reach these audiences?

Support from WP6 is needed to co-develop physical materials in collaboration with the MINKA communication team, including brainstorming sessions, design work, and promotional campaigns across ENFORCE's official channels. This also includes creating visual identities for signage, graphic designs for infographics on litter and noise, and mobile-friendly communication materials that are tailored to a beach setting.

Who are the key stakeholders in this case study and why are they important?

Key stakeholders include:

1. NGOs, which help organize clean-ups, local actions, and campaigns.

2. Coastal or waste management authorities, which provide permits, offer feedback on data protocols, support citizen engagement campaigns, and help ensure citizen science data can be used for formal monitoring.

3. Recreational water sports organizations, which assist in involving citizens in activities and supporting engagement campaigns.

4. Research centers in Barcelona, which create synergies around protocols and European Commission-defined Data Reporting Levels (EC-DRL).

Together, these stakeholders are essential for both data collection and environmental enforcement.

How were these stakeholders identified and mapped?

Stakeholders were mapped through meetings with local authorities and public organizations involved in citizen science, such as the Barcelona Local Council, which established the Department of Citizen Science to coordinate and map local activities, organizations, and objectives. These interactions informed the stakeholder mapping process and contributed to Deliverable D5.1.

What engagement activities were initiated in Phase A?

Since the Barcelona Living Lab was already active, Phase A focused on consolidating its activities. Planned initiatives include campaigns such as the Biomarathon, and beach clean-ups, alongside workshops that promote collaboration and improve the data flow from citizen acquisition to policy implementation. These activities support stakeholder coordination and align with Milestone MS2.

What capacity gaps have been observed among stakeholders?

Roles and responsibilities have been defined within the framework of the Living Lab, based on the capacities of participating organizations. However, training sessions would still be beneficial to strengthen technical expertise, improve understanding, and enhance overall effectiveness.

What data has been collected during Phase A, and why?

Data collected includes information on marine litter – specifically wet wipes and cigarette butts and smoking-related waste - both on the beaches and underwater. Biodiversity data, covering fauna and flora along the coastline, has also been gathered. These data points are critical for tracking progress and contribute directly to Deliverable D6.9.

What KPIs make sense for this case study?

Key performance indicators identified include the number of environmental observations submitted through MINKA, progress on the beta version of the marine litter underwater protocol, and the number of workshops or meetings held to strengthen collaboration specifically around wet wipe monitoring.

How is data collected, validated, and shared with WP6?

Data is collected through the MINKA platform, which records submitted environmental observations and tracks the development of the marine litter underwater protocol. Additionally, information from workshops and meetings is gathered using event forms. All of these data sources are complemented by the publication of papers, ensuring that validated findings are systematically shared with WP6 for integration into the KPI dashboard (MS2).

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

The activity of capacity building internally to the BCN LL will be performed after the definition of the protocols.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

This Living Lab is closely tied to the local ecosystem, particularly in terms of stakeholder collaboration. The Barcelona City Council has a dedicated office for citizen science, reflecting a strong local culture of participation. While this makes the Living Lab a potential best-practice example, its scalability and replicability are limited due to its intrinsic reliance on the unique participatory culture and the established dialogue between local administration and citizens

4.5 East Devon Catchment, UK, Lead: WRT, Participants: UNEXE, UNIBI

4.5.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

The regulatory frameworks most relevant to CS5 are the Environment Agency enforcement and sanctions policy and the Farming Rules for Water, also known as The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018. WRT is aware of these frameworks via extensive experience of working with various stakeholders in the water and environment industry, including relevant government regulatory bodies (Environment Agency, Natural England).

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

Prior knowledge and networks (including the UK national Citizen Science Catchment Systems thinking Cooperative (CaSTCo)alongside desk-based research / literature searches.

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

In the UK case study, we are not intending to encourage citizen scientists to directly engage with legal action.. Rather, our intention is to improve processes and relationships for supplying evidence from citizen science and remote sensing to regulatory authorities (Environment Agency, Natural England) and other organisations (Catchment Sensitive Farming, Farming and Wildlife Advisory Groups, National Landscapes, Wildlife Trusts), supporting the environmental performance of farms to improve catchment planning and management. In this context Citizen Science data and remote sensing/modelling approaches can contribute to triaging limited regulatory resources. Regulatory bodies may then choose to undertake their own independent investigations and legal actions, but this is not our focus.

Through professional networks across the UK, we are aware of a very limited number of cases (outside South West England) where Environment Agency investigations have been prompted by citizen scientists independently alerting them of potential issues. However, as stated, this is not a model we intend to follow or encourage in the context of East Devon.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

Due to the complexity of managing diffuse agricultural pollution and attributing pollution to a specific source court cases are not directly relevant to this case study. We do not intend to be involved in this type of legal process.

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

Through prior experience and other on-going projects, we are aware that citizen science data have not previously been used by relevant bodies to inform regulatory activities due to the lack of standardisation of citizen science monitoring methods and the perceived lack of data quality control. This is now changing to some extent, with the Environment Agency (and other regulatory bodies such as Natural England) increasingly looking for ways to include a wider range of data sources, including citizen science data, in catchment management decisions. WRT are involved with driving that change through projects such as the Catchment Systems Thinking Cooperative (CaSTCo) and the development of standard methodologies for citizen science in freshwater environments.

Have you identified policy issues to be encountered throughout the implementation of your case study?

See above.

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

WRT are involved with other UK national projects (e.g. CaSTCo) that are enhancing the application of citizen science data within catchment management frameworks and/or regulatory contexts. Building on these relationships and the processes developed through these projects will be crucial.

Have you now clearly identified the environmental compliance objective of your case study?

For Case Study 5, this is summarised by the key functions of ENFORCE compliance Tier 2: detect irregularities early; generate evidence; increase monitoring density; support risk-based oversight. In particular, information resulting from additional evidence and risk-modelling can inform WRT's farm advice activities to encourage environmental compliance amongst landowners/tenants. In some cases, this information may also be presented to regulatory bodies (*e.g.* Environment Agency) – they may then choose to undertake their own independent investigations and actions. In March 2025 the UK Environment Agency published Citizen Science Technical Advisory Framework helping to ensure citizen science data can contribute to a shared understanding of the environment.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

Case Study 5 will not require court action.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

No additional policy issues.

4.5.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Implementation of the ENoLL Methodology:

The UK Case Study team has actively participated in ENoLL training sessions and contributed to the completion of relevant project deliverables. Through this process, it became evident that current working practices–particularly those facilitated through the Catchment Based Approach (CaBA) –are well-aligned with the principles of Living Labs, including co-creation, real-world experimentation, and open innovation. A stakeholder mapping exercise was also carried out to support the initial design of the East Devon Living Lab, which will be primarily implemented through the existing structure of the East Devon Catchment Partnership (EDCP).

Stakeholder Engagement Actions:

Stakeholder engagement efforts have included discussions with key actors such as the Environment Agency, Devon County Council, representatives of aligned initiatives like the CaSTCo project and community science and conservation groups in East Devon These networks are instrumental for advancing the project's objective of improving the uptake of citizen science data in regulatory contexts. The stakeholder mapping process further documented the diverse range of actors within EDCP, supporting a more strategic engagement plan.

Planned Activities:

The next step will involve presenting the project to the full EDCP once the case study team has established clear priorities, methodological approaches, and communication messages. The EDCP includes a broad spectrum of relevant stakeholders, such as regulatory bodies, environmental NGOs, local authorities, citizen scientists, researchers, landowners, and water company - ensuring a comprehensive and inclusive Living Lab ecosystem.

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

All ENoLL training offered to date has been attended, including the introductory living labs workshop and in-person stakeholder mapping workshops. These activities clearly identified the link between CaBA-funded Catchment Partnerships and Living Labs highlighting both their similarities (strong governance, cross sectorial approaches) and highlighting some gaps e.g. the greater focus on Open Innovation in a Living Lab. Additional potential stakeholder organisations have been identified (e.g. National Highways). The second Living Labs workshop is forthcoming, and guidance will be implemented in ENFORCE activities following this.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available?

The aims, objectives and initial remote sensing research activities of the UK Enforce project have been presented to local stakeholders and citizen scientists, alongside other WRT projects operating in the same region (TransformAR (EU Horizon), Rivers Run Through Us (Devon County Council)) at the East Devon Resilience workshop in August 2025 Citizen scientists were invited to discuss these projects with project leaders, and also to present their own independent catchment monitoring activities and local concerns in East Devon.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

The East Devon Catchment Partnership holds regular meetings where progress with Enforce can be discussed, feedback obtained and opportunities to participate further can be disseminated to the relevant audience. A workshop is planned for East Devon in late spring 2026 focusing on QA/QC for citizen science water quality monitoring methods. This is a concern for researchers, regulators and citizen scientists themselves. Results will be analysed and shared with all participants in an accessible format. Where funding allows, we may be able to provide higher specification equipment and further training for monitoring phosphate (a priority modelling parameter) in relevant water bodies.

4.5.3 Data and Tools Action Plan

The needs of the case study:

This case study aims to enhance the uptake and value of third-party data (including citizen science data) within regulatory frameworks, working through the East Devon Catchment Partnership. More specifically, we aim to use a combination of remote sensing (satellite) data and citizen science (water quality monitoring) data and existing data sets e.g. UK Environment Agency Water Quality Archive, UK Met Office rainfall data and WRT monitoring data, to identify and monitor areas with potentially high-risk soil erosion issues. This evidence can be used to flag potential issues to landowners, environmental organisations and regulatory bodies , as appropriate.

Other relevant data may also inform these activities, including professional water quality monitoring undertaken by the Environment Agency itself (Water Quality Archive), academia, business (South West Water, utilities company) and 'third sector' organisations (e.g. WRT).

The current data ecosystem, existing data, tools, and limitations:

A comprehensive data audit has been conducted for the East Devon case study to assess the availability, coverage, and quality of existing datasets relevant to water quality and catchment management. The audit identified the following key data sources:

The Westcountry Rivers Trust (WRT) Citizen Science program provides volunteer-driven, low-specification water quality monitoring, characterized by high spatial and temporal density n certain catchments. This data source offers significant coverage but may lack theaccuracy and precision of professional methods. It also presents opportunities for integrating new methodologies, such as the "Mud Spotter" approach for identifying soil erosion issues.

Professional monitoring by WRT includes field-based water quality assessments using spot sampling and continuous water quality sondes. This method provides high-density data in

specific, targeted areas, offering a more precise and consistent dataset compared to volunteer contributions.

The Environment Agency conducts regulated water quality monitoring, adhering to defined quality standards. This approach, while highly reliable, is typically lower in spatial density and more targeted, focusing on critical locations where regulatory oversight is required.

Data from the Water Framework Directive (WFD) provides insights into the factors preventing certain water bodies from achieving good ecological status. This includes diffuse or point source pollution, invasive species, physical modifications, and sectoral impacts from agriculture, wastewater treatment, construction, and forestry. However, the evidence base can be limited in certain areas, potentially affecting the robustness of the assessments.

Additionally, the University of Exeter is exploring potential sources of remote sensing and related data to complement ground-based measurements. These include Earth observation data from the Copernicus Sentinel missions (available through the Copernicus Data Space Ecosystem APIs), Ordinance Survey (OS) data on land use, elevation, and geological features (available through the OS data hub), river flow data from the National River Flow Archive, and land cover data available for academic use via the digimap.com API. The university also has the capacity to collect high-resolution aerial imagery using drones, although this data will be gathered on a targeted basis as specific needs arise.

This diverse data ecosystem provides a strong foundation for comprehensive catchment analysis, though gaps in spatial coverage and data resolution remain key challenges that need to be addressed for more effective water quality management.

The barriers to effective data collection and usage:

Paywalled and/or restricted datasets (e.g. commercial remote sensing data) may restrict the value of tools or analytical approaches developed as part of the case study.

The resolution of remote sensing datasets will need to be carefully considered with regards to the case study aims. In terms of broader catchment management, multiple actors are involved in collecting, storing and managing data and evidence and this is not always publicly available or easily accessible. The API's listed are free for UNEXE to use currently, but changes in policy could restrict access or necessitate finding an alternative source

The Living Labs as collaborative environments for innovation:

The Environment Agency is an evidence-led organisation, which produces substantial datasets (e.g. water quality monitoring), as well as using datasets produced by other organisations. Catchment planning decisions may be informed by data submitted by third parties. Catchment plans (developed as part of CaBA) are underpinned by robust data and evidence from a variety of sources, including public bodies (e.g. Environment Agency) and third sector organisations (e.g. Westcountry Rivers Trust). Multiple local river groups collect their own data supported by

organisations such as WRT. Frustrations exist that no clear mechanisms yet exist to include community data in catchment planning and management decisions.

The valorization of existing and the development of new citizen science tools:

Westcountry Rivers Trust (WRT) has an extensive network of citizen science volunteers. This includes a citizen science water quality monitoring programme, which has had >1,000 volunteer sign-ups across South West England since its inception in 2016, with approximately 600 currently active volunteers across the region (>150 in East Devon). Through Enforce there may be an opportunity to expand citizen science approaches to include a wider range of methodologies, e.g. "Mud Spotter", which is focussed on reporting soil erosion issues.

The value of citizen science data will be enhanced by developing processes for:

1. linking volunteer monitoring activities with remote sensing
2. feeding into regulatory frameworks (e.g. catchment planning).

Additionally, UNIBI are developing AI/ML processes to enhance the value of existing and future WRT citizen science data, to explore trends in qualitative aspects of citizen science surveys (e.g. observations of potential pollution sources and issues).

The goals for the use of data in relevance to environmental compliance

As above.

Key potential users and user requirements:

The primary users of the data in this context are the Westcountry Rivers Trust (WRT) and the Environment Agency. Both organizations have specific requirements regarding data privacy and sensitivity. Citizen science data, a critical component for both users, must be fully anonymized to protect the privacy of volunteers and landowners. This ensures compliance with data protection regulations and maintains the trust of contributors.

For the Environment Agency, outputs from the analysis and modelling of remote sensing data should be presented at broader catchment scales. This approach prevents the identification of specific locations or landowners, addressing privacy concerns and reducing the risk of unintended consequences, such as reputational harm or disputes over land use. WRT, in particular, relies on a foundation of collaboration and mutual trust with farmers and landowners. This relationship is critical for ongoing data collection and engagement, requiring careful handling of data to respect the sensitivities of these stakeholders and encourage continued participation.

Identify the spatial intelligence scope and objectives:

To be defined.

Establish the methodological framework:

The initial steps will involve collecting the available datasets and developing a preliminary model to retrospectively identify and predict historical land erosion events. This will include integrating data from multiple sources, such as citizen science contributions, professional field measurements, regulatory records, and remote sensing observations, to establish a comprehensive baseline for model training and validation.

Determine data types to be analysed, such as EO data sets from Copernicus services: EO Copernicus data from Sentinel one, two and three, along with land use and OS topographic data. Westcountry Rivers Trust citizen science data are a range of quantitative, semi-quantitative and qualitative observations relating to water quality. This includes measurements of specific parameters (e.g. phosphate concentrations, turbidity, etc), as well as observations (e.g. visual evidence of pollution, wildlife, etc).

