Enforce
Empowering Citizens for Environmental Action

# D4.1 Initial Roadmap and monitoring plan for the activities and actions at the Case Studies

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

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| Deliverable Abstract |
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| The Deliverable outlines the initial activities related to the Case Studies in ENFORCE project, reflecting the coordination actions carried out during the first nine months of implementation. The content of the deliverable highlights the interrelation between methodologies for environmental compliance assurance along with the distinct parameters of compliance that Case Studies will focus on. The document presents methodological directions emerging from Work Packages 2, 3, 5 and 6 and describes how these have informed the preliminary planning at the Case Study level. The deliverable is structured around six main topics and specifically the status and updates on each Case Study, the policy and legal framework assessment, the stakeholder engagement actions through Living Labs, monitoring activities regarding data collection and tools and actions related to impact assessment, dissemination, exploitation, and communication. This Deliverable will inform the upcoming field activities in each Case Study and provide strategic guidance for their next steps. |



| Keywords |
| --- |
| Environmental Compliance; Case Studies; Monitoring Plan; ENFORCE |



| Project Summary |
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| 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 |
| NGO | Non-Governmental Organisation |
| SDG | Sustainable Development Goal |
| SME | Small and Medium-sized Enterprises |
| WP | Work Package |

# Executive Summary

The Deliverable outlines the initial activities related to the Case Studies in ENFORCE project, reflecting the coordination actions carried out during the first nine months of implementation. The content of the deliverable highlights the interrelation between methodologies for environmental compliance assurance along with the distinct parameters of compliance that Case Studies will focus on. The document presents methodological directions emerging from Work Packages 2, 3, 5 and 6 and describes how these have informed the preliminary planning at the Case Study level. The deliverable is structured around six main topics and specifically the status and updates on each Case Study, the policy and legal framework assessment, the stakeholder engagement actions through Living Labs, monitoring activities regarding data collection and tools and actions related to impact assessment, dissemination, exploitation, and communication. This Deliverable will inform the upcoming field activities in each Case Study and provide strategic guidance for their next steps.

# 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 will test the integration of environmental citizen science data and technological solutions for environmental reporting, auditing and compliance. Towards this aim, ENFORCE will implement a comprehensive and integrated approach, centred around the creation of the ENFORCE Plaza – a one-stop digital hub designed to facilitate stakeholder engagement, data certification, knowledge transfer, and tool accessibility. The Plaza will host four interconnected sub-plazas (data, citizens, knowledge, tools), while these components will be piloted and validated across eight diverse Case Studies (CSs) in seven countries, each representing a unique environmental, legal, and social context.

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

As the first step to achieving these aims, Task 4.1 (T4.1) develops a roll-out agenda of collaboration and co-creation activities within each CS leading to the implementation of the Compliance LLs. Linked to T4.1, this deliverable presents the initial roadmap and monitoring plan for all activities related to the ENFORCE eight CSs, reflecting the coordination actions carried out during the first nine months of the project. It is structured around the interconnection between the methodological frameworks for environmental compliance (as a result of work implemented in Work Packages (WPs) 2,3,5,6 of the project) and the context-specific priorities and challenges of each CS.

A central focus is the assessment of each CS's maturity, including their strategic approach, legal and policy context, data collection plans, and impact pathways. As such, this deliverable first presents the methodological framework and then provides an analytical profile of the CSs. The document is grounded in weekly coordination discussions with CS leaders and WP partners, desk research, and ongoing communication with stakeholders. It represents a shared framework to guide each CS through the co-creation process, from citizen science data collection to legal and policy outcomes. This Deliverable will inform the upcoming field activities in each CS and provide strategic guidance for their next steps.

## 1.2 Structure of the Deliverable

The Deliverable begins with a methodological section describing the common framework agreed for the organization of CSs work. 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 have been undertaken to lay the foundation for the CS implementation. These activities can be grouped into two main categories:

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.

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.


*Image 1: ENFORCE Case Studies*

## 2.2 Preparatory Activities for Building a Successful Roadmap

From the start of the ENFORCE project, a structured coordination mechanism was established to support the effective integration of CS activities with the methodological developments across WPs. A key element of this structure has been the organisation of weekly meetings, held every Friday at 12:00 CET, bringing together CS and WP leaders. These meetings serve as a regular space for reporting progress, exchanging updates, and aligning on methodologies, combining elements of both structured monitoring and open collaboration.

Participation in these meeting is considered essential for at least one representative from each CS and WP on a bi-weekly basis, ensuring a continuous feedback loop between the implementation level and the methodological design. The meetings also provide an open space for discussion, enabling flexibility while maintaining shared accountability. To support transparency and collective documentation, meeting minutes are recorded in a live online document, stored in a shared folder on the project's SharePoint, accessible to all project partners.

As a first step to operationalise this collaboration, a conceptual activity framework was developed. This framework outlines the core thematic areas of the CS work (policy and legal context, stakeholder engagement through LLs, data and tools, and impact activities) and links them directly to the methodological directions of WPs 2, 3, 5, and 6. This deliverable is structured accordingly: first, by presenting the methodological basis (Chapter 3), and then by detailing how these are translated into tailored implementation plans at the CS level (Chapter 4). Both Chapters outline activities already done and activities planned for the following months with specific focus until month 18. CSs activities first include a CS

Description to have a shared understanding over the environmental compliance priority of the project and next they present the tailored implementation plans having this as basis.

## 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) has been selected based on the project's objectives, the nature of environmental compliance challenges, and the specific activities foreseen 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 |
|---|---|---|---|---|
| Identification of links between environmental compliance and socio technical innovation- | Number of existing laws, policies, strategies, foundational concepts, analysis of results from 'perception analysis' questionnaire, number of best practices gathered, analysis of expert interviews | Texts identified | 50+ | Legislation and Policy |
| 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 |
| 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 |
| Number of Stakeholders involved in LLs in different spatial levels | Tracks the number and representation of stakeholders on each CS | Stakeholder lists | 10+ | LLs Roadmap |
| 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 |
| 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 |

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| 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 |
| 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 the ENFORCE Plaza Toolkit. | CSs monitoring activities | Integration of at least 75% of CS-specific tools by the second project phase | Data and Tools |
| 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 |
| 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 |
| Citizen Science Uptake for Environmental Compliance | Proportion of citizen-generated environmental data integrated into official reporting or regulatory processes across CSs | CSs monitoring activities | ≥ 60% of CSs demonstrate formal use or recognition of citizen data in institutional frameworks by project end. | Impact, Exploitation, Dissemination and Communication and Capacity building |
| Capacity Building Effectiveness Score | Percentage of trained stakeholders (citizens, NGOs, legal actors) who report improved | Case studies monitoring activities | ≥ 80% of respondents rate training and materials as | Impact, Exploitation, Dissemination and |

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|---|---|---|---|---|
| | understanding and confidence in using project tools and frameworks (e.g., ENFORCE Plaza, DRL, apps) | | "effective" or higher in post-training assessments across CSs | Communication and Capacity building |

## 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.

# 3. Case Studies Horizontal Action Plans

To ensure effective implementation and monitoring across CSs four horizontal action plans have been developed under the topics: Law and Policy; Living Labs Implementation; Data and Tools; Impact, Exploitation, Dissemination, Communication & Capacity Building. Each thematic action plan is structured in the logic of different preparatory, development, and validation/assessment processes. The allocation of work under these topics was made to link methodologies and new knowledge that will be developed in the ENFORCE different WPs into co-creation activities in the CSs. As a result, it creates the basis for CSs to develop their own action plan adjusted to their specifications. The development of these horizontal action plans was based on discussions with WP/ Task leaders and CSs in the WP4 meetings. The processes outlined in the following sections will be monitored and revised following the first round of implementation and evaluation. The agenda outlined in the roadmaps will thus be considered as an internal live document, to be updated continually throughout the project, through a dedicated stakeholder feedback process to account for the project's development and achievement and emerging issues.

Subsections and Figures 1-7 below present the phases of the four thematic action plans in detail.

## 3.1 Legislation and Policy Roadmap

The first working thread identified 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)**
The first phase identified is the grounding 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 is addressed by T2.1 and T2.3.

