Developing metrics and instruments to evaluate citizen science impacts on the environment and society

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Abstract (for dissemination)	Deliverable D4.5 provides a description and evaluation of the findings on the impact of citizen science in the case study sites. The MICS impact assessment approach was applied to the five MICS case study sites across Europe, each of which have differing levels of citizen science engagement and approaches to environmental management. The case study are: (i) Outfall Safari (UK): aims to use citizen science to detect and record pollution from surface water outfalls to gather evidence and

	report on pollution incidents; (ii) Riverfly Monitoring (UK): aims to monitor key macroinvertebrate species (riverflies) that are indicators of river water quality; (iii) Marzenego River NBS Project (Italy): aims to establish a monitoring program to gauge the effectives of NBS implemented within the Marzenego River catchment; (iv) The Creek Rákos Citizen Science project (Hungary): aims to use citizen science as a means of establishing the baseline condition of the Creek to identify suitable sites for restoration and promote public support for NBS; and, (v) The Carasuhat Wetland NBS Project (Romania): aims to establish a monitoring programme to gauge the effectives of wetland NBS implemented in the Danube Delta.
Keywords	Citizen science, impact assessment, Nature Based Solutions (NBS), Outfall Safari, Riverfly monitoring, Marzenego River NBS Project, Creek Rákos Citizen Science Project, Carasuhat Wetland NBS Project, co-design

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Contents

Acronyms

ARMI	Anglers' Riverfly Monitoring Initiative
ARPAV	Agenzia regionale per la protezione ambientale / Regional Agency for Environmental Protection and Prevention of Veneto
CaBA	Catchment Based Approach
CSIA	Citizen Science Impact Assessment
DDBRA	Danube Delta Biosphere Reserve Administration
EA	Environment Agency

FWAG	Farming and Wildlife Advisory Group
FWW	FreshWater Watch
IA	Impact Assessment
IJM	Impact Journey Map
IMS	Impact Monitoring Strategy
LCSP	Lincolnshire Chalk Stream Project
MBKT	Magyar Biodiverzitás-kutató Társaság / Hungarian Biodiversity Research Society
NBS	Nature Based Solution
NGO	Non-Governmental Organisation
PMEL	Planning, Monitoring, Evaluation and Learning
PSWO	Polluting Surface Water Outfall
RP	Riverfly Partnership
SAC	Special Area of Conservation
SCI	Site of Community Importance
SWOP	Surface Water Outfall Program
SWT	Surrey Wildlife Trust
SWO	Surface Water Outfall
ToC	Theory of Change
UNESCO	The United Nations Educational, Scientific and Cultural Organisation
UK	United Kingdom
WFD	Water Framework Directive
WILD	Water with Integrated Local Delivery
WP	Work Package
WRT	Westcountry Rivers Trust
WWF	World Wide Fund for Nature
ZSL	Zoological Society London

Executive Summary

The MICS project has developed approaches and tools to assess citizen-science impacts across five domains: society, environment, economy, science and technology, and governance. These approaches and tools can help to plan and implement projects in ways that lead to more effective citizen science.

Five case-study sites (two in the UK, and one in Italy, Hungary, and Romania) explore the applicability of the MICS approaches and tools in regions with differing needs, contexts, and approaches to nature-based solutions (NBS), and with various levels of citizen-science application. The MICS case studies represent different types and stages of water-related NBS implementation, with some activities in the early planning phase, some underway and others already implemented. This report provides a description and evaluation of the process of applying the MICS impact assessment (IA) described in MICS deliverables D2.2, D2.3, and D2.7 to the case studies.

The MICS case studies include two existing contributory citizen-science projects (UK), and three new projects (Italy, Hungary and Romania) that applied the Ground Truth 2.0 co-design light methodology to guide the set-up of citizen-science activities with local communities. Implementation of the co-design process in the 'new project' case studies increased the active involvement of citizens in the design and set-up of activities.

Workshops served as a mechanism to bring stakeholders together, provided a focus for discussion, and helped to develop a common language among partners. This co-design process added value to the citizen-science project development, incorporated local knowledge regarding the specific issues, and fostered a commitment to the activities. Elements of the co-design process can be incorporated into different types of citizen-science project, i.e. contributory or collaborative, at any stage of the project, to help improve the effectiveness of a project.