Necessary infrastructure and guidelines for data collection and analysis:

UNEXE will develop a method for assessing soil erosion risk in agricultural areas using remote sensing data, preferably as an open source tool that can be applied by WRT and potentially other organisations. This will use EO image data, processed into relevant bands/indices. To be processed with Convolutional Neural Networks, pre-trained on satellite data and fine-tuned to our objectives. Citizen science data will be collected via existing networks and methodologies and stored on the Cartographer corresponding data platform space.

UNIBI will develop AI/ML methods for assessing pollution risks based on WRT CSI data.

The scope and objectives of the xAI technologies to be developed:

AI/ML tasks incorporate unsupervised ones, specifically pollution risk is related to emerging anomalities and outliers. As this is ill-posed, human inspection is required. XAI methods enable us to substantiate detected outliers by a reason why they are marked as such by the AI method, i.e. by pointing to the most relevant features which distinguish the observation from normal behaviour. The objective is the identification and explanation of the most relevant deviations of observed behaviour as compared to expected one, considering seasonal and spatial specifics of normal behaviour.

The methodological framework for xAI:

AI tools will be employed, including both classical methodologies for tabular data and more recent foundational models such as TabPFN, depending on the nature of the data and the specific analytical objectives. These models will be used for density-based or residual-based outlier detection, selected according to the findings from preliminary data exploration. To enhance interpretability, feature-based explainable AI (xAI) methods will be incorporated, focusing on mathematically rigorous local approaches such as SHAP (SHapley Additive exPlanations), as well as computationally efficient techniques based on derivatives or permutations, ensuring both robustness and scalability in the analysis.

Data types to be analyzed for xAI, such as EO data sets from Copernicus services:

Data are tabular data (measurements of parameters such as phosphate concentration, turbidity), qualitive data (e.g. presences of visible pollution evidence), enriched with time axes and spatial location. If suited, the xAI methods will be extended to EO data.

The necessary infrastructure and guidelines for xAI:

The measurements will come from other sources within the project, since xAI is topically a step in the data processing pipeline which is built on top of initial data analysis. Thus, it will be based on EO tools and measurement kits provided to volunteers only indirectly. CS applications will be based on typical open-source tools, especially PyTorch and foundation models such as TabPFN. The developed pipelines will be implemented as Python-notebooks.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

Case Study 5 is focusing on several direct variables measured by citizen scientists (phosphate, turbidity, dissolved solids), as well as observations of land use derived from earth observation data. Case study members are engaging with data readiness level surveys and training.

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

See above.

4.5.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In East Devon, efforts to detect and enforce against water pollution combine citizen monitoring, AI tools, satellite imagery, and real-time monitoring across a rural-urban water basin. The work integrates multiple actors and technologies, aiming to strengthen environmental compliance through collaborative monitoring and informed decision-making. Phase A covers Process a (Strategic Communication & Awareness Building), Process b (Stakeholder Mapping & Engagement), and Process i (KPI Tracking, Impact Assessment & Data Management).

What are the communication objectives in East Devon during Phase A?

The main communication objective during Phase A is to raise awareness among volunteers about the potential links between remote sensing and citizen science, focusing on how these tools can work together to improve water quality monitoring. All communication efforts are designed to protect and maintain positive working relationships with stakeholders, recognizing the importance of collaboration in achieving environmental outcomes. Sensitive approaches are being

developed to ensure the project's aims are communicated carefully to citizen science volunteers and other stakeholders. These goals align with the broader objectives set out in Deliverable D6.1.

Who are the priority audiences and why?

The priority audiences for this phase are citizen science groups and the Environment Agency, engaged through the East Devon Catchment Partnership. After internal discussions, it was decided not to communicate directly with farmers and landowners at this stage, as the project's framing could raise legitimate concerns and risk damaging established working relationships. Instead, the focus is on enhancing the use and value of citizen science data within regulatory frameworks and catchment management, rather than using the data to target specific individuals or businesses.

Which communication tools and formats are most appropriate for this context?

Given the sensitive nature of this case study, the project primarily uses targeted communication methods rather than broad public campaigns or social media outreach. Communication is conducted through the East Devon Catchment Partnership, the volunteer management platform ("Assemble"), and existing professional and community networks. These channels ensure that messages are directed to the right audiences in a controlled and constructive manner.

What kind of support is required from WP6 to reach these audiences?

At present, the project team at WRT has the expertise to produce the necessary communication materials and does not require additional support from WP6 for visual content, infographics, or presentation materials.

Who are the key stakeholders in this case study and why are they important?

The key stakeholders involved are the Environment Agency (as the environmental regulator), national government agencies such as DEFRA, local government authorities, agricultural landowners (who contribute to both diffuse and point source pollution), the regional water company (involved in point source pollution), civil society groups participating through the East Devon Catchment Partnership, and environmental NGOs. Each of these actors plays a role in pollution reporting, enforcement, or shaping local environmental policies.

How were these stakeholders identified and mapped?

Stakeholders were identified primarily through WRT's established professional networks, including the East Devon Catchment Partnership and the Catchment Systems Thinking Cooperative (CaSTCo). These networks provided a solid foundation for stakeholder mapping and engagement and contributed to the development of Deliverable D5.1

What engagement activities were initiated in Phase A?

The key engagement activity in Phase A has been focused on raising awareness among volunteers about the potential integration of remote sensing data with citizen science. This targeted

communication lays the groundwork for collaborative environmental monitoring and strengthens the operational network in line with Milestone MS2.

What capacity gaps have been observed among stakeholders?

A major challenge identified is the historical exclusion of citizen science data from UK environmental regulatory frameworks, largely due to concerns over standardization and quality control. Although this is now beginning to change, the development of processes to integrate citizen-generated data into formal decision-making frameworks is still underway and will require significant time and effort. The project aligns with several national initiatives working toward this goal.

What data has been collected during Phase A, and why?

From the project's inception on September 1, 2024, to April 23, 2025, a total of 124 active volunteers in East Devon have conducted 988 water quality surveys across more than 200 locations. These data are recorded and stored on the Cartographer platform, providing a detailed dataset that supports early project impact assessment and contributes to the Deliverable D6.9 KPI dashboard.

What KPIs make sense for this case study?

Key performance indicators identified for this case study include:

1. Successful targeting of citizen science monitoring efforts based on insights from remote sensing.

2. Inclusion of citizen science-derived data in Environment Agency "weight of evidence" approaches, decision-making processes, and catchment management strategies.

3. Improved mechanisms, methodologies, and approaches for incorporating big data into environmental decision-making and catchment management.

How is data collected, validated, and shared with WP6?

Data are collected through the Cartographer platform and are validated by WRT staff. The processes for linking these data with WP6 and determining how they will be integrated into the broader KPI dashboard (MS2) are still under development.

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

All capacity-building workshops have been attended, with WRT providing specific contributions to workshops on user uptake, engaging with local governments. Relevant project stakeholders, including citizen science groups, have been made aware of the Enforce project and its aims in East Devon. Several aligned projects have been identified (e.g. Rivers Run Through Us, Axe Nutrient

Neutrality) that will enable a consistent approach to the collection and use of citizen science data across East Devon.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

Case Study 5 is building on a pre-existing, long-term citizen science programme (established 2016). Best practices that emerge from the ENFORCE project can be readily incorporated into this programme. In March 2025 the UK Environment Agency published a Citizen Science Technical Advisory Framework helping to ensure citizen science data can contribute to a shared understanding of the environment.

4.6 Puglia Region, IT, Lead: CIHEAM, Participants: ENoLL, AMRN.

4.6.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

In order to find information and reference regulations on the subject, several interviews were carried out with public officials, local municipal police representatives, and representatives of the company that manages waste in the area. To this was added a research desk and a direct meeting with the group of stakeholders.

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

In order to find information and reference regulations on the subject, several interviews were carried out with public officials, local municipal police representatives, and representatives of the company that manages waste in the area. To this was added a research desk and a direct meeting with the group of stakeholders.

Phase B: The jurisprudence relevant to your case stud

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

With the support of law enforcement authorities, local administrations and territorial bodies, as well as through targeted research activities, data related to the case study were collected.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

In the previous months, several research activities and interviews were carried out as part of the project work.

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

Compared with what was initially planned and communicated at the start of the project, the involvement of local administrations, decision makers and municipal councillors proved challenging due to political factors.

Have you identified policy issues to be encountered throughout the implementation of your case study?

The first policy issue we faced was the difficulty experienced by municipalities in collecting and organising data. The second issue was the identification of the actual actors involved in illegal dumping across the different areas. A third issue was linked to internal political dynamics within municipal councils.

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

Not yet.

Have you now clearly identified the environmental compliance objective of your case study?

Following the meetings held in the area, it is clear that the true interest of the citizens and stakeholders of the BioDistretto delle Lame is compliance with environmental regulations regarding waste disposal in rural areas, and in particular, avoiding the creation of waste collection points along roadsides and in more peripheral areas.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

Not yet.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

We have not encountered any other problems. For those already highlighted, we propose to hold further meetings and try again to establish more effective cooperation with the administrations.

4.6.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Application of the ENoLL Methodology:

During this initial phase, the team developed an extensive stakeholder mapping aligned with the Quadruple Helix model, ensuring the inclusion of both direct and indirect actors relevant to the case study. A dedicated working group was established, assigning clear roles such as pilot managers, panel managers, and local facilitators. Together, they defined a general action plan structured around two key phases: problem identification and the subsequent exploration of potential solutions.

Stakeholder Engagement Efforts:

Engagement activities focused on direct meetings with municipal representatives, leveraging the established network of the Biodistretto delle Lame. Through these initial interviews, additional key actors and organizations within the territories were identified. These individuals and groups, possessing valuable insights and capacities, were then invited to participate in the upcoming Living Lab process.

Planned Future Activities:

To further assess stakeholder interest and gather input, a dedicated survey has been prepared for distribution to those who participated in early engagement activities and the initial meeting held on 17 April. The results of this survey guided the subsequent planning and ensured responsiveness to stakeholder priorities. A follow up meeting was scheduled for June 2025 to deepen collaboration and refine the Living Lab approach based on the emerging insights.

The next meeting held in November laid the foundations for the implementation of the action plan with gathered suggestions from participants

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

The team participated in the first ENoLL training course, building on previous involvement of the Biodistretto delle Lame Living Lab and its members in earlier ENoLL training programmes and Living Lab creation initiatives. This prior experience facilitated continuity and methodological consistency in the application of the Living Lab framework within the ENFORCE project.

In the preparatory phase, the team applied ENoLL's stakeholder mapping model and panel matrix to systematically identify and categorise relevant stakeholders. This structured approach supported the definition of engagement priorities and ensured representation across the Quadruple Helix dimensions in subsequent Living Lab activities.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available?

In the first phase of the first meeting, the methodology of the living labs was introduced, the aims and objectives of the Enforce project and the reason why the Bio-District of Blades was identified as a territory in which to observe and try to develop solutions regarding the issues of waste abandonment and arson in rural areas.

All participants were asked a question: "What are the main obstacles that in your opinion local actors encounter in enforcing and respecting environmental compliance?"

The participation of those present was wide and the contributions collected numerous. The presence of the main actors involved in environmental issues such as the Local Police, Policy Makers, the associations of volunteers and the company in charge of waste management in the area was important. Important suggestions came from the political part of the participants and from the citizens present.

The second workshop presented national, regional, and local regulations on waste management and fires, along with the related data collected by local authorities. Reporting and litter data were highlighted, and specific cases were presented. In a second phase, barriers and obstacles were analyzed through a structured brainstorming session with the 20 participants.

During the third workshop, the results of the survey and the most recent meetings were presented, and a world café was organized to launch the co-design phase of a regional action plan, to be validated at the next meetings in 2026.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

At this stage, the citizen science data collection phase has not yet been initiated. Consequently, the current focus remains on the co-design of a structured action plan to be presented to policymakers, while efforts continue to obtain and consolidate relevant data from law enforcement authorities.

The solutions proposed during stakeholder engagement activities will be further examined in collaboration with the waste management company, which represents a primary stakeholder both in terms of data availability and the operational implementation of potential corrective measures. This coordinated approach aims to ensure that proposed actions are institutionally feasible and aligned with existing enforcement and management structures.

4.6.3 Data and Tools Action Plan

The primary objective is to prevent illegal dumping by ensuring proper waste management and enforcement of relevant regulations. Key data sources include citizen complaints, which often provide real-time alerts to potential violations, and municipal police reports, which document observed incidents and provide critical evidence for enforcement. Reports from waste management companies also contribute, capturing discrepancies in waste collection and unauthorized deposits. Additionally, environmental organizations and NGOs provide long-term monitoring data, highlighting the broader ecological impacts of illegal dumping. Together, these data streams support effective detection, accountability, and enforcement efforts, ensuring a cleaner and more sustainable environment.

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem will be mapped by first identifying and cataloguing all available data sources, including citizen science contributions, professional monitoring data, regulatory records, and remote sensing inputs. This will be followed by an assessment of the tools and platforms currently used for data collection, processing, and analysis. Finally, a gap analysis will be conducted to identify data limitations, inconsistencies, and areas where additional data or improved methodologies are needed to support the project's objectives.

The barriers to effective data collection and usage:

Effective data collection and usage are often hindered by the fragmented management of waste-related data, which is distributed across multiple municipalities and private waste management providers. This decentralization can lead to inconsistencies in data quality, formatting, and availability, making it challenging to integrate datasets for comprehensive analysis. Additionally, differences in data governance policies and varying levels of technical capacity further complicate efforts to create a unified, accurate picture of waste management activities.

The Living Labs as collaborative environments for innovation:

Living Labs provide a collaborative environment for municipalities, waste management companies, and other stakeholders to co-create innovative solutions for waste management. Each

municipality utilizes data differently, aligning its use with local priorities and policy goals, while waste management companies focus on using this data for prevention, awareness, and sensitization efforts. By bringing these diverse perspectives together, Living Labs enable the development of integrated, context-specific strategies that enhance waste management efficiency and sustainability.

The valorization of existing and the development of new citizen science tools:

Currently, no specific tools or methodologies for citizen science have been developed, but the approach will focus on engaging local stakeholders to collaboratively define the key strategies needed to achieve the desired outcomes. This initial phase will involve identifying critical data needs, setting project goals, and outlining the functional requirements for a digital tool that can support data collection, validation, and analysis. Once these foundational elements are established, the development of a tailored digital platform will proceed, designed to effectively capture and utilize citizen-generated data.

The goals for the use of data in relevance to environmental compliance:

The primary goal for data use in this context is to gain deeper insights into citizen behaviour, as well as the interests and motivations of policymakers and businesses, in order to inform more effective environmental policies and strategies. High-quality, accurately collected data will be essential for identifying gaps in current waste management practices and assessing the impact of potential policy changes. Additionally, efforts will focus on improving data quality and ensuring broader uptake by key stakeholders to support ongoing compliance and long-term sustainability.