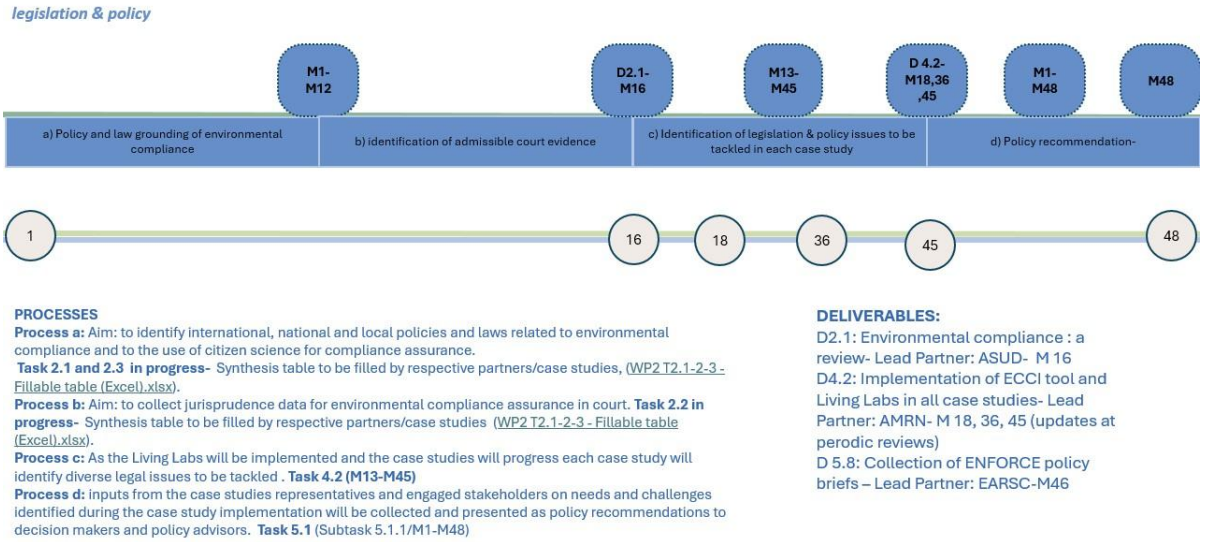



*Figure 1: Legislation and Policy Roadmap*

Phase A is developed as a two-fold procedure leading to different results linked to the three aforementioned tasks. Thus, on the one hand, an examination will be conducted on the existing laws, policies, strategies, and foundational concepts related to environmental compliance and the innovations that have arisen from research and existing projects, and that are documented in grey and academic literature, and in the media. Environmental regulation, as pointed out in research, has quickly emerged as a major focus in environmental protection research in response to intensified and organized efforts among nations in the adoption of environmental law as the dominant regulatory instrument to cope with rapidly deteriorating environmental degradation (Ellis et al., 2020). This will offer perspectives on the theoretical development of the notion of compliance, identify connections between compliance and innovations able to influence policies, and demonstrate how these relate to policy evolution. Special attention will be given to socio-technical innovations within the three pillars of ENFORCE (pollution, biodiversity and illegal deforestation), as well as focusing on other interesting issues highlighted by the partners, such as; illegal logging as an extended concept of the land use umbrella of the illegal deforestation pilar forest, national and local practices, and effective strategies at both policy and practical levels. As it is highlighted in relevant research, socio-technical transitions research is a distinctive approach within the sustainability transformations debate (Geels, 2019). This process will involve an intersectional analysis across different geographical levels (national and international) and environmental compliance domains, clarifying innovative concepts and processes. Finally, a concerted effort will be made to define key terms and create a shared language and terminology shared in the project glossary (developed in T2.1) across the diverse disciplines engaged in environmental compliance.

On the other hand, qualitative methods will be used (including a 'perception analysis' questionnaire aimed at identifying actual and perceived barriers to the use of citizen science in compliance assurance) beginning by utilizing existing data on environmental compliance and focusing on its innovation and relevance in various contexts. Moreover, best practices will be gathered and utilized, particularly in the EU's priority areas of biodiversity, pollution and agriculture. This way a deeper and more detailed understanding of the key challenges faced by citizens, authorities, legal experts, and those seeking to develop smart compliance innovations will be developed. This review will be enhanced by conducting 3-5 expert interviews from partner networks and stakeholder mapping in each of the countries involved in the consortium, to validate the findings from desk research and from the perception survey. The aim of this phase is to define, on the one hand, international law and policy frameworks and, on the other hand, to focus on national and local policies in order to ultimately define case-specific interventions which will inspire the next legislation and policy phases.

**Phase B: Identification of admissible court evidence (M1-M12)**

The second phase is based on the feedback selected by the first and concerns the collection of jurisprudence and legal cases related to environmental compliance and evidence admissible in court. It is addressed by T2.2.

To ensure the collection of reliable and valid data, a list of admissible court evidence in civil, administrative and criminal proceedings, based on EU legislation and the national laws of CS members, is created. The participating CS carries out baseline research on admissible court evidence under their national laws under the coordination of the CS leader. The CS then compiles a report on the applicable procedural law frameworks and existing case law. Simultaneously, a study is conducted to explore how evidence gathered through citizen science can be delivered to environmental auditors, prosecutors, and judges.

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

The third phase concerns each CS distinctively and will unfold during the implementation of the CSs as each one of them will identify and tackle their own respective legal and policy matters related to their line of work. It will be implemented by T4.2. Each CS involves different modelling activities and case-specific tools for their implementation. All these actions will be carried out and documented within this task, with the specific modelling activities being executed in each CS.

Each CS tackles distinctive specific environmental issues aiming to utilise citizen science data in order to promote environmental compliance in their respective domain. Thus, during the development of each CS, issues regarding the treatment of the diverse respective environmental issues will arise, ranging from collaboration with local authorities to meet the requirements of the environmental legislation under the obligatory reporting systems to data admissible in court procedures. These points will have to be treated in different ways according to the CSs' capacity and needs.

**Phase D: Policy recommendation (M46)**

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 stems 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. Thus, as environmental compliance is succeeded through law and policy developments and through court rulings, ENFORCE necessitates a solid legal analysis running throughout the whole project.

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.

## 3.2 Living Labs Roadmap

The ENFORCE project will apply the LL approach, led by ENoLL, to co-create environmentally compliant, citizen-centered innovations. This will be done through four participatory co-creation phases: perceive, co-design, realize, and evaluate. The project will engage 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 will facilitate the development of real-world solutions, integrating research and innovation within local communities. 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

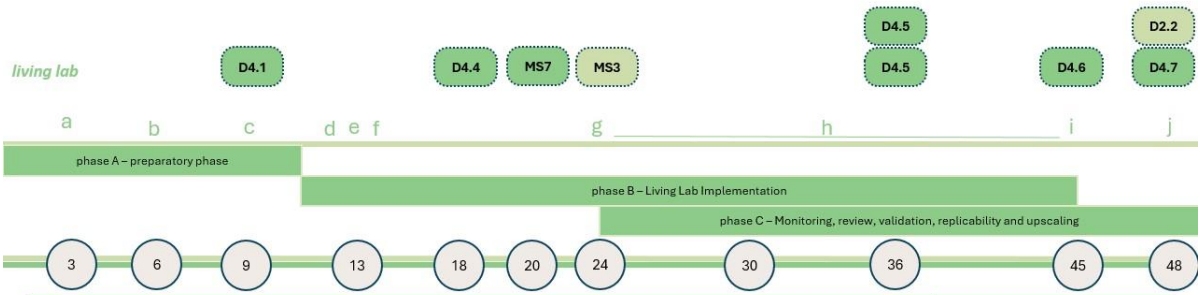
solutions (Beaudoin et al., 2022; Engez et al., 2021). The design and assessment of the Living Labs in the 8 CSs will be organised around the activities of T2.4 and Task 4.3 while activities around T4.1/T4.2 will focus on implementation while ensure the alignment with CSs Plaza Toolkit Development specificities.

**Phase A (Preparatory Phase | M01-M12 | T2.4 & T4.1):** The main aim of Phase A is for the CSs to understand the LL methodology and for ENoLL to grasp the specificities of each site. This will enable co-designing the implementation phase and prioritizing the ENFORCE Plaza Tool. The conclusion of this phase comes together with the submission of D4.1 and finishes with the completion of the 1st year of the project. The first activity involves a survey aimed at understanding the specificities of the CSs) in relation to the implementation of LLs. This survey was conducted by ENoLL as part of T2.4 and was completed by Month 3 (M3). Afterwards the self-evaluating home assignment was designed by ENoLL for the CSs, to study their key components and matureness of LL processes. Evaluation of the home assignment is used to inform next steps and the corresponding trainings.