The MICS IA approach was adapted to accommodate the differing needs and backgrounds of the target audiences. Key stakeholders involved in the case-study sites were engaged through a series of workshops during which they participated in a series of interactive activities designed to present the IA approach in a simple and easy to understand manner. The impact of citizen science was shown to be varied and complex, and to gain a complete understanding of impact required the participation of multiple stakeholder groups to bring differing perspectives and experiences. The IA activities centred on the creation of impact journey maps (IJM) which provided an effective means of visualising the cause-and-effect relationship between strategies, outcomes and impacts for each project.

Impact journey mapping provided the context for focusing on which impact monitoring had the highest priority. Variations were frequently observed between the stakeholder groups as to which impacts were deemed important, which reflect the differing motivations of project participants. Selecting impacts to monitor should therefore include input across the range of stakeholders to ensure a balanced impact monitoring strategy (IMS) that is not overly weighted to the motivations of any one stakeholder group.

The lessons learnt through the case-study activities are influencing the current development of the MICS platform. This platform will provide a means for project coordinators to measure the impact of the citizen-science initiatives they manage. This case-study validation is helping to ensure that the platform addresses the needs and considerations of all stakeholders, and that the MICS IA approach and platform are relevant and applicable in different citizen-science contexts.

Part A: Introduction

1. Background to MICS

The MICS project has developed approaches and tools to assess citizen science impacts. These approaches and tools can help to plan and implement projects in ways that lead to more robust results. The MICS project specifically aims to:

- provide comprehensive, participatory and inclusive metrics and instruments to evaluate citizen science impacts;
- implement an impact-assessment knowledge-base through toolboxes for methods application, information visualisation, and delivery to decision makers, citizens and researchers;
- improve the effectiveness of nature-based solutions through test-site development and citizen-science tool validation;
- generate new approaches that strengthen the role of citizen science in supporting research and development;
- foster a citizen-science approach to increase the extent to which scientific evidence is taken up by policy makers through recommendations and guidelines.

The long-term result will be an integrated platform where these metrics and instruments are available for use by anyone involved in a citizen-science project wanting to understand its impact, whether at the planning stage or several years after the project's conclusion.

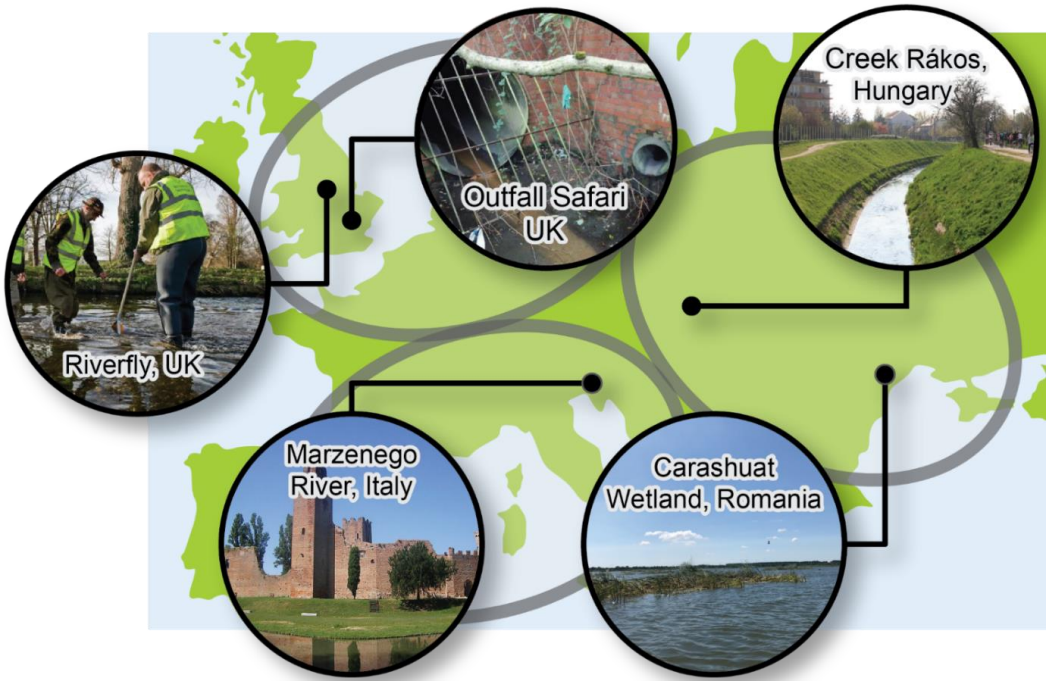


Figure 1. The locations of the MICS case study sites across Europe.