Key potential users and user requirements (privacy issues if any):

Key potential users of the data and tools include municipal waste management departments, environmental regulators, and research institutions. These users may require anonymized data to protect individual privacy, particularly when integrating citizen science contributions, and must ensure compliance with relevant data protection regulations.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

Not identified yet.

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

We have initiated discussions with the waste management company that owns an app useful for citizen science data collection, but we are unable to finalize the process. Unfortunately, we cannot

use another app unless we agree with them to avoid political problems, including with the municipalities.

4.6.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

Context: Illegal waste dumping and burning in rural bio-districts, with fragmented enforcement, health concerns, and citizen-driven monitoring supported by local municipalities.

Process a: Strategic Communication & Awareness Building

What are your communication objectives in Puglia during Phase A?

During phase A, the main objectives focus on the engagement of stakeholders and the visibility of the Project to strengthen engagement strategies. The main objective of communication activities is to create interest and consolidate involvement in the activities planned for the subsequent phases. It is also important at this stage to build trust in the LL and its objectives. In the subsequent phases, during which it will be necessary to involve more users, the activities will be more focused on awareness and awareness of the issue.

Who are your priority audiences and why?

The audience of the communication activities in Phase A are policy makers, staff of Municipalities, NGO and volunteers associations, local police and firefighters, waste management companies.

Which communication tools and formats are most appropriate for this context?

In this phase a dedicated email and a WhatsApp Broadcast have been created for direct communication with stakeholders. The project communication templates are used to strengthen the project identity.

What kind of support do you require from WP6 to reach these audiences?

Potential needs include visuals linking dumping to health outcomes, Italian-language reporting guies, localized ENFORCE branding, or template materials for use by local governments.

Process b: Stakeholder Mapping & Engagement

Who are the key stakeholders in this case study and why are they important?

Local waste authorities: they are responsible for the waste management, management of illegal landfills and implementation of sensibilization campaigns for citizens.Municipal police: the local police force responsible for the management of reports by citizens and monitoring in the territory.Environmental NGOs and voluntaries: They are representative of groups of citizens who are sensitive to environmental issues and who want a change in the territory. They are fundamental for data collection and intervention activities on the territory.

Organic farming cooperatives: these are the companies interested in the healthiness of the territory and sensitive to the strategies of prevention and reduction of the phenomenon.

How did you identify and map these stakeholders?

The stakeholders were identified and identified thanks to a desk and brainstorming phase between the main promoters of the native beginning, CIHEAM Bari and the Biodistretto delle Lame. Through a mapping of relationships and contacts, a first group of main stakeholders was reached, thanks to which it was possible to identify the other fundamental actors included in the prices of illegal fire and waste management.

What engagement activities were initiated in Phase A?

The activities are focused on direct and bilateral meetings with policy makers and staff of the municipalities responsible for the environment sector. From these, dedicated meetings were held with volunteer associations and cooperatives.

A first presentation meeting was organized involving the first group of main stakeholders. The meeting will be followed by the transmission of a survey to complete the collection of data and the consolidation of the group.

What capacity gaps have you observed among stakeholders?

There is a limited and disruptive conception of environmental comliance at the local level. Added to this is a scarcity of resources of local authorities aggravated by a discrepancy in data collection. The mechanisms of signaling are quite uniform but not able to guarantee monitoring in the territory. This preliminary information is very useful for defining the training, awareness-raising and co-creation activities planned in the subsequent phases.

<u>Process i: KPI tracking, Impact Assessment & Data Management</u>

What data have you collected during Phase A, and why?

We have been able to collect data on the abandonment of waste in the year 2024 and the reporting of illegal fires as well as the awareness campaigns launched by the waste management company.

What KPIs make sense for this case study?

# of illegal dumps reported

# of illegal fires reported

# of sensibilization campaign lunched

# of illegal landfills reclaimed

How is data collected, validated, and shared with WP6?

The data collection will be verified and validated thanks to the legitimacy of the source (municipality, police, fightfires).

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

We offered training on living labs and innovation processes, seeking to foster collaboration, a sense of belonging, and a shared understanding of a common problem across all regions.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

Some associations are considering organizing joint awareness-raising initiatives in three municipalities.

4.7 The Netherlands, NL, Lead: Waag, Participants: EVI

4.7.1 Legislation/Policy Identification Action Plan

Phase A: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

Most of the work so far has been desk research and interviews with citizens and experts who have experience with environmental legislation/court cases. These interviews further informed the desk research. The research includes both Dutch (national) and English (European) sources and texts.

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

The work so far for this specific topic has been desk research into both scientific and grey literature. As well as the interviews, where we asked about this specific topic.

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

Most of the work so far has been desk research informed by the same meetings as the legislation. We have searched for and read legal cases focussing on pesticides and citizen science. We have reached out to a few citizen science groups to ask about legal actions they have experience with.

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

The work so far has included desk research into the court cases to identify admissible evidence. One of our partner organisations in the Living Lab has had a recently concluded court case, which we communicated about during the process. We also have the official ruling by the court, which we are analysing with legal experts. Furthermore, we have reached out to a Dutch NGOs with a history of environmental court cases and environmental lawyers. Stating that we wish to explore the use of CS data in existing cases with them.

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

Yes, one of the policy issues is exactly what the court case was about namely: There are management plans about the protected natura 2000 areas that allow for certain 'business' activities, including dumping over 30.000 tonnes of discharge water annually. This number was framed as being backed by science with certain papers. However, the scientific basis and the parties who started the case highlighted that the basis of the research concluded that a lot of molecules and chemicals that are discharged in water have unknow effects. Most likely harmful effects on ecological and biological processes. Keeping that in mind, in combination with the cautionary principle to protect nature, the court agreed that the management plans allowed activities that could not be ruled out as being not harmful. So, the activities must be put on hold and stronger patent evaluation, and application must be enacted.

A second policy issue: All companies in the Netherlands must take a few measurements of their emissions yearly and report this to the national authorities. The type of measurements and frequency is determined by which industry the company falls under. The issue is that for all companies in the Netherlands, their (yearly) emission data will be made public, including location where they are situated. However, due to some deal made long ago between the government and the oil industry, oil and gas platforms in the North Sea are not shown with their emissions and locations.
So the policy issue is twofold: The frequency of measurements is too low, and the companies can decide when to take measurements to favour them. And the data of specifically oil and gas companies in the North Sea, even in natura 2000 areas, is not as openly available as is the case in other sectors. Making it more difficult to monitor these companies.

Have you identified policy issues to be encountered throughout the implementation of your case study?

Yes, if we wish to measure any data in natura2000 areas we would need a permit. As this process can be slow, we will need to figure out if we want that early in the project.

A larger policy issue in the Netherlands is the fact that the national government (state) is responsible for translating EU directives into national policies and laws. However, most often for the environmental side, such as habitat and water directive, the state has mandated the provinces and water bodies separately to regulate and translate these directives. Sometimes without clear national regulation. Therefore, all provinces and water bodies handle things differently and there is often a lot of uncertainty and lack of clarity on who is responsible for what and where the enforcement need to come from.

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

Applying for the necessary permits on time. Furthermore, we would like to speak with policy makers and involve them into the living lab. And figure out the new policy cycle and how we can have an impact there. We would like to assist citizens in starting a new legal case but have not yet identified a specific one.

Have you now clearly identified the environmental compliance objective of your case study?

Currently, the governmental management plans for the North Sea, even in natura 2000 areas, allow industrial activities to dump polluted water and perform ecologically disturbing acts. Very little is known about the effect or reported of these activities and pollutants. What there is, does not give a complete overview.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

The collected court cases tell us that moving forward further court action should not be a hard necessity for achieving the environmental protection. But that in the case of corporations or even governmental bodies operating against environmental law there is a precedent and template for using court action to enforce these laws.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

Not applicable.

4.7.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Application of the ENoLL Methodology:

In the early stages of the project, the team participated in the first ENoLL webinar and completed the corresponding home assignment. Additional stakeholder mapping was also conducted to support the development of the Living Lab, with a focus on broadening the network and ensuring representation across key societal sectors. We have furthered our efforts to build up our Living Lab and acknowledged the importance of finding a governance structure from the ENoLL workshops. Towards this end we have set up a working group with experts from different sectors and fields across the stakeholder spectrum. This working group consists of actors from our closest partners. Wherein we hope to meet regulalrly to discuss the progress, data and next steps. Furthermore, we wish to invite different experts to some of these meetings to help us further, think of Earth Observation experts, legal experts, journalist and government authorities.

Stakeholder Engagement Efforts:

To build momentum and foster collaboration, we initiated meetings with citizen-led initiatives relevant to the project's goals. Outreach was also extended to various environmental organisations, scientific experts on ocean pollution and marine biology, legal experts and a knowledge-sharing meeting was held with a European project focused on citizen science. These interactions aimed to establish synergies, exchange best practices, and lay the groundwork for future cooperation.

Planned Future Activities:

We will organise further activities with our working group, both internally, to engage with stakeholder, and to engage with the broader public. Think about database and policy analysis. And public data analysis workshops and data storytelling. We also wish to engage more with governmental authorities, policy makers and industry stakeholders.

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

We have attended all the ENoLL workshops so far. Both the one online and in person during the GAs. From these meetings we gained more understanding of the governance structure and which factors/stakeholders to consider in a Living Lab. This helped us to produce a more detailed stakeholder map and get started with governance structure and guidelines for our Living Lab. The supporting documents are currently only in Dutch in word document in our own cloud. But we will translate them to English when finalized and make them shareable.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available?

The Living Lab activities so far have mainly been internal workshops and meetings. They were structured in such a way that first all the partners could share their concerns, wishes and needs without being influenced by each other. Then we proceeded from there to find shared goals, questions and need which we used to form the working group for the Living Lab. The supporting documents are currently only in Dutch in word document in our own cloud. But we will translate them to English when finalized and make them shareable.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders?

Planned upcoming Living Lab workshops include data collection and analysis for ocean water quality and pollution caused by human activities, an Earth Observation introduction and guideline for how to get started using open-source data, and a session about the recently won court case and how this lends itself as an example for further environmental protection through the legal instrument. During the sessions we will take pictures and maybe record audio. We also want to take the key elements and steps and translate them into a step-by-step method, which will be published openly online.

4.7.3 Data and Tools Action Plan

The needs of the case study

Water quality measurements include: Heavy metals concentrations, polycyclic aromatic hydrocarbons (PAHs), man-made chemicals (biocides, PFAS etc.), water coloration with NDWI and algae blooms with NDVI, oil concentrations and spreading using optical assessments (A binary variable oil spill or not? Basically, is it the normal color or is there an anomaly in color), electrical conductivity (µS/cm) and pH.

Biodiversity data is also relevant, think of different biodiversity indexes, species occurrence, though it is typically collected and managed by national organizations through coordinated species monitoring programs and periodic counting days.

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem is still scattered, and it is in our current activities to collect the most relevant and complete databases, unite them under one platform, and make it easy for data to be compared and cross referenced. We make use of a combination of ESA data, governmental pollution databases and samples taken by nature protection organisations.

The barriers to effective data collection and usage:

Several challenges currently limit the effectiveness of data collection and usage in our case study. Particularly most measurements are to be done by industrial companies and national authorities because of the sites distance to the mainland. However, the sites cover large areas, and currently

industrial companies can choose when they take measurements. The frequency of measurements is also too low in our opinion.

Finally, data ownership presents another barrier. In many cases, the data comes from companies themselves and is not all freely made available by the national authorities.

The Living Labs as collaborative environments for innovation:

Living Labs have enabled diverse stakeholders to engage with data in meaningful ways, fostering community-driven innovation and problem-solving. We see already that the talks are fruitful between citizen groups and scientific experts sharing their concerns. The next steps will be to broaden the collaboration to include governmental partners, legal experts and even industry partners.

The valorization of existing and the development of new citizen science tools:

The EVISights Five-Step Evidence to Insights Process is a structured methodology that facilitates the transformation of raw environmental data into actionable insights. The process begins with understanding the "why" behind policy and legislation, establishing the foundational context for data use. It then moves to identifying the "who" – the stakeholders and communities affected by the data. The third step focuses on the "what" and "which" – determining which insights can be generated to benefit citizens and policymakers. Next, the "when" and "where" of engagement are addressed, considering the optimal timing and channels for policy influence, whether in the context of policy formation or enforcement. Finally, the process concludes with a reflection on "what you learned," capturing lessons from past actions to inform future strategies. This iterative approach turns raw data into meaningful insights, driving continuous learning and impact.

Waag's Citizen Sensing Method is a specific form of citizen science that emphasizes bottom-up, participatory, and community-driven environmental monitoring. It empowers citizens to actively engage in data collection and environmental action by using accessible sensor technologies, democratizing data collection, and fostering local research. This method not only enhances the volume and granularity of environmental data but also strengthens community ownership over environmental issues.

The Co-Creation Navigator is a continuously updated tool developed by Waag, providing a comprehensive framework for organizing co-creation sessions and workshops. It includes methods, exercises, and templates that support the full co-creation process, from stakeholder mapping and ideation to research, analysis, and reflective learning. By bringing together diverse stakeholders, the Co-Creation Navigator facilitates the collaborative design of solutions, knowledge exchange, and alignment of shared objectives.

The T-Factor Guide for Temporary Placemaking focuses on developing temporary use programs within urban regeneration initiatives across Europe and China. It harnesses culture and creative collaboration to prototype sustainable urban hubs, fostering social innovation, inclusion, and resilience. By drawing on the lessons from advanced cases of urban regeneration, T-Factor aims

to empower local stakeholders, build sustainable communities, and inspire global conversations on the role of temporary spaces in shaping vibrant, adaptable cities.

The Urban Ecology Field Atlas is a dynamic, subjective mapping tool developed under the T-Factor project. It presents the city as a living ecosystem, incorporating biological and sensory observations from citizens alongside physical measurements, building descriptions, development plans, and potential walking routes. This tool encourages users to view urban spaces from a more-than-human perspective, emphasizing the interconnectedness of all life forms within the urban environment. The Field Atlas continuously evolves, reflecting the ever-changing nature of its surroundings, and offers a platform for integrating green initiatives and community-driven urban planning.

The goals for the use of data in relevance to environmental compliance:

The primary goal for the use of data in the context of environmental compliance is to ensure that citizen-generated data can meaningfully contribute to regulatory processes. This involves closely collaborating with relevant authorities to understand the specific data quality standards and thresholds they require, enabling the validation of citizen data as either sufficient for direct use, supplementary to existing datasets, or as reliable early indicators of environmental change.

To achieve this, ongoing partnerships with data scientists, such as those at Rijkswaterstaat, will be prioritized. These collaborations aim to calibrate and validate our data analysis and cross-referencing efforts to ensure it is useful and aligns with what the authorities need. This approach will help bridge the gap between grassroots monitoring and formal regulatory frameworks, enhancing both data coverage and quality.

Key potential users and user requirements (privacy issues if any):

Key potential users of the data and tools include citizens, environmental authorities, national government and hopefully industry partners. municipal or provincial governments.

Citizens typically require anonymized data without traceability to their person to protect their privacy and may also prefer open data standards to ensure transparency and accessibility.