The second activity consists of internal training sessions for the CSs, which included take-away exercises focused on the fundamentals of LLs, stakeholder engagement and panel management, as well as governance models. This training was carried out by ENoLL and the CSs as part of T2.4, and it was completed by Month 6 (M6). Next, the initial LL self-assessment framework is planned, along with an initial monitoring strategy. Action plans were also developed through collaboration between T2.4 & 4.1 in M9. This process included ongoing discussions with the CSs through recurring meetings in WP4 and bilateral meetings with WP/ Task leaders, ensuring alignment and a shared understanding among all partners.

**Phase B (Implementation Phase | M13-M45 | T2.4-4.2):** Phase B focuses on implementation, which includes addressing the timeline and carrying out workshops and other engagement activities to actively involve local stakeholders. The analysis of the self-assessment framework will be conducted by ENoLL under T2.4 as the 1st step of Phase B. Internal training will also be provided by ENoLL as part of T2.4, with the related deliverable being D2.2. The training will take place to map the key components of LLs, following the LL Mapping Canvas tool. This is a tool developed by ENoLL, used to guide the CSs in their LL development. By mapping key components, it helps CSs pinpoint knowledge or practice gaps that need to be addressed to successfully build Macro-level LLs. Additionally, a workshop will be held in the 2025 General Assembly (GA) by ENoLL under T2.4, with the corresponding deliverable being D2.2. At the end of this phase LLs will have been implemented respecting key performance indicators (4 workshops in 2 iterative cycles, totalling 32 workshops | 1 physical user uptake workshop per CS, amounting to 8 workshops in total | 2 online workshops will be held to train CS leaders on LL methodology, totalling 2 workshops | 3 internal and 2 external co-creation exploitation workshops, for a total of 5 workshops under the responsibility of CSs in collaboration with ENoLL (T4.2 & 2.4).

*KPIs to be defined in the process: 4 workshops per CS LLs in 2 iterative cycles—total 32, ii) 1 physical user uptake workshop per CS—total 8, iii) 2 online workshops training CS leaders on LL methodology—total 2, and iv) 3 internal and 2 external co-creation exploitation workshops—total 5.




| 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 | T4.2 & T4.3):** 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.

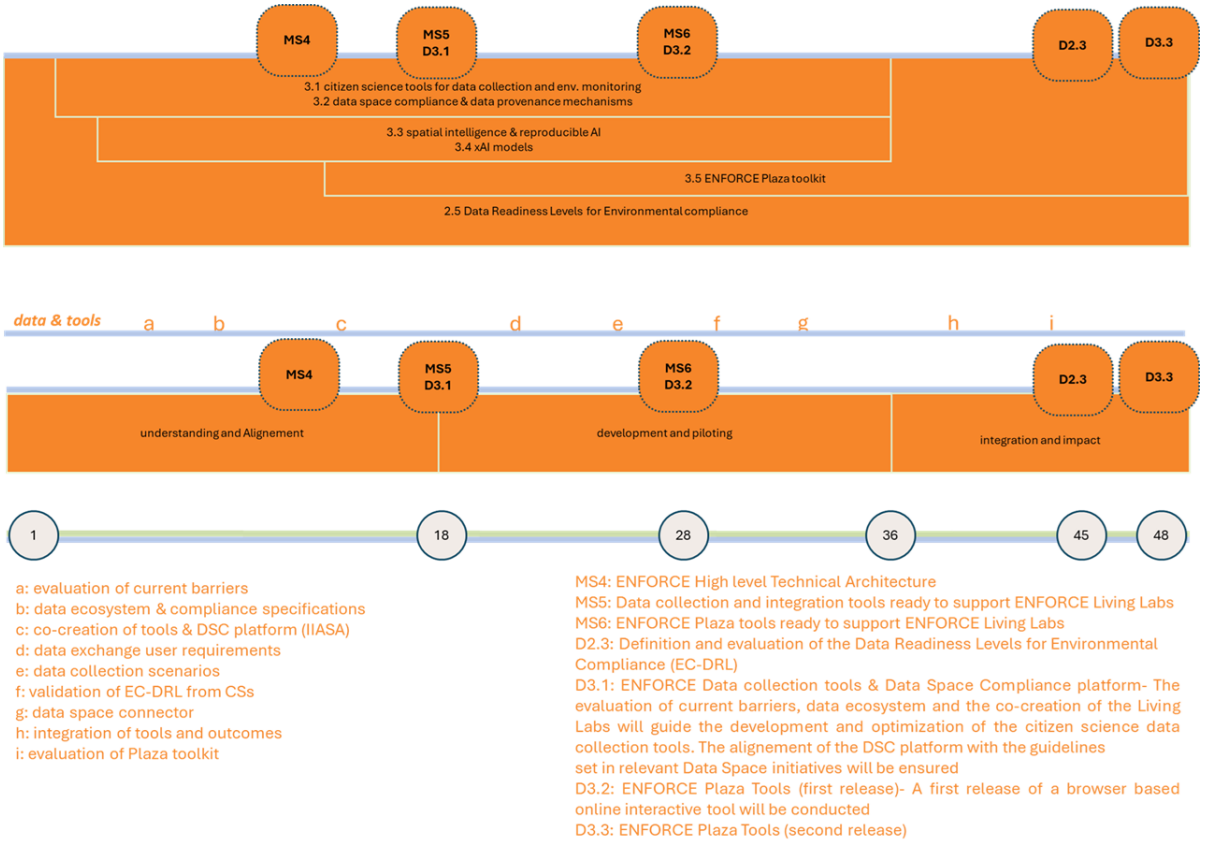



*Figure 3: Data and Tools Roadmap*

**Phase A: Understanding and Alignment (Month 1-18):**

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. CS 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 that is intrinsic at each CS due to it depends by the 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.

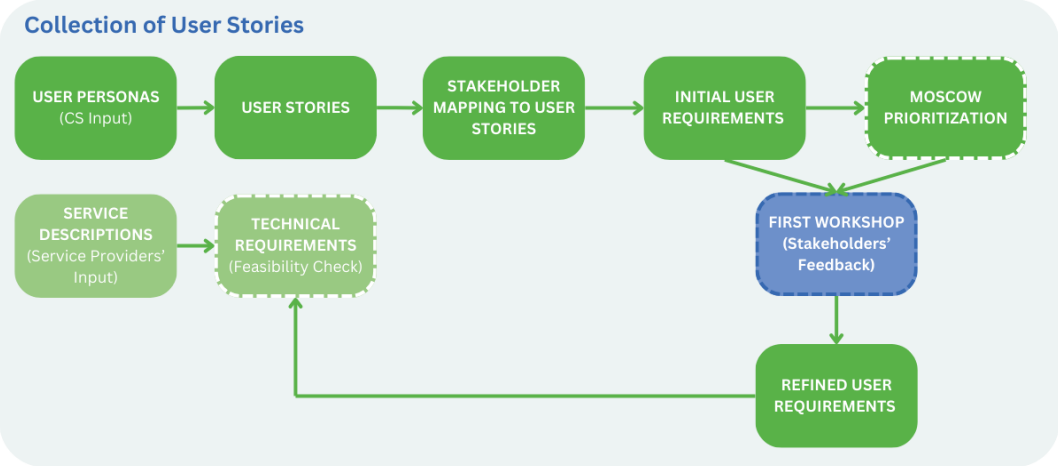



Figure 4: Co-creation methodology for tools design during Phase A

For T2.5: Data Readiness Levels for environmental compliance, this phase involves the identification of the scope and objectives of the EC-DRL. This includes defining the EC-DRLs and determining the types of data required at each level in the framework of the perspective fit for purpose. The focus will be on understanding the minimum requirements and steps for validity of the data through the dataflow and setting up the framework for trustworthy citizen initiatives in terms of maturity of data linking the maturity level with a potential use (Haklay, 2015). The maturity level is aligned with a fit to purpose approach to data usability. At this phase T2.5 is mostly high level, involving works like literature review, specifications of barriers, definition of EC-DRL and its scales in accordance with the environmental compliance and the baselines of the legislative requirements. In regards to the involvement of CS the task mostly requires coincides with the feedback for T3.1 (see below), involving scoping of the case specific environmental compliance objectives and the existing or to be developed datasets and tools ecosystem.