2. WP4 Case Studies: Test-site Development and Tool Validation

The MICS project adopts and adapts the best practice generated by the Ground Truth 2.0 project in the co-design of hands-on citizen science in support of nature-based solutions (NBS), validated in five

case-study sites across Europe. It will result in a comprehensive conceptual framework and clear recommendations for those involved in citizen-science projects.

The five sites (two in the UK, Italy, and one in Hungary and Romania – Figure 1) explore the applicability of MICS impact-assessment tools in regions with differing needs, contexts, and approaches to NBS, and with various levels of citizen-science application outlined in MICS deliverables D4.1, 4.2, 4.3 and 4.4. For example, in Western Europe, river restoration is increasingly carried out within an ecosystem-based management framework at river or catchment scale; in Southern Europe, river restoration tends to be issue-specific with some ecosystem relevance; in Central and Eastern Europe, river restoration is about ecosystem protection and related to existing infrastructure.

The MICS project is tasked with setting up and implementing an impact assessment (IA) framework, tools and metrics for citizen-science projects that serve to capture impacts in five domains: society, science & technology, environment, economy, and governance.

3. Impact Assessment Approach

The MICS impact assessment conceptual framework was developed in Work Package 2 (WP2) – D2.2 (Wehn *et al.,* 2020a), D2.3 (Wehn *et al.,* 2020b) and D2.7 (Wehn *et al.,* 2021); and it is used and applied in WP4. The application of the Impact Assessment conceptual framework involves three main steps (documented in the Citizen Science Impact Assessment (CSIA) Framework compendium, D2.3):

1) **Context analysis** is dedicated to reflecting on the context in which a citizen science project is being established. Identifying pathways of change and articulating desired outcomes and impacts is not possible without a thorough understanding of the context. The context analysis is part of the co-design compendium and involves evaluating each case study's political, environmental, social, and economic boundaries and an analysis of the stakeholders and their interest and influence in the project. This is an important step as it identifies who should be involved in the impact monitoring journeys and develop the impact monitoring strategies.

2) **Design and Validation of a Theory of Change (the 'Impact Journey')** is the most elaborate step in the impact assessment process and focuses on the design of the Theory of Change (also referred to as Impact Journey, or Impact Journey Map (IJM) for ease of communication with stakeholders) for each MICS case study. This step, based on the IA framework (Figure 2), includes the identification of relevant domains of change, expected impacts, and expected outcomes; formulating strategies for achieving desired changes; determining cause and effect relationships; and documenting causal assumptions.

   Impacts broadly define (widespread) changes that occur over a longer period of time which result from an accumulation of outcomes and affect the wider economy and society beyond those directly affected by the intervention. They are strongly influenced by external factors. In contrast, ***outcomes*** capture the immediate changes in a situation, including behavioural changes that result from the intervention ***outputs*** (including intended and unintended, positive and negative changes). Strategies define the various actions that a project needs to take to achieve the desired outcomes and impacts.

   Strategies can include several ***activities***, for example: 'engaging with citizen scientists', 'developing communication links with statutory agencies and local authorities', and 'securing land access permission from landowners' are separate actions that can be said to fall within a single strategy that could be titled 'fostering stakeholder engagement'.