Environmental authorities similarly prioritize anonymized data with reduced location precision, balancing the need for actionable insights with the protection of individual privacy. However, we have also found that the industry partners and the national government have an agreement that keeps the exact water quality monitoring results private for the individual locations and only industry wide measurements are shared publicly.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

We have found multiple relevant and possible variables that can serve as proxies and indicators relevant for our case study. We also established that we need to do more work to specify risk factors and how they are assessed for our environmental pollution factors. Furthermore, we are assessing recently finished court cases that can help us understand the level of data/claims needed to be admissible in such cases in the future to better inform the DRLs.

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

The biggest insight that we have gained is that it will likely be most beneficial to have a platform where EO data can be used to cross reference measurements given by industrial companies, where time and date are important metadata factors and a system that allows for citizens to create indicators and early warnings for the relevant authorities.

4.7.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In Dutch waters, marine natura 2000 areas in particular, monitoring is currently not sufficient now. This is extremely pressing as multiple industrial activities are being permitted in these protected areas. Where authorities do not have the capacity to monitor such a vast area, the strength of citizen communities comes into play. The project aims to connect local knowledge, environmental awareness, and policy engagement. Phase A covers Process a (Strategic Communication & Awareness Building), Process b (Stakeholder Mapping & Engagement), and Process i (KPI Tracking, Impact Assessment & Data Management).

What are the communication objectives in The Netherlands during Phase A?

The communication objectives focus on raising awareness about current environmental issues, the ecological state of marine natura 2000 areas, and the directives and legislation that can be used to support environmental protection. Another key aim is to increase public understanding of the differences between politics and policy and provide citizens with tools to engage more effectively with policy discussions. Additionally, the project encourages people to join either through the Living Lab or their own initiatives, while informing the public that ENFORCE will offer tools for broad community use during the project. These efforts are aligned with the strategic goals and audience engagement frameworks outlined in Deliverable D6.1.

Who are the priority audiences and why?

The priority audiences include local citizens interested in environmental protection, NGOs, and public administration or enforcement authorities These groups are central because they both contribute to and use the data collected; they help determine which data should be gathered, in what format, and for what purpose. In this way, they serve as both data collectors and key target users.

Which communication tools and formats are most appropriate for this context?

The most suitable tools and formats include social media, website visuals, newsletters, community co-design sessions, hands-on workshops, and the use of digital atlases or maps. Story maps, podcasts, and visual materials that showcase biodiversity trends and citizen contributions can further help engage both the public and specialist audiences. These tools may draw on or adapt materials from Deliverable D6.5 or be co-developed through participatory activities.

What kind of support is required from WP6 to reach these audiences?

Support is needed from WP6 in developing environmental health and health impact infographic templates, visual storytelling materials, and design assets. Additionally, assistance is needed in packaging complex policy and legislative information into engaging video messages or other accessible formats, ensuring that key concepts are effectively communicated to both expert and non-expert audiences.

Who are the key stakeholders in this case study and why are they important?

Key stakeholders include:

1. Citizens, who are the heart of the project, central to data collection & analysis, while also drive community-efforts and need support and empowerment to build stronger connections with the public sector.

2. Environmental authorities, who ensure research aligns with regulatory frameworks, issue permissions for research in protected areas, and have a vested interest in using citizen-generated data for enforcement and conservation.

3. Governmental research and knowledge organizations (data managers and analysts), whose expertise is essential for validating, interpreting, and applying citizen science data for environmental monitoring and policy influence.

4. Policymakers, who need to be engaged early to ensure they understand and are ready to adopt citizen-generated data for shaping policies and considering legal frameworks.

How were these stakeholders identified and mapped?

Stakeholders were identified through Waag's extensive community network, supplemented by interviews with citizens and local stakeholders. Additionally, exercises from the European Network of Living Labs (ENoLL) were conducted to deepen the mapping process and ensure alignment with participatory and governance principles, contributing to Deliverable D5.1.

What engagement activities were initiated in Phase A?

Several activities were carried out in Phase A to build relationships and activate community involvement. Meetings were held with citizen science groups, an initial meeting was organized with environmental NGO's, a public-facing citizen science table was hosted at a local museum, and

there was a knowledge sharing event with partners and stakeholders who all aim to protect aquatic environments that we joined. These actions support long-term engagement, contribute to trust-building, and help advance Milestone MS2.

What capacity gaps have been observed among stakeholders?

Several gaps have been observed, including difficulties and uncertainty in linking citizen-generated data to regulatory enforcement, a low perception of the value of such data among authorities, and scepticism around the reliability of citizen analysis. On the citizen side, there is often a lack of data, scientific, and policy literacy, which can result in reduced confidence and limited participation. Additionally, authorities sometimes lack knowledge on how to effectively include and collaborate with citizen groups while lacking the capacity to effectively monitor the whole natura 2000 area regularly.

What data has been collected during Phase A, and why?

Data collected so far includes the number and locations of industrial platforms in the North Sea, Earth Observation images and water samples testing for the presence of different molecules This information helps track early engagement, provides insights for project development, and supports progress reporting under Deliverable D6.9.

What KPIs make sense for this case study?

Relevant key performance indicators for this case study include:

1. Number of residents involved in storytelling activities.
2. Number of governmental officials and bodies participating.
3. Number of public data analysis workshops given.
4. Number of natural areas mapped through citizen measurements.
5. Establishment of a validated workflow where authorities can check, validate, and correct citizen science data for formal use.

How is data collected, validated, and shared with WP6?

Data is collected through a combination of open data repositories, dashboards, and samples acquired by project partners. All these data streams are validated by experts, because they are either from national or international environmental agencies, the European Space Agency or university laboratories. The team is still working on determining the best way to share this data effectively for integration into the KPI dashboard under Milestone MS2.

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

Our working group meeting and presence at a knowledge sharing event help to make our case study feel real and more visible for stakeholders. This has made it easier for us to reach out to stakeholders for interviews and meetings.

What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

We have spoken to multiple experts who agree that something needs to be done and that there is indeed a current knowledge and capacity gap. Furthermore, we are contacting existing NGO's and citizen action groups to test the interest and find gaps into what type of public workshops there is a need for. This will inform our scale, repetition and the sustainability/ adoption of the methods after the end of the case study.

4.8 Flanders Region, BE, Lead: HU, Participants: AMRN, ASUD

4.8.1 Legislation/Policy Identification Action Plan

Phase 1: The theoretical basis of your case study

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts related to your case study's environmental compliance goal

Searching and identifying the local (Flemish, Belgian) and EU regulations on PFAS and any provisions on remediation thresholds for soil, groundwater and plants (desk research)

Describe your case study's actions (e.g. desk/field research, interviews, meetings) implemented to identify legislation and policy texts on the use of citizen science for environmental compliance (state of art, barriers, needs etc.)

Skepticism regarding the reliability of data collected by non-professionals, existing regulatory frameworks do not seem to adequately recognize or facilitate the incorporation of citizen science data into formal environmental compliance processes, resource limitations e.g. funding/training.

Legal recognition and policies to formally acknowledge and integrate citizen-generated data into compliance and enforcement mechanisms are necessary.

(desk research)

Phase B: The jurisprudence relevant to your case study

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the legal cases based on the use of citizen science data for environmental compliance related to your case study

Desk research. The citizen science initiatives on national level that were found did not evolve into legal proceedings, for example, the CurieuzenAir project: https://curieuzenair.brussels/en/home/

Describe the actions (e.g. desk/field research, interviews, meetings) implemented for identifying the admissible citizen science court evidence you have identified

Immature legal framework for citizen science court admissibility (desk research)

Phase C: The legislation and policy issues faced by your case study

Have you already encountered policy issues (e.g. involvement of authorities, legal barriers, meetings with law experts, meetings with citizen groups/local associations etc.)?

Lack of:

- legally-binding PFAS food norms (or a general PFAS framework) in Belgium

- legal PFAS remediation thresholds

- binding PFAS reduction/bans on EU level apart from a few PFAS thresholds in legislation (such as the recast Drinking Water Directive and REACH Regulation)

Currently there is only a temporary PFAS action plan in place in Belgium and waste laws which complicate soil remediation efforts.

Have you identified policy issues to be encountered throughout the implementation of your case study?

Not yet apart from the legal barriers mentioned above

Have you foreseen any actions (e.g. obtaining necessary permissions, interventions in local authorities' decision making, interventions in existing legal cases, initiation of new legal cases) required for dealing with the policy issues to be encountered?

Not yet, TBD

Have you now clearly identified the environmental compliance objective of your case study?

The case study aims to assess the bioavailability of PFAS and selected heavy metals in soil and their transfer to plants in private gardens located near industrial areas in the Province of Antwerp. **The compliance objective is twofold:** first, to generate scientific citizen-generated data on soil–plant pollutant transfer, and second, to evaluate the adequacy of existing Flemish, Belgian, and EU regulatory frameworks in addressing soil contamination, remediation thresholds, and food safety risks.

Based on the court cases collected, have you identified if your case study will require court action in order to achieve its environmental compliance objective?

No, not at this stage. Based on the court cases and jurisprudence collected, the case study does not presuppose court action in order to achieve its environmental compliance objective. Desk research indicates that, at both national and EU levels, citizen science initiatives have rarely evolved into judicial proceedings, and where they have, the admissibility and evidentiary weight of citizen-generated data unfortunately remain legally underdeveloped. In the absence of a framework legally recognising citizen science data as admissible court evidence, litigation is not currently considered an effective or necessary pathway for achieving the objectives of the case study. The focus remains on data generation, with the aim of informing *future* legislative and administrative developments (e.g. stricter PFAS thresholds in food/water/soil, etc.) rather than initiating or supporting judicial enforcement actions at present.

Have you encountered any additional policy issues and what are the plans foreseen to deal with them?

No additional policy issues have been encountered at this stage beyond those already identified.

4.8.2 Implementation of Living Lab Action Plan

Phase A – Preparatory Phase

Application of the ENoLL Methodology:

During this initial phase, the team conducted a public lecture aimed at introducing the Living Lab concept and raising awareness about the ENFORCE project. This served as an entry point for community engagement and knowledge dissemination in alignment with ENoLL principles.

Stakeholder Engagement Efforts:

Stakeholder engagement was initiated through a combination of public outreach and direct communication. A public lecture was organized to engage the broader community, while farmers in the target area were approached through house-to-house visits to inform them about the project's objectives and explore their potential involvement.

Planned Future Activities:

The next steps involve the installation of field plots to support phytoremediation trials targeting PFAS contamination. This will be followed by environmental sampling and the presentation of results to stakeholders, supporting ongoing co-creation and the participatory validation of findings within the Living Lab framework.

What ENoLL trainings did the team attend, what skills and competencies were gained, what preparatory outputs were produced (e.g. stakeholder mapping, guidelines, background documents), how will these be used in Living Lab activities, what capacity gaps were identified for Phase B, and are links to analytical or supporting documentation available?

In January 2025, the team participated in the 1st ENoLL Training on Living Lab Methodology, which covered Living Lab fundamentals, stakeholder and panel engagement, and governance models. Through this training, the team developed competencies in stakeholder identification, participatory design, and governance structuring. As preparatory outputs, background data were collected through the case study survey.

In October 2025, the team took part in the ENFORCE General Assembly in Crete. In preparation of the ENOLL Workshop there regarding stakeholder identification, the case study further refined its Purpose, Vision and Scope, Context, and more.

In December 2025, the team attended a capacity-building workshop on engagement with local governments organised in the context of ENFORCE. This activity enhanced competencies related to public authority engagement, institutional communication, and policy-oriented collaboration.

Capacity gaps identified for Phase B include the need for further skills in translating citizen-generated data into formats usable for regulatory and compliance purposes, as well as deeper expertise in the legal and administrative integration of citizen science outcomes in the EU as a whole.

Phase B – Implementation of First Workshop

What Living Lab activities have been carried out so far, how was the first workshop structured and facilitated, who participated, what were its objectives and key outcomes, what challenges and lessons were identified, and are analytical reports of the workshop produced/available

A series of Living Lab–related activities have been carried out in 2025, focusing on stakeholder engagement, knowledge exchange, and the positioning of the case study within broader scientific, policy, and citizen science communities within Flanders, Belgium, and beyond. The case study and the PFAS phytoremediation trials conducted was presented and discussed in multiple settings, e.g.:

- a poster pitch at the PFAS Symposium in Amsterdam (25 September),
- a public lecture on soil quality and health aimed at a general audience (26 September),
- a policy-oriented ENSOR workshop for government representatives and public waste agencies (13 October)
- citizen science project gatherings across Flanders (20 October),
- a scientific presentation at a PFAS symposium in Brisbane, Australia (28 October),
- contributions to expert meetings and symposia on food safety, crop science, and PFAS uptake in plants (3, 5, and 16 November), including a large public lecture at Hasselt University, Belgium, addressing PFAS contamination in Flanders.

Participants included researchers, policy makers, representatives of public agencies, citizen science practitioners, and members of the public (citizens, farmers, students). No standalone analytical report of these initiatives has been prepared.

Next Workshops and Documentation

What is the plan for upcoming Living Lab workshops, which CS themes and methods will be prioritized, and how will results be documented, shared, and linked to analytical documentation for stakeholders**?**

In 2026, the team's co-lead and biologist Dr. Sofie Thijs will attend the:

- soilcare program by the Flemish government to address the issue of soil remediation (8/01, 16/01 and 24/1)

- co-development of a PFAS remediation living lab in another town, Ronse (Belgium)

- other activities and talks TBD.

No other phytoremediation field trial in Zwijndrecht (Flanders, Belgium) is planned in the framework of the ENFORCE project (in actual situations, phytoremediation is monitored for 10 years after the onset).

4.8.3 Data and Tools Action Plan

The needs of the case study:

The primary environmental compliance objective of this case study is to address the challenges associated with PFAS (per- and polyfluoroalkyl substances) contamination, including exceeded soil remediation norms, agricultural and food safety risks, biodiversity impacts, and the limited availability of effective remediation options. This requires the collection and analysis of specific data types to assess the extent of contamination, monitor recovery efforts, and ensure compliance with relevant EU and national regulations.

For the Exceeded Soil Remediation Norms challenge, data on PFOS and PFOA concentrations in soil are critical. Given that PFOS levels in some areas have been measured as high as 100 µg/kg, far exceeding the safety threshold of 3.8 µg/kg, accurate and consistent soil sampling is essential to assess the scale of contamination and identify priority sites for remediation. This data must be collected in accordance with established protocols to ensure reliability and comparability across sites.

To address Agricultural and Food Safety Risks, data on soil contamination levels, crop uptake, and livestock exposure are required. This includes monitoring PFAS translocation from soil to plants and potential bioaccumulation in animals, which directly impacts food safety and agricultural productivity. Such data are crucial for determining compliance with EU regulations on sustainable land use and food safety, as well as for assessing the potential economic impact on the more than 100 affected farmers.