For T3.1: Citizen science tools for data collection and environmental monitoring, this phase focuses on laying the groundwork for the project. It involves evaluating current barriers and the existing data ecosystem (T2.3) to understand the challenges and opportunities for the dataflow of the data generated by citizen science. Additionally, it includes the involvement of LL (T2.4), which will serve as collaborative spaces for developing and testing new tools and methodologies. The Data Readiness Level (DRL) is not solely applicable at the stage of data collection but is instead implemented throughout the entire dataflow. It establishes a structured set of ordered criteria to define the scale of DRL (Schade et al., 2017). At each point on this scale, a description of the level of "fit for purpose" of the data is provided, reflecting how well the data meets the requirements of each defined level. These criteria are comprehensive, integrating multiple dimensions, including data science requirements, such as standards for metadata, data analysis and validation thresholds, and adherence to the FAIR (Findable, Accessible, Interoperable, Reusable) and CARE (Collective Benefit, Authority to Control, Responsibility, Ethics) principles. Legislative requirements are also considered, including alignment with regulatory frameworks, standards for data protocols, monitoring programs, and legal compliance. In addition, social requirements are included, such as participatory approaches, inclusivity, and stakeholder engagement in data generation and use. Given this broader scope, it is critical to approach DRL as an assessment of the entire data pathway, rather than focusing solely on the

initial data collection. This approach ensures that data generated by citizens is appropriately validated, integrated, and utilized in alignment with the diverse requirements outlined above.

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

- Understand the needs of the CS, relevant to their environmental compliance objectives defined in WP 2
- Explore the current data ecosystem, existing datasets, tools, and gaps and hinders.
- Critical analysis of the criteria (gaps and needs) to an effective citizen science data flow and therefore usage based on the fit to purpose concept within the pathway from data to policy
- Establish LL as a collaborative environment for innovation.
- Set clear goals and objectives for the valorisation of existing and the development of new citizen science tools.

For T3.2: Data space compliance and data governance mechanisms, this phase involves evaluating current barriers, reviewing guidelines, and setting objectives, within the context of Data Space initiatives like IDSA and GAIA-X. This task involves more horizontal work, but there is also some light involvement of the CSs specific to

- Mapping of the user roles per CS.

For T3.3: Spatial Intelligence and reproducible AI, this phase involves the scanning of CS to identify which ones can offer a clear narrative on how spatial intelligence can be derived from the combination of the existing and developed data ecosystem and AI techniques. Such examples could be those of contaminant fingerprinting and chemical fate (de Sherbinin, A., et al., 2021). A framework for establishing a comprehensive approach to spatial intelligence and reproducible AI will also be developed, ensuring effective data analysis and environmental compliance monitoring. This involves the following action points:

- Identify the spatial intelligence scope and objectives for one frontrunner CS.
- Establish the methodological framework
- Determine data types to be analysed, such as Earth Observation (EO) data sets from Copernicus services
- Set up the necessary infrastructure and guidelines for data collection and analysis
- Identify at least a second CS

For T3.4: xAI models, this phase involves the identification of scope and types of data relevant for xAI models. This includes setting objectives, determining data types, and establishing the framework for improving data quality and decision-making. This task will also be scanning CSs to identify the ones that offer a clear narrative for the following objectives: a) quality of data, b) guidance to which aspects are relevant, c) categorization of events, d) alignment of observations with semantics, e) counter factual outliers and f) feature relevance. The action points for this phase are:

- Identify frontrunner, scope, objectives
- Set the framework for frontrunner
- Determine data types to be analysed, such as EO data sets from Copernicus services
- Set up the necessary infrastructure and guidelines for data collection and analysis

- Identify at least a second CS

For T3.5: ENFORCE Plaza toolkit, this phase involves only preparatory works on the brainstorming of what the toolkit is, what it will look like, what is the ambition of each CS for this toolkit, etc. The action points for the CSs are:

- Give feedback on the aspiration for the ENFORCE Plaza toolkit
- Contribution to the high-level architecture of the Plaza toolkit
- A first draft for user requirements

**Phase B: Development and Piloting (Month 19-36):**

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.

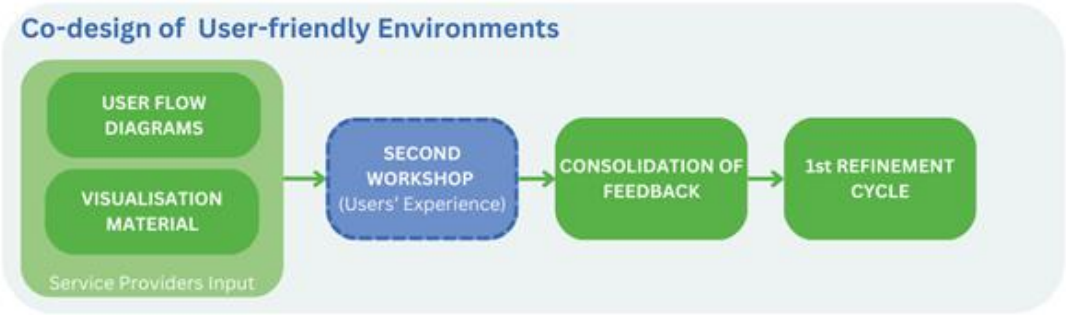



Figure 5: Co-design of user-friendly environments during Phase B

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 (Month 37 to the end):**

The 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.

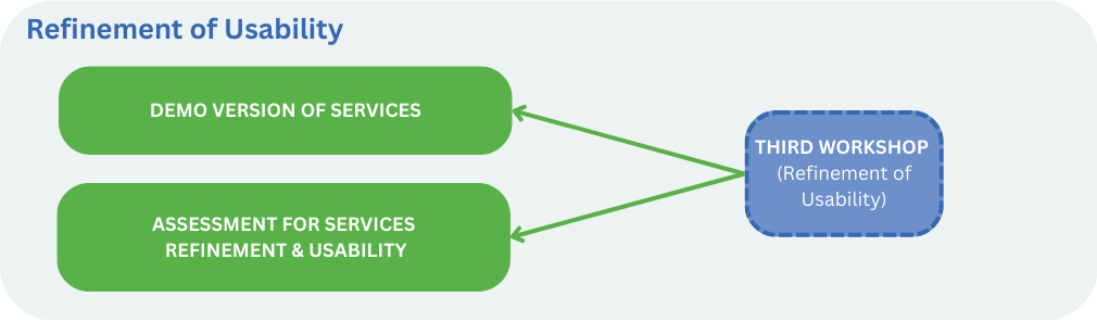



Figure 6: Refinement of Usability during Phase C

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 different data 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 certification 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 certification, 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 certification 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 (Months 1–12)**
The first phase of ENFORCE focuses on building a solid strategic and operational foundation for what is to come. A central task during this period is to establish the project’s visibility and shared vision through the early development of a communication strategy. This includes branding, digital platforms, and outreach activities, forming the basis of a long-term engagement

approach. In parallel, a mapping of key stakeholders—ranging from citizen science communities and NGOs to environmental regulators and legal experts—is undertaken to better understand the broader stakeholder ecosystem in which ENFORCE operation. Aligning with the collaborative dynamics outlined by Veeckman et al. (2013).

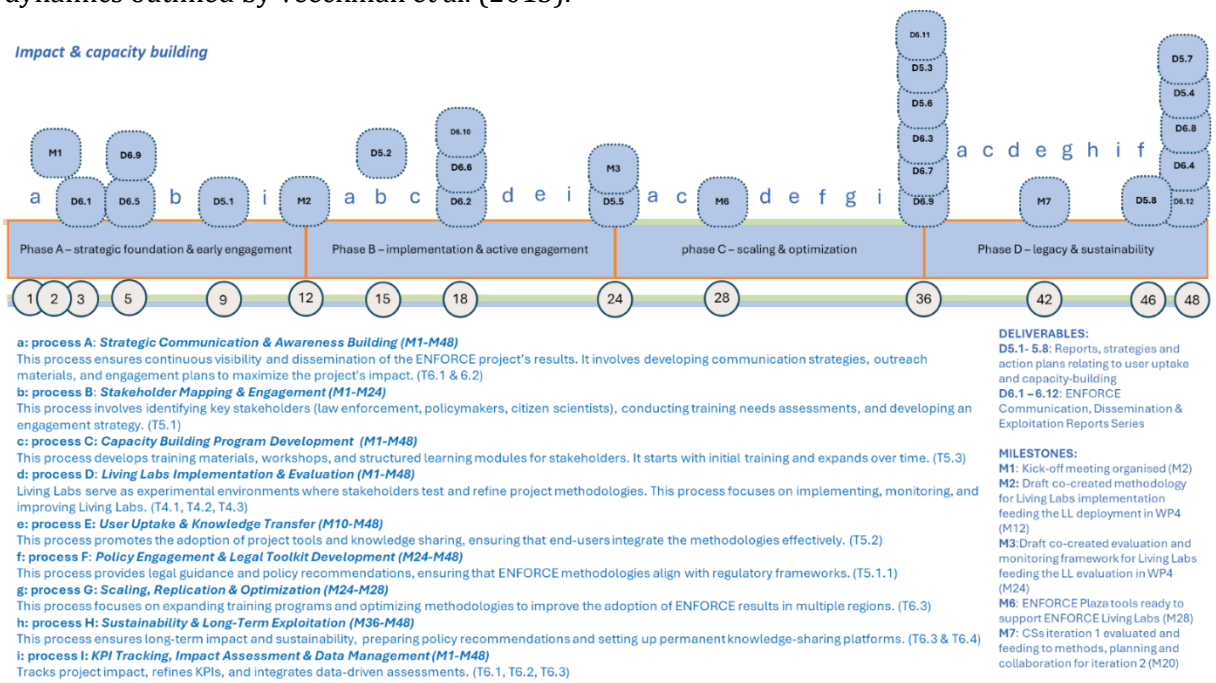



Figure 7: The ENFORCE roadmap phased approach to "impact & capacity building" over the extent of the project. It outlines four project phases (A–D) and nine parallel processes (a–i), highlighting key milestones and deliverables.