   Impact assessment workshops were developed for each of the MICS case studies; citizen

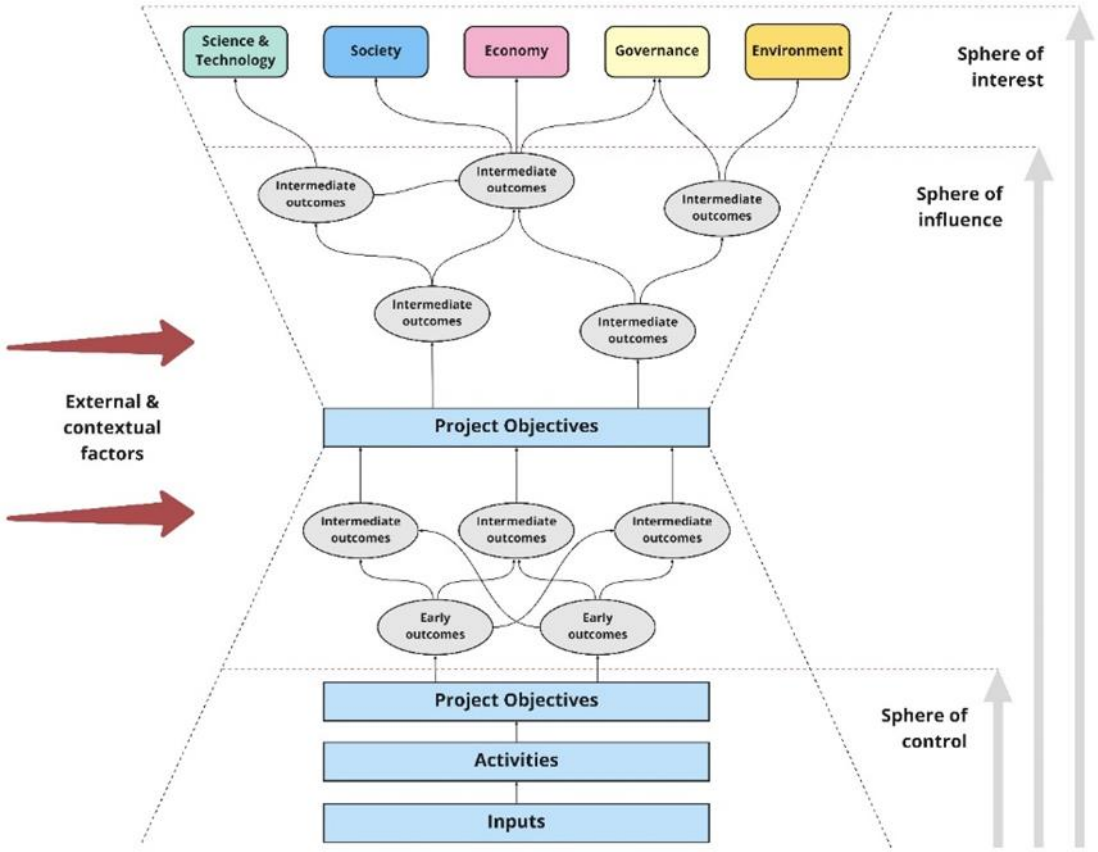


Figure 2. Theory of change elements. Source: MICS D2.3 (Wehn et al., 2020)

scientists, community members, and other stakeholders were invited to these workshops. The workshops involved discussing the impact of the citizen science activities associated with their projects and taking part in a series of IA activities. These activities focused on creating a visual representation of the ToC.

The content and language of material presented to project participants and stakeholders during the workshops was adjusted to help explain the complex concepts of the IA framework and ensure that all those involved understand what is being discussed. This not only promoted a feeling of inclusion but also ensured constructive discussion and feedback. Terminology and definitions within the IA framework that were adjusted to better suit the target audience, included:

- ToC: during the workshop, this term was avoided and instead participants were asked to 'investigate impact'.
- Visual ToC was retitled as IJM
- Outcomes were re-titled as **short-term impacts**, and a time element was added to the definition: changes over a short time period of **<3 years**.
- Impacts were re-titled as **long-term impacts**, and a time element was added to the definition: changes over a longer time period of **>3 years**.
- Planning, Monitoring, Evaluation and Learning (PMEL) was re-titled as Impact Monitoring Strategy (IMS)

The terminology and definitions above are used in this report from this point forward.

Using the impact assessment framework, impacts, outcomes, and strategies were identified for each of the case studies, and a visual representation of the ToC (IJM) was created. The visualisation of the ToC during the stakeholder meetings provided an effective means of showing the cause-and-effect relationship between strategies, outcomes and impacts for a given project. The impact assessment workshops and processing of the outputs were developed for each case study, reflecting and building on experience gained within the previous workshops; in Part C we reflect on this experience and provide advice to take forward or apply in other case studies.