For the Biodiversity and Ecological Harm challenge, data on PFAS concentrations in critical habitats, such as the Blokkersdijk nature reserve, are needed to evaluate the impact on local wildlife and ecosystems. This includes assessments of soil and water quality, as well as biodiversity monitoring to detect changes in species composition and abundance, ensuring compliance with habitat and species protection laws.

Addressing the Limited Remediation Options challenge requires data on the effectiveness, feasibility, and environmental impact of various soil remediation techniques. This includes experimental measurements of PFAS uptake in plants and soil to explore alternative remediation strategies, as well as data on the costs and logistical challenges associated with large-scale soil treatment and disposal.

Importantly, no personal data will be collected within the framework of this Case Study Work Package. Instead, the focus will be on collecting raw experimental measurement data and

numerical data regarding PFAS uptake in plants and soil to provide insights into potential remediation options, directly addressing the challenges outlined above.

The current data ecosystem, existing data, tools, and limitations:

The current data ecosystem includes a mix of publicly available datasets, ground-based sensors, citizen science contributions, and remote sensing technologies. Key sources include the DOV (Databank Ondergrond Vlaanderen) platform, which provides publicly accessible soil PFOS data, available at DOV PFAS Verkenner. This platform offers critical baseline data for understanding contamination levels but may vary in quality and consistency depending on sampling methods.

Ground sensors provide localized, real-time measurements but require careful calibration, while citizen science initiatives expand geographic coverage but may present challenges with data reliability. Remote sensing and drone-based monitoring add valuable spatial context, though these methods often require complex data processing to produce actionable insights.

The barriers to effective data collection and usage:

One key barrier to effective data collection is the need for plant-soil PFOS concentration data pairs, which are essential for understanding plant-specific PFAS accumulation factors. This information is critical for developing strategies to reduce PFAS uptake in crops and improve the effectiveness of soil remediation efforts.

The Living Labs as collaborative environments for innovation:

Stakeholders are actively involved in the data collection process, with farmers participating in soil and plant sample collection, responding to questionnaires, and assisting in the installation and maintenance of phytoremediation trial plots. To ensure effective collaboration, an initial information session will be held to provide stakeholders with the necessary guidance and context for their roles in the project.

The valorization of existing and the development of new citizen science tools:

The approach will focus on identifying potential citizen science tools and data sources as the project progresses, with future plans to assess their suitability for PFAS monitoring and community engagement.

The goals for the use of data in relevance to environmental compliance:

The primary goal for data use in this context is to identify which plant species are more likely to accumulate PFOS and other PFAS compounds at concentrations exceeding EU safety norms for vegetables and other crops. These maximum permissible concentrations include 0.001 µg/kg fresh weight (fw) for PFOS in vegetables and fruits, 0.01 µg/kg fw for PFOA in root vegetables, 0.005 µg/kg fw for PFNA in tubers and bulbs, and 0.015 µg/kg fw for PFHxS in tubers and bulbs.

By collecting data on PFAS uptake in different plant species, the project aims to rank plants according to their sensitivity to PFOS-norm exceedance, providing critical insights for targeted

remediation efforts. This approach will support more effective environmental compliance by informing planting and land management strategies that reduce PFAS exposure in the food chain.

Key potential users and user requirements (privacy issues if any):

Key potential users of the data and tools include researchers, policymakers, and the general public. The data will be openly accessible to all, presented in workshops and seminars, and published as open-access content in both scientific journals and more widely accessible formats for non-experts. Given this open approach, care will be taken to ensure that the data is fully anonymized, with no personally identifiable information, to comply with privacy regulations and promote transparent, ethical data sharing.

Progress on Data Pathways, Indicators, and DRL Preparation: Could you briefly update us on any progress made regarding the definition or refinement of your Case Study's data pathways (e.g., indicators, variables, proxies, data sources) and on any preliminary steps towards assessing Data Readiness Levels (DRLs) for your datasets (if any)?

Not applicable for CS8. We monitored the PFAS-levels in soil and plant tissues, in addition to collecting soil texture, pH, organic matter variables, and weather conditions as these can influence the pollution uptake levels. No other proxies or sources were recorded.

Progress on Tool Requirements, Prototyping, and Integration Needs: Could you describe any developments concerning tool needs, user requirements, or early testing activities for citizen science, EO/modelling, or Plaza-related tools, including any new insights on functionalities or integrations required for your Case Study?

The data will be shared with the team to allow visualization on a geographical map.

4.8.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In Belgium, soil contamination from PFAS (per- and polyfluoroalkyl substances) near industrial zones is being addressed through strong citizen science leadership, legal advocacy, and close coordination between farmers, scientists, and environmental agencies. The project focuses on combining grassroots action with institutional collaboration to drive evidence collection, risk communication, and policy influence. Phase A covers Process a (Strategic Communication & Awareness Building), Process b (Stakeholder Mapping & Engagement), and Process i (KPI Tracking, Impact Assessment & Data Management).

What are your communication objectives in Belgium during Phase A?

The main communication objectives are to raise awareness about the risks and realities of PFAS contamination, promote the credibility and reliability of citizen-collected soil data, and support public understanding of the legal and health implications associated with PFAS exposure.

Communication efforts aim to strengthen community knowledge and foster public trust in the data and actions emerging from citizen science initiatives.

Who are your priority audiences and why?

The priority audiences include farmers, local residents, scientists, journalists, legal professionals, and policymakers. These groups play key roles in evidence gathering, public advocacy, risk communication, legal actions, and policy decisions related to PFAS contamination and its remediation.

Which communication tools and formats are most appropriate for this context?

The most appropriate tools and formats include fact sheets explaining PFAS contamination, soil sampling demonstration videos, interactive data maps showing contamination levels, community forums for discussion and knowledge exchange, and infographics that visualize key contamination facts and figures. These tools help make complex scientific and legal issues accessible and actionable for diverse audiences.

What kind of support do you require from WP6 to reach these audiences?

Support from WP6 may be needed for designing visually accessible reports on PFAS contamination, creating templates for briefing farmers, or developing additional outreach materials as needed. Specific support requirements will be determined as the communication work progresses.

Who are the key stakeholders in this case study and why are they important?

The key stakeholders include citizen soil scientists, farmers, environmental regulators, toxicologists, local governments, remediation experts, nature agencies, agro-cooperatives, and legal aid organizations. Each of these actors plays a vital role in co-producing evidence, verifying findings, or applying the evidence in legal, regulatory, or remediation efforts related to PFAS.

How were these stakeholders identified and mapped?

Stakeholders were identified based on prior institutional collaborations focused on PFAS issues, connections within farmer networks, and insights gathered through expert interviews. This mapping process ensures that all relevant actors are engaged and that responsibilities are clearly distributed across the evidence chain.

What engagement activities were initiated in Phase A?

Phase A included soil sampling campaigns, training sessions for stakeholders, and collaborations between citizen scientists and research labs. These activities help build technical capacity, strengthen community engagement, and create pathways for integrating citizen-generated data into broader environmental strategies.

What capacity gaps have you observed among stakeholders?

No significant capacity gaps have been identified among stakeholders at this stage.

What data has been collected during Phase A, and why?

Data collected so far includes soil sample data and attendance records from training sessions. These datasets are essential for early impact assessment, tracking stakeholder participation, and feeding into project indicators under Deliverable D6.9.

What KPIs make sense for this case study?

Relevant key performance indicators include the establishment of a hemp plot on 10 hectares for land remediation, the collection of 10 soil samples for PFAS concentration analysis, and the collection of 10 plant samples for PFOS concentration analysis. These KPIs help track the project's progress in gathering evidence and piloting remediation actions.

How is data collected, validated, and shared with WP6?

Data is compiled in an Excel table, following the citizen-lab protocol for soil sampling and verification. The validated data is then prepared and aggregated to be shared with WP6 for integration into the project's KPI dashboard, supporting Milestone MS2.

What capacity-building activities have been implemented since Phase A, and what concrete changes have they produced among stakeholders?

Since Phase A, capacity-building activities have focused on strengthening stakeholder understanding of PFAS-related soil contamination. These activities include sessions with local farmers linked to soil sampling campaigns, public lectures, and targeted workshops under ENFORCE and ENoLL, particularly on stakeholder engagement and collaboration with local authorities (see previously).
What evidence of impact or uptake has emerged since Phase A, and how is this informing the scaling, replication, or sustainability of the case study?

Evidence of impact is emerging mainly in the form of growing stakeholder engagement and visibility of the case study within scientific, policy, and citizen science networks. The case study has been presented and discussed in a range of national and international fora (see previously), contributing to awareness-building and positioning the project as a relevant reference point for PFAS-related soil monitoring and remediation discuss

4.9 Case Studies Integrated Monitoring and Key KPIs

4.9.1 Case Studies Integrated Monitoring

Below is an **integrated analytical table** synthesizing the key developments and current status of each ENFORCE Case Study, structured around compliance objective, legal/policy positioning, Living Lab maturity, data pathway development, and overall implementation status (M18).

Table 4: Integrated Analytical table with Case Studies key developments

CS	*Legislation / Compliance Focus*	*Living Lab Status*	*Data & Tools Focus*	*Impact / KPI Direction*
4.1 Valle Galeria (IT)	EU/national legal mapping on waste & pollution; admissibility of citizen data; transparency gaps; potential litigation readiness (not mandatory). Compliance objective: improve environmental monitoring (air, water, soil) & enforcement.	Embedded in existing civic committee; 1 structured LL workshop (June 2025); stakeholder mapping completed; iterative co-design ongoing.	Air (PM), water (PFAS, metals, BOD/COD), soil indicators; civic reporting platforms (GeoQuest, Athena); exploring EO/fire detection; validation for possible legal use.	KPIs: reports submitted, % authority responses, EO use capacity, legal literacy. Impact still early-stage.
4.2 Brașov (RO)	Forestry Code & illegal logging enforcement; legislative complexity & governance gaps; citizen alerts as proxy for enforcement effectiveness.	Stakeholder workshop held; mapping completed; LL under development;	SUMAL 2.0 & Forest Inspector; citizen alerts; EO integration planned; mobile reporting prototype under development.	KPIs: suspected illegal transports; stakeholder engagement;

		awaiting KPI alignment guidance.		improved reporting & transparency.
4.3 Crete (EL)	Land clearing in Natura areas; fragmented enforcement; GDPR & admissibility explored; court action possible but not required.	2 stakeholder meetings (June & Oct 2025); Themis app integration; interoperability discussions ongoing.	LIFE Themis app (geo-tagged reports); EO filtering; GIS crime mapping; new app version planned.	KPIs: app downloads, reports submitted, reports forwarded, land clearing cases.
4.4 Barcelona Beaches (ES)	MSFD compliance (biodiversity & marine litter); no-smoking & wet wipes monitoring; citizen science not yet integrated in formal monitoring.	3 working groups established (biodiversity, smoking waste, wet wipes); stakeholder ecosystem strong; next workshops 2026.	MINKA biodiversity platform; EMODnet; JRC litter app; camera inflow monitoring; protocol standardization ongoing.	KPIs: biodiversity observations; protocol development; workshops conducted.
4.5 East Devon (UK)	Diffuse water pollution; Tier 2 compliance (early detection); not litigation-focused; aligned with EA frameworks.	Integrated into existing Catchment Partnership; workshop Aug 2025; QA/QC workshop planned 2026.	Citizen science water monitoring (phosphate etc.); EO soil erosion model; AI/ML & xAI testing; 124 volunteers active.	KPIs: targeted monitoring via EO; CS inclusion in EA evidence; improved data integration.
4.6 Puglia (IT)	Illegal rural waste dumping & fires; political/institutional cooperation challenges; no litigation focus.	3 workshops completed; stakeholder mapping; co-designing regional action plan (validation 2026).	Municipal reports, citizen complaints; fragmented waste datasets; no dedicated CS tool yet.	KPIs: illegal dumps reported; illegal fires; awareness

				campaigns; landfill reclamation.
4.7 Netherlands (NL)	Industrial discharge in marine Natura 2000; transparency gaps in oil/gas emissions; precedent for court action exists but not required.	Working group formed; internal workshops; stakeholder outreach (NGOs, scientists, legal experts); public workshops planned.	Water quality (PFAS, PAHs, metals), EO cross-referencing; Citizen Sensing; Evidence-to-Insights method; data admissibility review ongoing.	KPIs: public data workshops; authorities engaged; areas mapped; validated CS-authority workflow.
4.8 Flanders (BE)	PFAS soil contamination; lack of binding PFAS norms; focus on regulatory reform via evidence generation; litigation not foreseen.	Public lecture; farmer outreach; multiple scientific/policy presentations; capacity-building ongoing.	PFAS soil & plant tissue sampling; DOV datasets; phytoremediation trial; paired soil-plant analysis.	KPIs: soil samples; plant samples; hemp remediation plot; regulatory awareness.

Further to this analysis, Table 5 presents the Future Action Table, synthesizing the actions identified by the Case Studies in support of the ENFORCE CSs roadmap and its forthcoming implementation phases.