Throughout this phase, the project prioritizes internal coordination and alignment. Mechanisms for governance, ethical compliance, and quality assurance are put in place, while systems for tracking project progress and collecting relevant data are activated. Crucially, indicators to measure impact are defined early, ensuring that outcomes can be meaningfully assessed later. Such early definition of impact metrics is consistent with best practices in structured, outcome-driven project planning frameworks (European Commission, 2020). Together, these efforts establish strong communication and awareness, begin cultivating relationships with future co-creators and data users, and ensure the consortium is aligned in its objectives. This early investment in clarity and trust is what makes the next phases possible.

**Phase B: Implementation & Active Engagement (Months 13–24)**

With its foundations laid, ENFORCE transitions into a phase of real-world activation. The eight LLs – ENFORCE's core testing environments – are 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, the first capacity-building programs are introduced. These include 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.

This phase also sees the beginning of broader knowledge transfer. Early success stories and lessons from the LLs are 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 (Months 25–36)**
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 (Months 37–48)**

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 not only a suite of tools and methods but 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. Customisation of action plans for each case study

This section explains which actions have been implemented so far (M8) 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, we 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 your case study.**

The team collected examples of past legal actions involving civic data, including those submitted to the TAR Lazio and other authorities. We are studying 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 you have 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 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 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.

### 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.

### 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.

### 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 are 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 A, 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.

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

### 4.2.1 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**

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 CS#2 team to engage with key stakeholders across the Quadruple Helix (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, however, future actions on qualitative data shall be implemented, especially through workshops/interviews, since local wisdom has proven to be more reliable than traditional sources of data.

**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 stakeholder workshop revealed the complexity of legislation and its formulation, the different challenges of policy elaboration and implementation (including the real impact of the public debate procedures), along with the excessive bureaucracy for compliance, the lack of subsidies and bottlenecks in the communication from and with the authorities. The workshop also revealed the impact of the obligation to use expert advice at high costs for the elaboration of environmental approval documents required by the national legislation.

**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?**

Besides participating in conferences and symposiums regarding either forestry or agriculture or both, no 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.

### 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.

### 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.

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.

### 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 A?**

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.

## 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.

### 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.

### 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. 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. 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.

**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.

### 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, 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.

**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.

## 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 local 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, based on the misconception that citizen science data is not trustworthy, and doesn't 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 2: 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 selected regulations are European obligations of the Member States to monitor the environmental quality of the coastal ecosystem. The Barcelona LL won't deal with legal disputes or infringements. It will focus on data collection and harmonisation to support the integration of citizen science data into the mandatory obligation of the MSFD and the local regulation on no smoking beaches.

**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 won't deal with the court in terms of litigation and citizen science, it will be dedicated to environmental compliance for official monitoring programme.

**Phase 3: 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.)?**

BCN LL held meetings with citizen science stakeholders and local government, who agreed to explore how citizen science data could be incorporated into their follow-up.

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

No

**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 includes collaboration with the local administration, so any potential issues will be addressed in partnership.

### 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. Currently, a series of individual follow-up meetings are being held with key stakeholders to deepen engagement and explore specific areas of interest.

**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.

### 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<br>Waste framework directive | MSFD - state of art of the descriptor D10<br>Waste framework directive<br>Directive SUP | MSFD - state of art of the descriptor D10<br>Waste framework directive<br>Packaging and packaging waste<br>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<br>Royal Decree 1093/2024, of 22 October. Waste management of filtered tobacco products and filters placed on the market for use with single-use plastic- | Royal Decree 715/2012, of 20 April. Interministerial Maritime Strategy Commission<br>Law 7/2022, of 8 April. Waste and contaminated land for a circular economy |

| | | | |
|---|---|---|---|
| | | containing tobacco products. | |
| **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<br><br>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. 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:**
The community of practice in Barcelona has a well-established focus on biodiversity, while efforts to build a similar network for marine litter monitoring are still in development. To support this, the first stakeholder workshop is planned for the end of March 2025. This workshop will use a co-creative approach to define a strategic plan for the Living Lab, encouraging active collaboration between scientists, local authorities, NGOs, and community members. 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.

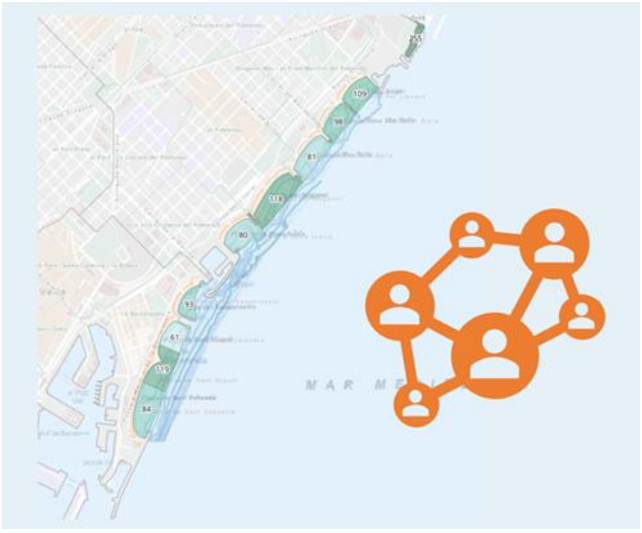


*Figure 8: Conceptual framework Living Lab of Barcelona- Network of groups of organizations monitoring in 10 beaches of BCN*

**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.

### 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 BioDiverCity and 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 BioDiverCity, 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 - 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).

## 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 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 our case study, we are not intending to encourage citizen scientists to directly engage with regulatory authorities. 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. 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 alerting 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**

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 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.

### 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 Partnerships—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 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 and representatives of aligned initiatives like the CaSTCo project. 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.

### 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 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 broad spatial distribution and high density in certain catchments. This data source offers significant coverage but may lack the 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 animals), 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.

### 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 sensing, 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.

## 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 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**

This activity is not started yet.

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

This activity is not started yet.

**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.)?**

In this phase we do not face any policy issue but we already collected some.

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

The first policy issue we will face should be the municipality difficulties in collecting and organizing data. The second one will be the identification of real actors involved in the illegal dumpling in the different areas.

**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.

### 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 Biodistrict of the Blades. 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 will guide future planning and ensure responsiveness to stakeholder priorities. A follow-up meeting is scheduled for June 2025 to deepen collaboration and refine the Living Lab approach based on emerging insights.

### 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.

### 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 guides, 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.

**Process i: KPI tracking, Impact Assessment & Data Management**

**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).

## 4.7 Amsterdam, 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 a handful of meetings with citizens who have experience with environmental legislation. 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 only work so far for this specific topic has been desk research into both scientific and grey literature.

**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 only included desk research into the court cases to identify admissible evidence. However, 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 CZ 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.)?**

We have not yet encountered real policy issues ourselves. A slight issue is connecting with policymakers.

**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.

There is also a fear that the current government is aiming to make starting an environmental case more difficult. Mainly through questioning the stake of the NGO or citizen group in question. This is luckily not yet in place but something to monitor.

**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.

### 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.

**Stakeholder Engagement Efforts:**

To build momentum and foster collaboration, the team initiated meetings with citizen-led initiatives relevant to the project's goals. Outreach was also extended to various environmental organisations, 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:**

Looking ahead, the team plans to continue its engagement with citizen-led initiatives and facilitate data analysis and policy co-creation workshops, bringing together a wide range of stakeholders. Efforts will also be made to expand collaboration with policymakers and individuals involved in the policy development process to strengthen the relevance and applicability of the Living Lab's outcomes. In addition, further discussions with the RIVM are planned to explore the calibration and validation of citizen-generated sensor data, assessing its compatibility with professional equipment and potential use as indicators or supplementary evidence in official monitoring systems.

### 4.7.3 Data and Tools Action Plan

**The needs of the case study**

Air quality data typically includes concentrations of particulate matter (PM) such as PM10, PM2.5, and PM0.1, as well as nitrogen dioxide (NO2) and ammonia (NH3), all measured in $\mu g/m^3$. Additionally, temperature (°C), humidity (%), wind direction, and wind speed are monitored, with the latter parameters often sourced from national meteorological agencies.

Water quality measurements, which may also be of interest, can include electrical conductivity (µS/cm), pH, salinity, water clarity (e.g., Secchi depth), nitrogen and phosphorus concentrations (mg/L), oxygen saturation (%), and temperature (°C).

Finally, biodiversity data is also relevant, 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 air quality data ecosystem consists of a network of over 150 active street-level sensors distributed across various municipalities. These sensors primarily measure PM2.5 concentrations and provide localized, real-time air quality information. Additionally, a comprehensive national database is maintained by the RIVM, which is freely accessible and serves as a critical reference point for validating sensor data.

Ongoing efforts include short-term comparative analyses to assess the accuracy and reliability of these distributed sensors, ensuring they collectively provide a realistic assessment of air quality across the Netherlands. In parallel, collaboration with citizens and government data analysts has focused on validating

these local sensors by cross-referencing their readings with those from official monitoring stations, further enhancing data quality and confidence.

**The barriers to effective data collection and usage:**

Several challenges currently limit the effectiveness of data collection and usage in air quality monitoring. First, achieving standardization in measurement methods becomes increasingly difficult as the number of participants grows. Large-scale, community-based data collection efforts often involve diverse sensor types, varying levels of technical expertise, and inconsistent calibration practices, all of which can compromise data reliability. Ideally, sensors should be carefully calibrated by manufacturers prior to deployment, but this is not always the case, leading to the need for time-consuming, project-specific recalibration. This step is crucial, as some sensor models may produce data spikes due to design sensitivities, such as improper airflow or susceptibility to environmental factors. Automating data correction and error checking could significantly improve data quality, reducing the manual burden on project teams.

Second, effective data usage requires rigorous validation, cross-referencing, and correction before the data can be considered reliable by both the public and the scientific community. This includes aligning data formats from multiple sources, which often conflict and require significant preprocessing before meaningful insights can be extracted. Moreover, maintaining accurate metadata is essential to ensure transparency and contextual understanding of the measurements, yet this can be challenging when integrating diverse data streams.

Finally, data ownership presents another barrier. In many cases, raw sensor data is first transmitted to the manufacturer, who then releases a corrected version for public use. However, this approach restricts access to unprocessed data, limiting the ability to fully validate and interpret the measurements independently, which can reduce trust and limit scientific scrutiny.

**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. Citizens have actively used air quality data as a basis for discussions about local environmental trends, both among themselves and in dialogue with municipal representatives. In one notable example, a resident successfully demonstrated the impact of secondhand smoke from nearby pubs and clubs on his balcony air quality, prompting local businesses to address the issue and increasing awareness of this overlooked problem.

Municipalities, while less actively involved, have begun using the data to identify areas that may require more intensive monitoring, supporting more targeted environmental interventions.

Additionally, environmental agencies have utilized portions of the data for larger studies, including cross-referencing it with official monitoring equipment to assess data accuracy. One agency is also using the data

as part of a pilot project aimed at identifying and locating sources of wood burning, further demonstrating the potential for integrating citizen-generated data into professional environmental management efforts.

**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 the RIVM, will be prioritized. These collaborations aim to calibrate and validate data from low-cost, widely distributed citizen sensors, ensuring they can complement the more precise but less numerous professional measurement stations currently used by regulators. 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, and municipal or provincial governments.

Citizens typically require anonymized data without precise GPS tracking 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.

Municipal and provincial governments often have the strictest privacy requirements, favoring data minimalization to prevent any potential identification of individuals. Given that public data requests can require full disclosure, these bodies aim to avoid collecting personally identifiable information to reduce legal and reputational risks.

### 4.7.4 Impact, Exploitation, Dissemination and Communication and Capacity building Action Plan

In Amsterdam's peri-urban agricultural zones, biodiversity monitoring is being strengthened through citizen-led data collection, participatory mapping, and ecological storytelling, all with a strong focus on community co-creation. 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 Amsterdam during Phase A?**

The communication objectives focus on raising awareness about current environmental issues, the ecological state of peri-urban areas, and the directives and legislation that can be used to support biodiversity 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, environmental organizations and NGOs, local governmental bodies such as municipalities, Omgevingsdiensten, provinces, and national research institutions like RIVM. 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 general 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 local data collection and community-driven 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 the province of North Holland, and a public-facing citizen science table was hosted at a local museum. 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 skepticism around the reliability of citizen sensing tools. 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.

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

Data collected so far includes the number of active sensors in use and some participant feedback. 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 working sensors deployed.
4. Number of natural areas mapped through citizen measurements.
5. Achievement of at least one concrete example where policy is created or changed using citizen-generated data.
6. 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 open data repositories and dashboards, including the Hollandse Luchten interactive map and data platform, as well as the Samen Meten database and map from RIVM. The RIVM provides occasional calibration to ensure data accuracy, while residents routinely monitor sensors for anomalies, such as unexplained spikes or inactivity. The team is still working on determining the best way to share this data effectively for integration into the KPI dashboard under Milestone MS2.

## 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

### 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.

### 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.

### 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.

# 5. Case Studies Monitoring

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"**—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 laid the groundwork for coordinated action across the eight ENFORCE CSs by presenting an initial roadmap that combines strategic planning with practical implementation. It brought together four central action plans – Legislation and Policy, Living Labs, Data and Tools, and Impact and Capacity Building – to ensure a consistent approach across all CSs, while still allowing for local flexibility and adaptation. Each action plan addresses a different but interconnected aspect of environmental compliance.

The Legislation and Policy plan helps define the legal basis for using citizen science data, identifying barriers and exploring how such data could be integrated into official procedures. Although the legal contexts differ across the CSs, the shared focus is on aligning local efforts with broader regulatory frameworks and enhancing the credibility of citizen-contributed information. The Living Labs plan focuses on participatory methods and co-creation, encouraging collaboration among citizens, institutions, and researchers. These labs are designed to support ongoing feedback, stakeholder involvement, and locally adapted innovation, helping ensure that environmental monitoring and compliance efforts are grounded in real-world needs. The Data and Tools plan addresses the technical infrastructure needed to support citizen science, including data collection, validation, and integration processes. It emphasizes the use of digital platforms, AI-enabled tools, and geospatial technologies, as well as the application of the DRL framework to ensure that data meets the necessary standards for policy and enforcement use. The Impact and Capacity Building plan focuses on equipping stakeholders with the knowledge, skills, and networks needed to support long-term environmental compliance. This includes training and awareness activities, along with strategies to embed citizen participation into formal governance structures and promote lasting community involvement.

A key feature of this deliverable is its adaptive nature. As a living document, it will continue to evolve throughout the project lifecycle, incorporating feedback, tracking progress, and adjusting strategies as needed. The inclusion of monitoring frameworks, performance indicators, and early-stage actions provides a strong foundation for consistent evaluation.
Preliminary results from the CSs based on which this initial CSs roadmap was established indicated:

The **Valle Galeria CS** (CS#1) carried out legal mapping and stakeholder analysis to understand environmental policy gaps and assess how citizen-generated data can be recognized in regulatory and legal contexts. A LL was established through partnerships with local institutions and residents, aiming to co-design monitoring tools, legal actions, and communication strategies based on civic data. Efforts also focused on improving data quality, building community capacity, and enhancing transparency, with targeted activities in environmental education, advocacy, and participatory governance.

The **Brasov CS** (CS#2) began with a legal and policy mapping process focused on Romania's forest governance and the role of citizen participation, identifying key legislative gaps, barriers to civic data use, and complex institutional frameworks. Early stakeholder engagement laid the groundwork for a LL, with strong interest from local actors in improving forest monitoring through participatory approaches and digital tools like the Forest Inspector app. Moving

forward, the case study aims to integrate citizen science with official data systems to enhance transparency, support compliance, and build trust among communities, institutions, and enforcement bodies.