Table 5: Case Studies Future Action table based on ENFORCE CSs roadmap

CS	*Environmental Compliance*	*Legal & Policy – Planned Actions*	*Living Lab – Planned Actions*	*Data Pathway & Tool – Planned Actions*	*Impact / Exploitation / Dissemination /*

	Objective (Next Steps)				*Communication / Capacity Building*
4.1 Valle Galeria (IT)	Strengthen compliance monitoring and enforcement pathways.	Continue defining admissibility standards for citizen data; maintain litigation readiness if needed; further engagement with legal experts.	Additional co-design workshops with civic committee; refine roadmap with stakeholders; continued structured engagement cycles.	Further interoperability testing (GeoQuest–Athena); expand EO/fire detection integration; refine indicator validation for potential legal robustness.	Develop accessible communication materials; strengthen legal literacy; increase authority responsiveness to citizen reports; continue trust-based community engagement.
4.2 Brașov (RO)	Improve forest enforcement transparency and detection.	Monitor Forestry Code developments; address governance ambiguities; clarify data responsibility in digital tracking systems.	Further stakeholder workshops; align KPIs with ENFORCE framework; deepen Quadruple Helix engagement.	Develop mobile reporting app; integrate EO geo-information; formal DRL assessment to follow; refine proxy indicators for illegal transport detection.	Raise awareness on illegal logging; improve communication between forest owners, NGOs and authorities; develop accessible materials with WP6 support.
4.3 Crete (EL)	Improve reporting and enforcement of	Continue engagement with judicial/administrative authorities; clarify	Organize additional stakeholder workshops; expand	Launch updated Themis app; improve EO filtering; enhance GIS integration; structure	Increase app uptake; awareness campaigns for biodiversity

	illegal land clearing.	procedural workflows for complaint forwarding; strengthen GDPR-compliant data handling.	institutional interoperability; broaden community engagement once new app version is ready.	validation workflow between citizens and authorities.	protection; engage schools and legal professionals; promote reporting culture.
4.4 Barcelona Beaches (ES)	Institutional integration of citizen monitoring into MSFD compliance.	Refine regulatory alignment for biodiversity, smoking waste and wet wipes; translate monitoring outputs into policy-relevant formats.	Conduct expert methodological workshop (early 2026); seasonal sampling campaigns; validate and refine working group outputs.	Harmonize protocols (MINKA, EMODnet, JRC); expand underwater biodiversity monitoring; improve analytics/visualization for policy uptake.	Expand public awareness campaigns (smoke-free beaches, biodiversity); increase citizen observations via MINKA; disseminate monitoring results through dashboards and workshop
4.5 East Devon (UK)	Strengthen Tier 2 compliance support for diffuse pollution.	Maintain alignment with Environment Agency Technical Advisory Framework; support regulator uptake of CS evidence.	Conduct QA/QC workshop (spring 2026); continue engagement through Catchment Partnership; potentially expand phosphate monitoring (funding dependent).	Advance EO soil erosion modelling; further AI/ML and xAI testing; enhance CS data integration into regulator weight-of-evidence systems.	Increase volunteer capacity in monitoring and data interpretation; communicate remote sensing insights to citizen scientists; demonstrate

					regulator use of CS evidence.
4.6 Puglia (IT)	Reduce illegal dumping and fire incidents.	Continue engagement with municipalities to improve cooperation; clarify governance coordination challenges.	Validate regional action plan in 2026; continue workshop cycles; strengthen local institutional participation.	Further mapping of waste datasets; explore feasibility of integrating/negotiating use of existing waste reporting app; define data pathway and DRL.	Expand awareness campaigns; strengthen cooperation with municipal staff and waste companies; increase reporting and reclamation actions.
4.7 Netherlands (NL)	Address industrial discharge in marine Natura 2000 areas.	Apply for necessary permits (if monitoring in Natura 2000); engage policymakers in new policy cycle; explore possible support for new legal case if relevant.	Organize public data analysis workshops; EO training sessions; expand engagement with authorities and industry stakeholders.	Develop cross-referencing platform linking EO data with industrial measurements; refine early warning indicators; clarify risk assessment thresholds; continue admissibility review.	Raise awareness on marine pollution; strengthen citizen-policy dialogue; develop visual storytelling and infographics with WP6 support; build authority validation workflow.
4.8 Flanders (BE)	Inform regulatory	Continue monitoring regulatory developments; support policy dialogue on	Participate in soil care program sessions; co-develop PFAS remediation LL;	Continue soil–plant PFAS paired measurements; visualize data geographically; assess suitability of citizen	Increase awareness on PFAS risks; disseminate scientific findings; strengthen

	reform on PFAS contamination.	binding PFAS norms and remediation thresholds.	continue farmer/scientific engagement.	science tools for PFAS monitoring.	farmer engagement; produce accessible explanatory materials.

4.9.2 CSs KPIs reported until M18

At project level, the following KPI assessment provides a consolidated overview of progress achieved across all eight Case Studies (CSs) up to M18. The numerical values reported under the Legislation and Policy KPIs are derived from the consolidated analysis of all eight Case Studies up to M18. More analytical references can be found in CSs dedicated descriptions. The counting approach reflects distinct regulatory references, jurisprudence cases, and environmental compliance issues explicitly identified in the Case Study documentation.

Identification of links between environmental compliance and socio-technical innovation (68 texts/frameworks).

This figure aggregates the legal, regulatory, and governance instruments mapped across the Case Studies. It includes EU-level directives and regulations (e.g. Water Framework Directive, Marine Strategy Framework Directive, Natura 2000 framework, REACH, Drinking Water Directive, Data Governance Act), national and regional environmental legislation (forest governance, waste management, land clearing, PFAS action plans, emission reporting rules, enforcement policies), as well as structured governance and methodological frameworks (Living Lab models, DRL framework, AI/xAI interpretability approaches, phytoremediation codes of practice, Catchment-Based Approach governance model). The count also incorporates documented expert consultations and institutional interviews that directly informed regulatory interpretation and compliance alignment. Together, these amount to 68 identifiable legal and governance references, exceeding the target value of 50+.

Diversity of case-study related admissible court evidence (23 jurisprudence cases).

A total of 23 jurisprudential references have been identified and analysed across the Case Studies. These include environmental rulings concerning Natura 2000 management plans, nitrogen pollution and industrial emissions (NL), land clearing enforcement cases (EL), environmental liability and landfill remediation disputes (IT), forestry compliance precedents (RO), and PFAS-related regulatory disputes (BE). While several Case Studies focus primarily on administrative compliance pathways rather than litigation, jurisprudential analysis has been undertaken where relevant to assess evidentiary standards and admissibility of citizen-generated data.

Diversity of case-study related legal issues (26 distinct compliance issues). Across the eight Case Studies, 26 distinct environmental compliance issues have been identified. These span illegal dumping and fires, landfill remediation delays, forest exploitation compliance, land clearing, marine litter and biodiversity loss, diffuse agricultural pollution, sewage discharge, industrial emissions in protected areas, emission transparency gaps, PFAS soil contamination, food safety risks, biodiversity impacts, and remediation feasibility constraints. In each case, the relevance of citizen science or data-driven monitoring has been assessed in relation to supporting compliance, enforcement, or regulatory improvement.

Further to this analysis, Table 6 presents an analytical overview of how activities and stakeholder engagement are embedded within the Living Lab dimension across the Case Studies, demonstrating the expanded and flexible framework required for context-specific

implementation.T he analysis shows that Living Labs are not applied through a uniform model but are adapted to diverse environments: civic committee ecosystems (IT – Valle Galeria), institutional-regulatory contexts (EL, UK), scientific remediation settings (BE), governance-fragmented regions (RO, IT – Puglia), and mature urban participatory systems (ES).Across all cases, stakeholder engagement functions as the core operational mechanism rather than a complementary activity. It enables data validation, regulatory translation, clarification of compliance pathways, institutional interoperability, and trust-building.

Table 6: Key KPIs related to CSs stakeholder engagement

KPI Title	*Description*	*Measurement Method*	*CS#1*	*CS#2*	*CS#3*	*CS#4*	*CS#5*	*CS#6*	*CS#7*	*CS#8*
Number of Stakeholders involved in LLs in different spatial levels	Tracks the number and representation of stakeholders in each CS	Indicate number of participants in LL activities and link to meeting minutes if available	16	16 (Workshop & bilateral meetings)	18 (10 SHs in first activity & 10 SHs in second activity; few overlaps)	TBC	56 active citizen scientists in target catchments (last 12 months); 26 organisations in East Devon Catchment Partnership. Total: 82	21 stakeholders (local authorities, law enforcement bodies, companies, producers, associations)	4 (internal working group meeting – 30/09/2025); 10 or more at international water & environmental protection event – 24/09/2025	6
Frequency of Engagement	Measures frequency of stakehold	Number of sessions/workshops with	Bimonthly meetings with committee	Workshop #1: First Meeting of Working	08/06/2025 – "Meeting to	21/10/2024 coordination;	Quarterly East Devon Catchment	17/04/2025 – ENFORCE presentati	Bi-monthly working group	Weekly meetings with farmers & local

Activities on each CS	er engagement activities	exact date and title	; ad hoc meetings with technicians, scientists, lawyers and institutions; at least three public events planned in 2026	Group with Forestry & related stakeholders (10/04/2025, on-site); Bilateral meetings with forest administrators (23/06/2025; 14/07/2025; 17/07/2025); 2 rounds of interviews (RP1); Informal interactions (1 bilateral legal	exchange points of view"; 08/10/2025 – "Stakeholder event" (GA Crete)	12/03/2025 coordination; 28/03/2025 WG with stakeholders; 16/06/2025 coordination; 17/06/2025 marine litter WG; 19/06/2025 marine litter WG; 04/07/2025 coordination; 18/07/2025	Partnership meetings (17/09/2024; 11/12/2024; 05/03/2025; 25/06/2025; 01/10/2025; 10/12/2025); UNEXE–Environment Agency meetings (25/09/2024; 10/10/2024); UUKi delegation (23/10/2024); Meeting	on to municipal administration; 23/06/2025 – Local challenge analysis & stakeholder mapping; 25/11/2025 – Needs analysis & action plan proposals	scheduled from 10/02/2026; at least 2–3 public activities planned in 2026	government; PFAS phytoremediation presented at: 1 international scientific conference; 1 policy workshop; 1 public lecture; 1 CS meeting; 1 overseas symposium; several expert meetings

		meeting; participation in 2 high-level international conferences; 2 public community events; 3 complementary project initiative meetings)	coordination; 30/09/2025 coordination; 23/10/2025 biodiversity WG; 24/10/2025 wet wipes & cigarette butts WG; 09/01/2026 coordination; 05/02/2026 coordination	with Arup (06/03/2025); Axe Integrated Monitoring Plan WG (06/05/2025; 11/06/2025; 16/07/2025); East Devon Resilience Showcase (02/08/2025); Meeting with Jacobs (12/11/2025); Institute of Water Rising Stars

							(26/11/2025)			
Stakeholder Feedback on each CS	Ensures stakeholder insights are recorded and fed back into the process	Indicate if feedback session conducted/planned; summary of results	Process evaluation sessions and questionnaires planned	Workshop (10/04/2025) objectives: tools for wood monitoring; validate personas; citizen involvement perception; identify forest management issues. Bilaterals positive; willingness to share forest	Feedback collected live (18/06/2025) and via email; positive responses; suggestions on filtering citizen reports	After March 2025 workshop, second feedback session Oct 2025; Padlet tool results per working group (wet wipes, cigarette butts, biodiversity)	Feedback planned for select engagement events	After each LL stakeholders shared additional information and suggested organisations; strong interest; consistently positive feedback	Feedback sessions (30/09/2025; 27/11/2025); expert interviews (31/01/2026); strong expert support; legal experts emphasized precautionary principle and role of CS data	Farmers gave positive feedback on phytoremediation participation; citizens concerned about legal admissibility of CS data

				plans/maps						
Stakeholder Engagement Coverage Index	% of identified stakeholder groups actively participating in project activities amd sector	Provide meeting titles, dates, categories and numbers	09/01/2025; 31/01/2025; 11/02/2025; 05/03/2025; 17/04/2025; 20/05/2025; 14/06/2025 LL workshop; 30/06/2025; 09/07/2025; 15/07/2025; 18/09/2025; 21/10/20	Workshop #1: Civil Society (3); Industry (2); Government (3). Direct interviews (18–19/06/2025): Industry (2); Authority (1); Civil society (1). Bilaterals: 23/06/2025 Industry (3); 14/07/2025 Industry (2);	08/06/2025: Public sector (8); Research & Education (2). 08/10/2025: Civil society (1); Public sector (6); Research & Education (3)	Multiple coordination & WG meetings (see above); thematic working groups active (biodiversity; wet wipes; cigarette butts)	Quarterly meetings (10–30 attendees each): local government, regulators, NGOs, citizen scientists, businesses, academia; EA meetings (10 attendees; 3 attendees); Arup (3); Jacobs (5); Institute of	LL participation: Academia (1); Business (6); Community organisations (9); Government institutions (8)	"Launch Doggerbank Coalition" (24/09/2025): NGOs (8); Legal professionals (2); Civil servants (6); Artists (5); Research institutes (7). "Setup North Sea data WG" (30/09/2025): NGOs (2); Research institutes	General stakeholder categories: Public sector (4); Research & Education (1); Civil Society (2); Industry (1)

		25 – participants included committee members, professors, ecologists, lawyers, former judge, biodiversity experts	17/07/2025 Industry (3)	Water (8); Resilience Showcase (21 attendees)	(2). "Case study problem analysis sessions" (13/01–11/02/2026): NGOs (1); Research (3); Legal (1). "First data WG meeting" (10/02/2026): NGOs (2); Research (2)

Overall, engagement-related KPIs (e.g. number of participants in citizen science initiatives, co-creation activities, and workshops) are clearly measurable and already being monitored across the Case Studies through documented Living Lab activities. Data-generation KPIs are also feasible, particularly in Case Studies focusing on environmental monitoring and remediation (e.g. forest monitoring, water quality, PFAS phytoremediation).

Several litigation-oriented KPIs (e.g. prosecuted cases, ex officio notifications, digital evidence admitted in court, workshops for judges/prosecutors) are not applicable to all Case Studies. In many cases, litigation is not the primary pathway; instead, the focus lies on data generation, regulatory dialogue, prevention, and policy influence. Therefore, reporting on these KPIs will depend on contextual developments and institutional uptake rather than direct Case Study control.

In addition, some Case Studies have defined additional internal KPIs tailored to their specific objectives. In particular:

- CS#2 (Brașov) monitors KPIs aligned with forest governance and stakeholder engagement.
- CS#8 (Flanders) tracks concrete remediation-related indicators (hemp plot establishment, soil and plant sampling for PFAS/PFOS), supported by structured data collection protocol.

5. Case Studies Monitoring Methodology

As mentioned in 2.1 section of the present Deliverable, from November 2024 to the present, the ENFORCE consortium has implemented a robust and sustained monitoring process for its eight CSs, anchored in weekly virtual meetings organized under WP4. These sessions – held each Friday and classified as either **"loose"** or **"strict" until M9 and biweekly during M09-M18**– have provided a dynamic framework for coordination, learning, and accountability across the project's geographically and thematically diverse case study teams.

Loose meetings have served as informal check-ins, fostering open dialogue, early troubleshooting, and space for flexible updates. In contrast, **strict meetings** have adhered to a structured agenda, focused on technical reporting, deliverable alignment, and tracking of defined milestones. This dual format has proven highly effective, offering both consistency and adaptability to the evolving needs of the CS leaders and the wider consortium.

The weekly meetings have had several core objectives:

- To track the operational and strategic progress of each CS.
- To ensure timely and coherent input into cross-cutting WPs, particularly WP2 (Legal and Methodological Roadmap), WP3 (ENFORCE Plaza Tools), and WP5 (Capacity Building and Policy Recommendations);
- To facilitate peer exchange and collaborative problem-solving across CSs;
- To support the preparation of critical project deliverables, notably the **D4.1 Case Study Roadmaps**.

Each meeting has been thoroughly documented, with detailed minutes capturing updates, action points, and key reflections. Over time, a number of insights and patterns have emerged from this ongoing monitoring process:

- **Consistent Engagement and Progress Tracking**: Case study teams have regularly reported on stakeholder engagement activities, legal framework analyses, data management practices, and interactions with national and local authorities. This has allowed the WP4 team to maintain close oversight of progress and adapt support where needed.
- **Cross-WP Synergy**: CSs have actively contributed to WP2 legal syntheses, participated in WP3 bilateral technical calls for tool development, and engaged in WP5 activities on EO capacity and stakeholder outreach. These cross-WP collaborations have ensured coherence and deepened the integration of citizen science within environmental compliance pathways.

- **Thematic Depth and Local Relevance**: Each case study has developed a distinctive focus, shaped by local environmental and governance contexts. These range from illegal waste monitoring (CS6 Puglia), to participatory epidemiology and landfill monitoring (CS1 Valle Galeria), to marine biodiversity and pollution tracking (CS4 Barcelona), to soil phytoremediation initiatives (CS8 Flanders). This diversity has enriched the overall project by showcasing varied models of civic engagement, enforcement challenges, and data needs.