The **Crete CS** (CS#3) builds on the LIFE Natura Themis project to strengthen environmental compliance through citizen reporting, legal empowerment, and improved use of digital tools. Legal and policy reviews, stakeholder engagement, and mobile application development aim to support enforcement against illegal land clearing, while addressing challenges such as fragmented legislation, limited institutional capacity, and citizen hesitancy. By enhancing the Themis app, promoting data integration with ENFORCE systems, and building trust among legal, civic, and environmental actors, the project seeks to improve detection, response, and accountability in protected areas.

The **Barcelona CS** (CS#4) focuses on integrating citizen science data into official coastal monitoring efforts, particularly for biodiversity and marine litter, in alignment with EU and local environmental regulations. Through strong collaboration with local authorities and NGOs, the LL promotes co-creation, stakeholder engagement, and the use of digital platforms like MINKA to collect and visualize data on issues such as wet wipes and cigarette butts. The main goal is to improve data harmonization, increase public participation, and support evidence-based compliance with marine environmental policies.

The **East Devon CS** (CS#5) focuses on improving water quality by integrating citizen science and remote sensing data into catchment management through collaboration with the Environment Agency and other stakeholders. While not pursuing legal enforcement directly, the project works to increase the regulatory value of citizen-generated evidence by enhancing data quality, standardization, and integration via tools like Cartographer and AI-based analysis. Communication remains carefully targeted to maintain trust with volunteers and landowners, supporting broader goals of collaborative environmental compliance and policy influence.
The **Puglia CS** (CS#6) addresses illegal waste dumping and open burning in rural areas by engaging municipalities, waste companies, and citizens through a LL focused on co-creating prevention strategies. Initial efforts included interviews with local authorities, mapping stakeholder networks, and gathering baseline data on environmental violations and awareness campaigns. As data tools and citizen science methods are developed, the project will aim to improve monitoring, support policy actions, and build trust and capacity among local actors to ensure long-term environmental compliance.

The **Amsterdam CS** (CS#7) explores how citizen-generated air quality data can support environmental compliance, focusing on participatory sensing, community engagement, and regulatory collaboration. Early efforts include sensor calibration, data validation, and outreach to stakeholders such as policymakers, environmental agencies, and local communities to build trust and align data with regulatory needs. The project aims to bridge grassroots environmental monitoring with institutional processes, ensuring citizen data is usable in decision-making and potentially influences future policy design.

The **Flanders CS** (CS#8) addresses PFAS contamination in soil and agriculture by combining citizen science, phytoremediation trials, and stakeholder collaboration. Early actions have included soil sampling, farmer outreach, and regulatory research, revealing gaps in both legal

thresholds and the integration of citizen-collected data. The project aims to inform effective remediation strategies and promote data-driven environmental policies by generating open, validated evidence through participatory research.

In summary, this Deliverable offers both a shared strategic guide and a flexible working tool. It supports collaboration across the ENFORCE project while enabling tailored approaches within each case study. As the project advances, the roadmap will be refined to support the implementation, validation, and scaling of citizen science in environmental enforcement 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**<br>Lucie Greyl, luciegreyl@asud.net<br>Sara Vegni, saravegni@asud.net | |
| **CS#2 Brasov, Central RO** | **NIRDF, BDG**<br>Nicu Tudose, cntudose@yahoo.com<br>Mirabela Marin, mirabelamarin@yahoo.com<br>Cezar Ungurean, ucezar@yahoo.com<br>Florentina Nanu, florentina.nanu@bdgind.ro | |
| **CS#3 Crete, EL** | Michalis Probonas, mprobonas@gmail.com<br>Christos Georgiadis, cgeorgiadis@gmail.com | |
| **CS#4 Barcelona Urban Beaches, Barcelona, ES** | **CSIC**<br>Vanessa-Sarah Salvo, vsalvo@icm.csic.es<br>Jaume Piera jpiera@icm.csic.es | |
| **CS#5 East Devon Catchment, UK** | **WRT, UNEXE**<br>Francis Rowney, francisrowney@wrt.org.uk<br>Annabel Martin, annabel@wrt.org.uk<br>emilywiddecombe@wrt.org.uk<br>Nicola Rogers, nicolarogers@wrt.org.uk<br>Yog Watkins, yog@wrt.org.uk<br>Mehdi Khoury, M.Khoury@exeter.ac.uk<br>Gareth Lewis, G.Lewis2@exeter.ac.uk<br>Lydia Vamvakeridou-Lyroudia, L.S.Vamvakeridou-Lyroudia@exeter.ac.uk | |
| **CS#6 Puglia Region, IT** | **CIHEAM**<br>Lorenzo Labellarte, (l.labellarte@iamb.it) | |

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| | Francesco Notarangelo, (notarangelo@iamb.it)<br>Linda See, see@iiasa.ac.at | |
| **CS#7 Amsterdam, NL** | **WAAG**<br>annew@waag.org ;<br>isayvani.naicker@evisights.com | |
| **CS#8 Flanders Region, BE** | **HU**<br>Ifigeneia Tsakalogianni, i.tsakalogianni@gmail.com<br>Sofie Thijs<br>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**<br>Anna Berti Suman annabertisuman@asud.net<br>Lucie Greyl luciegreyl@asud.net<br>Spela Zalocar, spela.zalokar@enoll.org<br>Noemi Caiazzo, noemi.caiazzo@enoll.org | |
| **WP3 - ENFORCE Plaza Tools Development (SLG)** | **SLG**<br>Sotiris Aspragkathos, saspragkathos@singularlogic.eu | |
| **WP5 - User uptake & capacity building and Policy recommendation** | **EARSC, ECSA**<br>Leon Wiesner, leon.wiesner@earsc.org<br>Leo Mensel leo.mensel@ecsa.ngo<br>Paul Sorrell paul.sorrell@ecsa.ngo | |
| **WP6 - Impact Maximization C&D&E** | **GAC, AMRN**<br>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 |
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| ***Case Study [#1]*** ***Leading Partner: [A Sud]*** ***Leading Person: [Sara Vegni]*** ***Participants: Waag, EVI*** | Name: Valle Galeria in Rome<br>Biogeographical Region: Mediterranean (reference)<br><br>Type [Urban/ Rural etc.)<br>Urban<br>Area [in km2]: 54 km2<br>  | 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 | 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 | 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)<br>- Local residents and community groups<br>- Municipality of Rome<br>- Lazio Regional Government<br>- Environmental protection agencies (ARPA Lazio, ISPRA)<br>- Companies involved in waste and fuel storage<br>- Journalists, lawyers, scientists, and public health advocates | - Lack of access to environmental data and technical documentation;<br>- Absence of effective, accessible mechanisms for public participation;<br>- Distrust between citizens and institutions;<br>- Legal complexity and slow litigation processes;<br>- Discontinuity in institutional action and shifting political will;<br>- Stigmatization of the area as a "sacrifice zone". | - Integrated monitoring strategy combining citizen science, legal advocacy, and institutional dialogue;<br>- Deployment of monitoring tools (air sensors, water and soil sampling, remote sensing for biogas);<br>- Co-designed policy demands and formal observations to public authorities;<br>- Strengthening of an autonomous, community-based observatory on environmental remediation;<br>- Institutional uptake of civic- |

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| | | marginal, often treated as a dumping ground 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.. | nearby waste treatment plant highlighted the area's vulnerability a…<br>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. | | | | generated data and practices. |

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| *Case Study [#2]*<br>*Leading Partner: [NIRDF]*<br>*Leading Person: [Nicu Tudose]* | Name: Brasov, Romania<br><br>Biogeographical Region: Mediterranean (reference)<br><br>Type [Urban/ Rural etc.): Urban<br><br>Area [in km2]: 186.9 km2<br><br>Map [image]: harta_BV.jpg | According to the 2021 census, with 237,589 inhabitants, Brașov is the 6th most populous city in Romania. CS is located in the 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 | 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 legislation, in the territory;<br>2) Private-public property based conflicts in complying with environmental legislation;<br>3) Difficult process in accessing funds for forestry conservation, resilience and recovery<br>4) Divergent legislation across sectors (water management, agriculture, local development, etc.);<br>5)Strengthening communication with stakeholders in relation with environmental compliance in the context of climate change challenges;<br>6) Non-compliance with wood | ) Transilvania University, Brasov;<br>2) Municipality of Brasov;<br>3) Environmental Forestry Guard;<br>4) Stefan Cel Mare University, Suceava;<br>5) Agency for Environmental Protection Brasov;<br>6) Community groups Brasov;<br>7) County Council Brasov. | 1) Transparency in public-citizen dialogue and cooperation on data and forestry knowledge;<br>2) Insufficient capacity of ''forestry staff'' (public, private) and informed citizens for new partnerships and protocols for enhanced awareness about forest;<br>3) Lack of clear legislation;<br>4) Degradation of environment/forests local culture for better forest management;<br>5) Increasing political influences in considering forests as a leverage topic in a complicated international context (post COVID-19, Ukraine | 1) Living lab to connect different DSSs, facilitate open dialogue, knowledge sharing and collaborative learning for improved data accessibility and governance, connecting to innovation within the one-stop-shop facilitated by the project and the European Green Deal Data Space;<br>2) Train–the-trainer sessions and (1) tailored guidelines/best practices (digital) tool for upscale and dissemination. |