- **Stakeholder Mobilisation and Ethical Sensitivities**: Many CSs have reported progress in organising Living Lab workshops, mapping stakeholders, and refining communication protocols. At the same time, several teams have raised questions regarding ethics compliance, data anonymization, and managing expectations around citizen participation–issues that have been addressed collaboratively within the meetings and in liaison with the Ethics Advisory Board.

- **Prioritisation and Follow-Up Mechanism**: To support the timely resolution of pending issues, action points discussed in meetings were categorized to help prioritise follow-ups, track risk areas, and facilitate smoother coordination among partners.

In conclusion, the weekly WP4 meetings have functioned as a vital coordination and learning mechanism within the ENFORCE project. They have enabled a continuous feedback loop between the CSs and the central management and technical teams, ensuring transparency, mutual support, and responsiveness across all levels of implementation. Beyond their logistical value, these sessions have fostered a strong culture of collaboration and reflexivity, positioning the CSs not just as sites of data collection, but as active laboratories of co-creation, governance experimentation, and civic science innovation.

Conclusions

This Deliverable consolidates the operational progress of the eight ENFORCE Case Studies (CSs) up to M18, demonstrating the transition from structured planning to active and coordinated implementation. The four interconnected action plans – Legislation and Policy, Living Labs, Data and Tools, and Impact and Capacity Building – are now operational across all CSs, providing a coherent yet adaptable framework for advancing environmental compliance through citizen science and data-driven approaches.

Across all Case Studies, foundational legal and policy mapping has been completed, environmental compliance objectives have been clearly defined, and relevant regulatory frameworks have been analysed. While enforcement pathways differ depending on national and regional contexts, the common strategic direction is to enhance the credibility, regulatory relevance, and institutional usability of citizen-generated data within administrative and governance systems.

Living Labs are fully activated and function as the central implementation mechanism. Stakeholder engagement has progressed from initial mapping and consultations to structured workshops, thematic working groups, co-creation sessions, and governance refinement processes. These Living Labs are adapted to diverse ecosystems — urban-industrial (IT – Valle Galeria), forest governance (RO – Brașov), protected area enforcement (EL – Crete), coastal urban systems (ES – Barcelona), rural catchment management (UK – East Devon), bio-district waste governance (IT – Puglia), participatory environmental monitoring (NL – Amsterdam), and scientific remediation contexts (BE – Flanders). Despite contextual differences, all maintain alignment with co-creation principles and structured monitoring logic.

Significant advancement has also been achieved in the Data and Tools dimension. Case Studies are developing and testing digital platforms, mobile applications, AI/xAI models, Earth Observation–based analyses, structured sampling protocols, and data integration workflows. Data pathways are increasingly defined, and progressive Data Readiness Level (DRL) considerations are being incorporated to strengthen validation, interoperability, and policy relevance.

Impact (incl. communication and dissemination activities) and Capacity Building activities have expanded substantially by M18. Stakeholder consultations, targeted institutional dialogues, training sessions, and public-facing events have strengthened awareness, technical competence, and collaborative capacity across all CSs. Internal KPIs are actively monitored in several Case Studies, and engagement-related project KPIs are supported by documented evidence from workshops, sampling campaigns, and co-creation activities.

Overall, progress up to M18 confirms that ENFORCE is successfully operationalising a flexible yet methodologically consistent framework. Governance models have been adapted to local environmental, institutional, and socio-political realities while maintaining alignment with compliance objectives, participatory innovation principles, structured data validation, and progressive evidence maturity. The roadmap established in this Deliverable is therefore both

strategic and operational, providing a robust foundation for the next implementation phase and for the longer-term institutionalisation of citizen science within environmental compliance systems across Europe.

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ANNEX I - WP4 Meeting Minutes Template

Date: - , Friday, 10:00-11:00 CET
Place: MS Teams
Author(s): Dimitris Kofinas, Nikos Mellios (Organiser: AMRN), Georgia Tseva , Sofia Gourgouliani (UTH)

General Announcements:
CSs update:

Case Study	Main Reporting Partner (&Person)	Update/ Action Points on Activities
CS#1 Valle Galeria, Rome, IT	**ASUD** Lucie Greyl, luciegreyl@asud.net Sara Vegni, saravegni@asud.net	
CS#2 Brasov, Central RO	**NIRDF, BDG** Nicu Tudose, cntudose@yahoo.com Mirabela Marin, mirabelamarin@yahoo.com Cezar Ungurean, ucezar@yahoo.com Florentina Nanu, florentina.nanu@bdgind.ro	
CS#3 Crete, EL	Michalis Probonas, mprobonas@gmail.com Christos Georgiadis, cgeorgiadis@gmail.com	
CS#4 Barcelona Urban Beaches, Barcelona, ES	**CSIC** Vanessa-Sarah Salvo, vsalvo@icm.csic.es Jaume Piera jpiera@icm.csic.es	
CS#5 East Devon Catchment, UK	**WRT, UNEXE** Francis Rowney, francisrowney@wrt.org.uk Annabel Martin, annabel@wrt.org.uk emilywiddecombe@wrt.org.uk Nicola Rogers, nicolarogers@wrt.org.uk Yog Watkins, yog@wrt.org.uk	

	Mehdi Khoury, M.Khoury@exeter.ac.uk Gareth Lewis, G.Lewis2@exeter.ac.uk Lydia Vamvakeridou-Lyroudia, L.S.Vamvakeridou-Lyroudia@exeter.ac.uk	
CS#6 Puglia Region, IT	**CIHEAM** Lorenzo Labellarte, (l.labellarte@iamb.it) Francesco Notarangelo, (notarangelo@iamb.it) Linda See, see@iiasa.ac.at	
CS#7 Amsterdam, NL	**WAAG** annew@waag.org ; isayvani.naicker@evisights.com	
CS#8 Flanders Region, BE	**HU** Ifigeneia Tsakalogianni, i.tsakalogianni@gmail.com Sofie Thijs Sofie.thijs@uhasselt.be	

*Please Mark with Colour (green meaning non urgent, yellow meaning moderate and red meaning urgent) to classify the action points mentioned.

WPs updates (relevant for WP4):

WP	Main Reporting Partner (&Person)	Update/ Action Points on Activities
WP1 - Project Management		
WP2 - ENFORCE methodology and Data-Driven Roadmap for ECCI	**ASUD** Anna Berti Suman annabertisuman@asud.net Lucie Greyl luciegreyl@asud.net Spela Zalocar, spela.zalokar@enoll.org Noemi Caiazzo, noemi.caiazzo@enoll.org	
WP3 - ENFORCE Plaza Tools	**SLG** Sotiris Aspragkathos, saspragkathos@singularlogic.eu	

Development (SLG)		
WP5 - User uptake & capacity building and Policy recommendation	**EARSC, ECSA** Leon Wiesner, leon.wiesner@earsc.org Leo Mensel leo.mensel@ecsa.ngo Paul Sorrell paul.sorrell@ecsa.ngo	
WP6 - Impact Maximization C&D&E	**GAC, AMRN** Nina Olivier nolivier@group-gac.com	

*Please Mark with Colour (green meaning non urgent, orange meaning moderate and red meaning urgent) to classify the action points mentioned.

ANNEX 2 – CASE STUDIES OVERVIEW

Case Study	General Characteristics	General Description	Environmental Challenges	Environmental Compliance Challenges	Stakeholders	Barriers	Expected Outcomes
Case Study [#1] *Leading Partner: [A Sud]* *Leading Person: [Sara Vegni]* ***Participants: Waag, EVI***	Name: Valle Galeria in Rome Biogeographical Region: Mediterranean (reference) Type [Urban/ Rural etc.) Urban Area [in km2]: 54 km2 	Valle Galeria is located on the western periphery of Rome, in a transitional zone between agricultural lands and expanding urban development. It's important to mention the natural wealth surrounding this area. To the northwest is the 250-hectare LIPU Oasi Reserve Castel di Guido; to the west, near the city ring road, is the 870-hectare Tenuta dei Massimi Nature Reserve.The area has historically been considered peripheral and marginal, often treated as a dumping ground	The environmental crisis in Valle Galeria is long-standing and multifaceted. The Malagrotta landfill, active for over 30 years and officially closed in 2013, still poses serious risks due to delays in remediation and ongoing leachate and biogas emissions. Other environmental pressures include illegal landfills, fire-prone industrial zones, air pollution, and odor nuisances, especially during the summer months. In 2022, a major fire at a nearby waste treatment plant highlighted the	Despite recurring reports and community pressure, institutional responses have been inadequate. Key challenges include a fragmented legal and administrative framework, lack of transparency, delayed implementation of remediation plans, and an ineffective legal system. Civic-generated data and monitoring efforts have rarely been taken into account by the authorities, which has further eroded public trust and participation	- Comitato Valle Galeria Libera (core civic actor) - Local residents and community groups - Municipality of Rome - Lazio Regional Government - Environmental protection agencies (ARPA Lazio, ISPRA) - Companies involved in waste and fuel storage - Journalists, lawyers, scientists, and public health advocates	- Lack of access to environmental data and technical documentation; - Absence of effective, accessible mechanisms for public participation; - Distrust between citizens and institutions; - Legal complexity and slow litigation processes; - Discontinuity in institutional action and shifting political will; - Stigmatization of the area as a "sacrifice zone".	- Integrated monitoring strategy combining citizen science, legal advocacy, and institutional dialogue; - Deployment of monitoring tools (air sensors, water and soil sampling, remote sensing for biogas); - Co-designed policy demands and formal observations to public authorities; - Strengthening of an autonomous, community-based observatory on environmental remediation; - Institutional uptake of civic-generated data and practices.

		for the city's most polluting facilities. With approximately 30,000 residents, the area is burdened by a concentration of infrastructures such as the Malagrotta landfill (Europe's largest until its closure), waste incinerators, petrochemical facilities, gas storage etc..	area's vulnerability a… Although Malagrotta landfill has been closed since 2013, the environmental implications persist. One of these problems is related to "leachate", which refers to waste absorbed by the environmental matrix contaminating the aquifers. This problem has a significant impact on the health of the environment as well as on the health of people who depend on the natural state of the soil and water for activities such as agriculture.				
Case Study [#2] Leading Partner: [NIRDF] Leading Person: [Nicu Tudose]	Name: Brasov, Romania Biogeographical Region: Mediterranean (reference) Type [Urban/ Rural etc.): Urban	According to the 2021 census, with 237,589 inhabitants, Brașov is the 6th most populous city in Romania. CS is located in the	Climate change pressures (e.g., drought, wind storm), expanding urban areas at the expense of forest areas.	1) Lack of clarity or application of existing environmental legi slation, in the territory; 2) Private-public property based	) Transilvania University, Brasov; 2) Municipality of Brasov; 3) Environmental Forestry Guard;	1) Transparency in public-citizen dialogue and cooperation on data and forestry knowledge; 2) Insufficient capacity of	1) Living lab to connect different DSSs, facilitate open dialogue, knowledge sharing and collaborative learning for improved data

	Area [in km2]: 186.9 km2 Map [image]: harta_BV.jpg	center of Romania, in the internal curvature of the Carpathians, including agricultural lands in the depressionary area, but also forest lands on the slopes of the Postavaru and Piatra Mare massifs. The forests occupy the southern part of the territory and are generally beech, but also spruce or mixtures of spruce, beech, and fir. These forests are mostly the property of the municipality of Brasov. The climate in the region has a specific temperate-continental climate, characterized by the transitional note between the temperate oceanic climate and the temperate continental climate. There are three protected areas (Natura 2000) and		conflicts in complying with environmental legislation; 3) Difficult process in accessing funds for forestry conservation, resilience and recovery 4) Divergent legislation across sectors (water management, agriculture, local development, etc.); 5)Strengthening communication with stakeholders in relation with environmental compliance in the context of climate change challenges; 6) Non-compliance with wood exploitation periods across the year in relation with current regulation.	4) Stefan Cel Mare University, Suceava; 5) Agency for Environmental Protection Brasov; 6) Community groups Brasov; 7) County Council Brasov.	''forestry staff'' (public, private) and informed citizens for new partnerships and protocols for enhanced awareness about forest; 3) Lack of clear legislation; 4) Degradation of environment/forests local culture for better forest management; 5) Increasing political influences in considering forests as a leverage topic in a complicated international context (post COVID-19, Ukraine war, energy crisis, etc.).	accessibility and governance, connecting to innovation within the one-stop-shop facilitated by the project and the European Green Deal Data Space; 2) Train–the-trainer sessions and (1) tailored guidelines/best practices (digital) tool for upscale and dissemination.

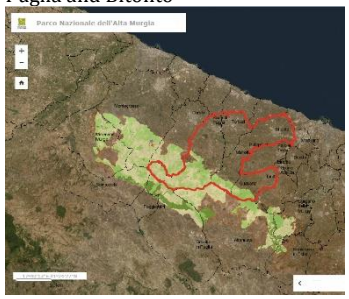
		four natural reserves on the territory of the municipality.					
Case Study #3 *Leading Partner: UoC* *Leading Person:* *Michalis Probonas, mprobonas@uoc.gr*	Name: Land clearing in the Regional Unit of Heraklion, Crete, Greece Biogeographical Region: Mediterranean (reference) Type [Urban/ Rural etc.): Urban / Rural Area [in km2]: 2,643 km2 Map [image]: https://gis.crete.gov.gr/sdi/?tab=viewport_maptab&loader=map0_loader_public	Crete is the southernmost island of Greece and 5th largest in the Mediterranean. It is mostly mountainous characterized by a high mountain range that runs from west to east. A coastline of more than 1,000 km, numerous islets around the main island and scattered plains complete the variety of landscapes enjoyed by the 610,000 inhabitants and around 3 million visitors each year.	Modern habitation development, tourism and energy projects as well as the illegal quarrying have a direct impact on the environmental situation of the Region and put added pressures to island's biodiversity. One of the invisible and relatively unknown environmental problems of the island is land clearing. The forest character of public and private land is in dispute, seashore is altered, road construction is often without permission, farmlands replace forests, while compliance & environmental remediation are not granted. The challenges of the CS are: a) lacking	Enforcement of environmental legislation for cases, for avoiding / preventing further land clearing in Crete	a) Law enforcement entities; b) Environmental agencies and institutes; c) NGOs / Citizens / Public bodies.	a) Difficulties with proving the liability of an operator/perpetrator; b) Limited responsibility of corporate persons/administrative bodies; c) Lack of effective and uniform application; d) Lack of expertise (no special environmental police / environmental courts).	a) At least 500 individuals from stakeholders in Crete to become aware of environmental compliance available tools; b) At least 1,500 individuals of main target groups audiences to become aware of environmental compliance available tools; c) At least 3 land clearing cases to be investigated and registered in project's database

			communication in prosecution chain, b) disrespect to environmental requirements, c) unaware of land use and rules, d) not conducting internal audits, e) lacking monitoring equipment. The CS background already involves: a) smartphone application, b) environmental crime Database, c) Court and administrative authorities communication, and e) citizen and administrative clerks' technical guides.				
Case Study [#4] *Leading Partner: [CSIC]* *Leading Person: [Jaume Piera/Vanessa Sarah Salvo]*	Biogeographical Region (reference) The city of Barcelona is part of the Mediterranean region of the Iberian Peninsula, specifically Barcelona is included in the province of Catalan-Provençal-Balear, one of the six provinces of the Western Mediterranean Sub-region. (Geographical National Institute, Spanish National Atlas) Type [Urban/ Rural etc.)	Urban coastal ecosystems. The coastal zone is heavily anthropised and exploited. Most of the coastline is surrounded by transport infrastructures parallel to the coast (main roads and railways) and in	Anthropic pressure (Transports, Tourism, Urbanization/Infra structure) Marine pollution (Water quality, Marine litter, Noise)	Marine litter; Noise; Water quality; Loss of biodiversity	Citizens; Port of Barcelona; BCN local Council (BCASA); Private sectors (mainly related with tourism, sports and leisure in water and transports such as diving); Hospital del Mar; Research centres (ICM-CSIC, PRBB);	Currently, citizen science data are not formally included in the data reporting of mandatory reports (MSFD, WDF, etc.). The citizen science data that are integrated are the result of specific efforts by administrations	Establish dialogues with different public administrations (EU, national and local) to formally integrate citizen science into official monitoring programmes (B1). Support the improvement of validation