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| | | 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 four natural reserves on the territory of the municipality. | | exploitation periods across the year in relation with current regulation. | | war, energy crisis, etc.). | |
| *Case Study #3*<br><br>*Leading Partner: UoC*<br><br>*Leading Person:*<br><br>*Michalis Probonas, mprobonas@uoc.gr* | Name: Land clearing in the Regional Unit of Heraklion, Crete, Greece<br><br>Biogeographical Region: Mediterranean (reference)<br><br>Type [Urban/ Rural etc.): Urban / Rural<br><br>Area [in km2]: 2,643 km2<br><br>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 | 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 | 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 |

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| | | variety of landscapes enjoyed by the 610,000 inhabitants and around 3 million visitors each year. | 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 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 | | | | investigated and registered in project's database |

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| | | | administrative authorities communication, and e) citizen and administrative clerks' technical guides. | | | | |
| *Case Study [#4]*<br><br>*Leading Partner: [CSIC]*<br><br>*Leading Person: [Jaume Piera/Vanessa Sarah Salvo]* | Biogeographical Region (reference)<br><br>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)<br><br>Type [Urban/ Rural etc.)<br><br>Urban<br><br>Area [in km2]<br><br>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)<br><br>Map [image] | 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 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 | Anthropic pressure (Transports, Tourism, Urbanization/Infra structure)<br><br>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); Fishermen's association | 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 and are very few and not formally included.<br><br>The lack of a clear definition of the citizen science data validation processes to certify the level of quality of the data.<br><br>The lack of a clear definition to assess | Establish dialogues with different public administrations (EU, national and local) to formally integrate citizen science into official monitoring programmes (B1).<br>Support the improvement of validation processes through guidelines and recommendations in synergy with other projects e.g. MBM-CINEA (B2).<br>Establish the EC DRL model for the maturity of citizen science data used for environmental compliance (B2; B3).<br>Consolidate the LL in BCN as a citizen observatory in collaboration with the local administration to |

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| | BCN coastline 3D map (Strategic plan for the coastline of the city 2018-28) | 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 cigarette butts pollution | | | | the maturity of the citizen science data related to the specific use of the ENFORCE project (environmental compliance). | support the environmental compliance |
| *Case Study #5*<br><br>*Leading Partner: Westcountry Rivers Trust (WRT)*<br><br>*Leading Person: Francis Rowney, Nicola* | Name: East Devon Catchment, UK<br><br>Biogeographical Region: Atlantic (reference) | 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. | Only 1 in 5 Rivers in the Westcountry meet good ecological standards set out in the Water Framework Directive (WFD) and most failures | Sources of diffuse pollution are inherently challenging to identify. This means that it can be difficult to ascribe responsibility for | Environment Agency (Environmental Regulator); National Government (DEFRA), Local Government; Agricultural | There has been pressure on regulatory bodies (Environment Agency) to reduce enforcements (due to budgetary constraints) or ignore third party | Increase in the amount of Citizen Science Data including community analysis (>20 volunteers/annual samples; 2 x WRT citizen science |

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| *Rogers, Annabel Martin* | Type [Urban/ Rural etc.)<br><br>Rural<br><br>Area [in km2]: Total area of East Devon river catchments: 2266 km2. Focus study areas (Creedy and West Exe; Lim and Axe): 854 km2<br><br>Map<br><br>  | 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. | 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). | 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 triaging and can be used to direct regulatory resources (see below). | Landowners (diffuse and point source pollution); Water Company (point source pollution); Civil society (via the East Devon Catchment Partnership | 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. | 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 application (3 x Living Lab Workshops & 4 x data sharing/evidence exchanges) |

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| *Case Study [#6]*<br><br>*Leading Partner: CIHEAM Bari*<br><br>*Leading Person: Francesco Notarangelo* | Name:<br><br>Waste reduction in Apulia Region<br><br>Biogeographical Region:(reference)<br><br>Mediterranean<br><br>Type [Urban/ Rural etc.)<br><br>Rural<br><br>Area [in km2]:<br><br>The territory covers 398km2 and comprises two municipalities, Ruvo di Puglia and Bitonto | 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 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, | 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 illicit fires (usually set to burn stubble or waste difficult to dispose of). | 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. |

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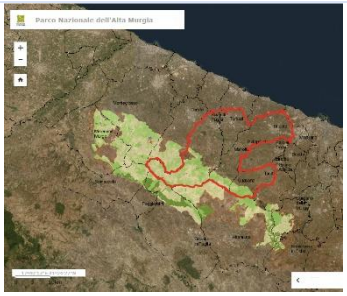
| |  | furrowed by limestone hemlocks, between the inland Murgia uplands and the Adriatic coastal strip. The landscape represents a perfect synthesis of the interaction between the physical (climate, geomorphology, etc.) and cultural elements of the land (distribution of plant crops, infrastructure, etc.) resulting from a millennia-long synergy and combination of natural and anthropogenic processes. | | | | | |
| *Case Study [#7]*<br><br>*Leading Partner: Waag Futurelab*<br><br>*Leading Person: Anne Wijnen, Nehis Osagie* | Name: Amsterdam<br><br>Biogeographical Region: the Netherlands<br><br>Type [Urban/ Rural etc.): Urban / Rural<br><br>Area [in km2]: TBD | the Netherlands consists of urban-industrial parts interspersed with rural landscapes and small nature areas. As one of the most densely | biodiversity in most of the Netherlands is under pressure, air quality improvements are stagnant and the | The protected nature areas (Natura 2000) in the Netherlands are heavily polluted and biodiversity in the Netherlands is in a poor state. This | 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 |

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| | Map [image]: TBD | 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. | soil and water are heavily polluted. | 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 that the Netherlands has to decrease the nitrogen pollution, | | | 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 |

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| | | | | which sparked many farmer protests and difficult policy debate. Another concern is the impact of pesticides on natural and human health. | | | |
| *Case Study [#8]*<br><br>*Leading Partner: UHasselt*<br><br>*Leading Person: Steven van Garsse, Sofie Thijs, Ifigeneia Tsakalogianni* | Name: Soil Pollutant Bioavailability Assessment in Flanders<br><br>Biogeographical Region: Atlantic (reference)<br><br>Type [Urban/ Rural etc.)<br><br>Agriculture<br><br>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:<br><br>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<br><br>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)<br><br>Costs for implementing phytoremediation carried by 3M |

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| |  | 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.<br><br>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.<br><br>Biodiversity and Ecological Harm: The pollution of | using phytoremediation at a larger scale .<br><br>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.<br><br>Agro-Industry and companies: 3M (Zwijndrecht): As the primary industrial stakeholder, 3M's operations have | | |

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| | | | | areas like the Blokkersdijk nature reserve compromises ecological integrity, violating biodiversity protection laws. PFAS exposure poses risks to wildlife, leading to potential breaches of regulations on habitat and species conservation.<br><br>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 | contributed to the PFAS contamination in the region. They 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.<br><br>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 | | |

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| | | | | practical and regulatory constraints, especially under waste management laws and policies governing hazardous substances. | evaluating contamination levels and advising on effective remediation strategies, particularly in relation to the PFAS pollution near the 3M facility.<br><br>Local and regional authorities:<br><br>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. | | |

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| | | | | | 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.<br><br>Environmental Organizations:<br><br>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 | | |

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| | | | | | provide expertise on managing natural areas during remediation processes and collaborate to preserve biodiversity while ensuring soil recovery.<br><br>Research and Technical Expertise:<br><br>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 | | |

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| | | | | | expertise in designing and evaluating phytoremediation strategies<br><br>Stakeholder Platforms and Networks:<br><br>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/) | | |

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| | | | | | 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 .<br><br>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 | | |

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| | | | | | 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.<br><br>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 | | |

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# Enforce

Empowering Citizens for Environmental Action

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