	Urban Area [in km2] The metropolitan area of Barcelona, with a surface area of 636 km2, has a total of 42 beaches with a total length of 30 km (of which 15 km belong to the BCN Local Council) and a surface area of more than 2 km2. (AMB) Map [image] BCN coastline 3D map (Strategic plan for the coastline of the city 2018-28)	the water by the Port of Barcelona and some marinas. Despite this, the 15 kilometers of beaches, most of which have undergone continuous nourishments, contain renaturalised areas and interesting underwater species. The quality of the water is improving, as is the knowledge of the marine species in the area (for example, the atlas of biodiversity of the BCN Local council has been integrated with 3 new layers - fish, crustaceans and molluscs in 2022 and 2023, as a result of the data collected by MINKA). Many initiatives have been taken to tackle marine pollution, such as the no-smoking beaches to combat			Fishermen's association	and are very few and not formally included. The lack of a clear definition of the citizen science data validation processes to certify the level of quality of the data. The lack of a clear definition to assess the maturity of the citizen science data related to the specific use of the ENFORCE project (environmental compliance).	processes through guidelines and recommendations in synergy with other projects e.g. MBM-CINEA (B2). Establish the EC DRL model for the maturity of citizen science data used for environmental compliance (B2; B3). Consolidate the LL in BCN as a citizen observatory in collaboration with the local administration to support the environmental compliance

		cigarette butts pollution					
Case Study #5 *Leading Partner: Westcountry Rivers Trust (WRT)* *Leading Person: Francis Rowney, Nicola Rogers, Annabel Martin*	Name: East Devon Catchment, UK Biogeographical Region: Atlantic (reference) Type [Urban/ Rural etc.) Rural Area [in km2]: Total area of East Devon river catchments: 2266 km2. Focus study areas (Creedy and West Exe; Lim and Axe): 854 km2 Map	At a combined area of more than 2000 km2, the East Devon river catchments have a varied landscape draining to the rivers Exe, Otter, Sid, Axe and Lim. Predominantly an agricultural landscape, with lowland cattle and sheep farms constituting 38% of the farming practice, there are several water problems affecting the Rivers Axe, Otter and Clyst. These mainly relate to manures, slurry and soil entering the river. Urban areas also present water quality problems, however the agricultural pressures are greater.	Only 1 in 5 Rivers in the Westcountry meet good ecological standards set out in the Water Framework Directive (WFD) and most failures are linked to either diffuse and point source pollutions from agriculture or pollution from sewage. Alongside this chronic large-scale failure there are acute smaller areas that have enhanced challenges due to them being Drinking Water Protection Areas (River Exe) and Special Areas of Conservation (River Axe).	Sources of diffuse pollution are inherently challenging to identify. This means that it can be difficult to ascribe responsibility for diffuse pollution to specific organisations, landowners or incidents. Regulatory bodies (Environment Agency) also require guidance for compliance visits, for both point and diffuse sources. Government driven barriers are linked to Brexit and the removal of European regulations and directives. Government pressure on regulators to further reduce enforcement or ignore third party data that helps	Environment Agency (Environmental Regulator); National Government (DEFRA), Local Government; Agricultural Landowners (diffuse and point source pollution); Water Company (point source pollution); Civil society (via the East Devon Catchment Partnership	There has been pressure on regulatory bodies (Environment Agency) to reduce enforcements (due to budgetary constraints) or ignore third party data that could help triaging and direct regulatory resources. However, these pressures may be starting to change, making citizen science data and third-party farm advice more relevant.	Increase in the amount of Citizen Science Data including community analysis (>20 volunteers/annual samples; 2 x WRT citizen science Scorecards per annum); increase in citizen science methodologies employed (e.g. "Mud Spotter"); increase in remote sensing satellite data tools available to assess pollution risk (tool application in catchment planning and/or 'weight-of-evidence' assessments); increase in use of tools and data by regulator to guide catchment planning and/or 'weight-of-evidence' assessments; Living Lab to integrate all aspects of ENFORCE approach with real-world

				triaging and can be used to direct regulatory resources (see below).			application (3 x Living Lab Workshops & 4 x data sharing/evidence exchanges)
Case Study [#6] *Leading Partner: CIHEAM Bari* *Leading Person: Francesco Notarangelo*	Name: Waste reduction in Apulia Region Biogeographical Region:(reference) Mediterranean Type [Urban/ Rural etc.) Rural Area [in km2]:	The Biodistretto delle Lame encompasses the territories of Ruvo di Puglia, Terlizzi, and Bitonto, located in an intermediate zone between the inland Murgia highlands and the Adriatic coast. Formed by the constant action of water flowing down from the Alta Murgia promontory to the Adriatic coast, the shallow furrows have sculpted the environment and the lives of the area's human	The Bio-district has several strategic orientations, one of which involves development and improvement of waste management: Increasing sensitivity and civic sense with respect to waste management; reducing of waste during production processes; effective control of the territory; facilitation of autonomous waste disposal. Moreover, connected to waste dumping are also	Prevention of illegal dumping and illegal fires	Association "Bio-distretto delle lame"; local farmers; citizens; local authorities; waste management company; local associations	Collecting data is very complex considering the involvement of different municipalities with different roles and offices. The involvement of companies is rather complex as they are not interested in the issue and are often mainly responsible for some incorrect behavior.	Citizens, companies and farmers are more aware on the issues and help on one hand to prevent illegal waste dumping and fires, and on the other to make report on this through digital app/website.

	The territory covers 398km2 and comprises two municipalities, Ruvo di Puglia and Bitonto 	communities, giving rise to a distinctive and unique agricultural, economic and social system. The biodistrict is located in a special geographical position: an intermediate area, furrowed by limestone hemlocks, between the inland Murgia uplands and the Adriatic coastal strip. The landscape represents a perfect synthesis of the interaction between the physical (climate, geomorphology, etc.) and cultural elements of the land (distribution of plant crops, infrastructure, etc.) resulting from a millennia-long synergy and combination of natural and anthropogenic processes.	illicit fires (usually set to burn stubble or waste difficult to dispose of).				

Case Study [#7] *Leading Partner: Waag Futurelab* *Leading Person: Anne Wijnen, Nehis Osagie*	Name: Amsterdam Biogeographical Region: the Netherlands Type [Urban/ Rural etc.): Urban / Rural Area [in km2]: TBD Map [image]: TBD	the Netherlands consists of urban-industrial parts interspersed with rural landscapes and small nature areas. As one of the most densely populated countries in Europe in a delta of some major rivers and downwind of some large industrial sites, there are significant levels of air, water and soil pollution.	biodiversity in most of the Netherlands is under pressure, air quality improvements are stagnant and the soil and water are heavily polluted.	The protected nature areas (Natura 2000) in the Netherlands are heavily polluted and biodiversity in the Netherlands is in a poor state. This has been brought to court in 2019 and a European jurisdiction ruled that the Netherlands has to decrease the nitrogen pollution, which sparked many farmer protests and difficult policy debate. Another concern is the impact of pesticides on natural and human health. The protected nature areas (Natura 2000) in the Netherlands are heavily polluted and biodiversity in the Netherlands is in a poor state. This has been brought to court in 2019 and a European jurisdiction ruled	Stakeholders*: citizens, municipalities, provinces, industry, farmers, scientists	right-wing government and pro-farmer sentiment, TBD	successful citizen science initiatives for the environment and what support they need to have a positive impact on policy and legal dimensions. We want to create constructive dialogue between citizens, industry and government in order to protect the environment and improve biodiversity. More specifically, we want to explore the value of citizens science data in enforcement processes

				that the Netherlands has to decrease the nitrogen pollution, which sparked many farmer protests and difficult policy debate. Another concern is the impact of pesticides on natural and human health.			
Case Study [#8] *Leading Partner: UHasselt* *Leading Person: Steven van Garsse, Sofie Thijs, Ifigeneia Tsakalogianni*	Name: Soil Pollutant Bioavailability Assessment in Flanders Biogeographical Region: Atlantic (reference) Type [Urban/ Rural etc.) Agriculture Area [in km2]: 8	The region around Zwijndrecht, particularly near the 3M factory, faces a severe soil contamination issue due to per- and polyfluoroalkyl substances (PFAS). These chemical compounds are notoriously persistent in the environment, with PFOS and PFOA being the most prominent contaminants in this region. More than hundreds of	The contamination affects over 100 farmers, degrading soil quality and harming agricultural productivity. The affected lands near the 3M factory, including the nature reserve Blokkersdijk, are crucial for both agricultural and ecological health. This pollution poses a risk to food safety due to the potential translocation of	Exceeded Soil Remediation Norms: The presence of PFOS and PFOA at concentrations significantly above established safe levels (e.g., PFOS up to 100 µg/kg compared to the safety threshold of 3.8 µg/kg) violates local and EU soil quality standards. This non-compliance necessitates remediation efforts under	Farmers and Farmer Associations: Zwijndrecht Farmers: Local farmers affected by PFAS contamination who will participate in phytoremediation trials by cultivating bioenergy crops like hemp. Their involvement will provide practical data on soil health improvements and help demonstrate the feasibility of	Absence of legally-binding PFAS food norms in Belgium Need to measure also PFAS concentrations in soil, 1, 2 years AFTER excavation and re-fill	Implementation, feasibility and monitoring of phytoremediation as clean-up strategy (according to code of good practice phytoremediation) Costs for implementing phytoremediation carried by 3M

		hectares of land, including agricultural areas, nature reserves, and residential zones, have been impacted by PFAS pollution. Soil samples have shown that PFOS concentrations in the area often exceed the proposed soil remediation norms. For instance, the concentration of PFOS in certain areas reaches up to 100 µg/kg, far above safe thresholds (3.8 µg/kg).	PFAS to plants and bioaccumulation in animals, threatening local biodiversity. Currently, remediation solutions are limited, expensive, and invasive, often involving the removal of contaminated soil.	environmental laws and poses challenges due to the scale and cost of treatment. Agricultural and Food Safety Risks: The contamination impacts over 100 farmers by degrading soil quality and reducing productivity, which contravenes regulations on sustainable land management. The risk of PFAS translocation to crops and bioaccumulation in livestock raises food safety concerns that could violate food safety and agricultural standards set by EU regulations. Biodiversity and Ecological Harm: The pollution of areas like the Blokkersdijk nature reserve compromises	using phytoremediation at a larger scale . Boerenbond: This is the main farmers' union in Flanders. It represents the interests of the agricultural sector and can play a critical role in mobilizing farmers to participate in the Living Labs. Boerenbond will help ensure that the developed soil health practices are widely adopted across the region, facilitating the scaling-up of successful solutions. Agro-Industry and companies: 3M (Zwijndrecht): As the primary industrial stakeholder, 3M's operations have contributed to the PFAS contamination in the region. They		

				ecological integrity, violating biodiversity protection laws. PFAS exposure poses risks to wildlife, leading to potential breaches of regulations on habitat and species conservation. Limited Remediation Options: Compliance with environmental directives often requires remediation; however, current solutions are costly, invasive, and environmentally disruptive. The practice of soil removal and disposal faces practical and regulatory constraints, especially under waste management laws and policies governing	will provide support in identifying contaminated areas and contribute data for the research. Their involvement is also key in understanding how industry can contribute to soil health recovery. ERM (Environmental Resources Management): ERM is a key environmental consulting firm involved in supporting 3M with soil remediation efforts around the Zwijndrecht site. As a recognized soil remediation expert, ERM will provide critical technical expertise in evaluating contamination levels and advising on effective remediation strategies, particularly in relation to the		

				hazardous substances.	PFAS pollution near the 3M facility. Local and regional authorities: OVAM (Flemish Waste Agency): Responsible for the enforcement of soil remediation policies in Flanders. OVAM plays a key role in setting the regulatory framework for soil health improvement projects, ensuring that remediation actions meet the necessary standards. Flemish Government: Provides overarching policy and governance support for the remediation efforts. The Flemish Government's environmental agencies (e.g., OVAM) will ensure that regional		

					policies on soil health are integrated into the project framework. Environmental Organizations: Natuurpunt: A major Flemish environmental organization dedicated to nature conservation. Natuurpunt will be involved in the Blokkersdijk site, where PFAS contamination has affected natural reserves. They will provide expertise on managing natural areas during remediation processes and collaborate to preserve biodiversity while ensuring soil recovery. Research and Technical Expertise: Hasselt University (UHasselt): Leading		

					research institution focusing on phytoremediation and soil health. UHasselt, through its Centre for Environmental Sciences (CMK), will lead scientific research, conduct field trials, and manage stakeholder coordination in the project. The university will provide technical expertise in designing and evaluating phytoremediation strategies Stakeholder Platforms and Networks: KIS-working group (Kenniscentrum Innovatieve Saneringstechnieken): KIS is a Flemish knowledge center dedicated to innovative soil remediation techniques. Their role in the project		

					will be to provide cutting-edge insights into emerging soil health technologies and support the dissemination of the findings across various regions in Flanders (https://kis.vlaanderen.be/en/home-english/) Citizen Science Vlaanderen (Scivil): As the knowledge center for citizen science in Flanders, Scivil will lead efforts to engage the local population in soil monitoring and data collection, helping ensure that remediation efforts are community-driven and that citizens are actively involved in the restoration of soil health . Zwijndrecht Gezond: A local advocacy group dedicated to		

					addressing environmental and health concerns in the Zwijndrecht area, particularly related to the PFAS contamination near the 3M factory. Zwijndrecht Gezond represents the interests of local residents and will play an important role in ensuring transparency, community involvement, and public health considerations are central to the remediation efforts. Municipal government of Zwijndrecht: The local government is a key stakeholder in the planning and execution of soil remediation activities in Zwijndrecht. They will provide governance support, facilitate community		

					engagement, and ensure that the soil health measures align with broader municipal environmental and health policies.		

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