3) **PMEL** focuses on developing a practical and flexible plan for monitoring and evaluation of citizen science impact, based on the indicators of the MICS conceptual framework. PMEL is referred to as IMS for ease of communication with stakeholders.

4. Purpose of this Report

This report is a comprehensive evaluation of WP4 – 'Test-site (case study) development and tool validation', which developed and organised the pilot testing of the MICS IA approach and tools in the case study sites in the UK, Hungary, Romania, and Italy. This report builds on the setting up of citizen science activities within the case studies reported in MICS deliverables D4.1, 4.2, 4.3, 4.4 and 4.6.

5. Structure of Report

Part A (Section 1) of the report briefly outlines the case studies and the impact assessment approach, the report structure and the evaluation methods.

Part B of the report details the application of the IA approach for each of the five case study sites (Sections 2 - 6) that are reported fully in the Deliverable 4.1 to 4.4 'reports on pilot testing'.

Sections 2 and 3 report and evaluate the two existing contributory citizen science projects (UK), detailing:

- Analysis of the project context,
- Impact assessment workshop(s)
- Impact monitoring strategy workshop
- Evaluation of the IA approach for that case study

Sections 4, 5, and 6 report and evaluate the three new projects (Italy, Hungary and Romania) that applied the Ground Truth 2.0 co-design light methodology (Deliverable 4.6) to 'guidance of co-design of citizen science' activities with local communities. These detail:

- Previous citizen science
- Co-design of a citizen science programme
- Citizen science activities and events
- Impact assessment workshop(s)
- Impact monitoring strategy
- Evaluation of the Co-design and IA approach for that case study

Part C (Section 7 and 8) summarises the key findings of this work and how it feeds into the ongoing and future development of the MICS impact platform.

6. Evaluation Method

For each of the case studies evaluation was undertaken at key stages during the application of the IA approach, through the mechanism of informal reflection amongst the MICS team. This led to revisions and adaptations of the approach for subsequent application. The stages at which evaluations occurred were:

- **Context analysis**: Review project material including previous MICS deliverables describing the case study sites, the NBS project, and set up of citizen science therein (i.e. Report on Pilot Testing in Western, Southern, Central and Eastern Europe – deliverable D4.1, D4.2, D4.3 and D4.4 respectively) with the case study leads/project coordinators to:
    1) Gain an understanding of the context of the project to help inform how best to apply the IA approach.
    2) Identify potential difficult stakeholder relationships.
    3) Ensure representatives from the relevant stakeholder groups take part in the IA process.
    4) Gain an understanding of the assumptions and causal relationships that are central to the ToC.
- **Development of the IJM**: Review the contextual analysis of the project with the WP4 leads, case study leads/project coordinators, and WP2 to:
    1) Ensure the IJM is consistent with the assumptions and causal relationships identified in the contextual analysis
    2) Ensure any edits to the IJM are logically consistent with stakeholder comments.
    3) Identification of areas/elements of the IJM that require particular attention by stakeholders during the validation process.
- **Impact workshops**: Review of feedback from the workshops by WP4 leads and WP2 to:
    1) Assess the format of the workshop and identify any improvements that could be made for future workshops.
    2) Assess the delivery of IA activities and identify if alterations are required in their delivery.
    3) Identify if any general comments made by stakeholders are pertinent to the IJM.
    4) Evaluate feedback from participants regarding their understanding of the IA activities, and their views as to how the IA may benefit the project they are involved.
- **Development of the IMS:** Review of the comments and prioritised impacts by WP4 leads and WP2 to:
    1) Develop an IMS based on the impacts that received the highest number of votes from stakeholders.
    2) Ensure the IMS included a range of stakeholders in the impact monitoring activities (not just project coordinators).

3) Identify any issues that may prevent certain impacts from being monitored.

Following the development of the IMS an informal discussion was held with the project coordinator/case study lead and WP2 to:

1) Evaluate whether the developed IMS covered all the targets identified by participants.
2) Evaluate the feasibility of the IMS within the structure and confines of the citizen science project.
3) Identify any support the MICS project could offer the case study in implementing the IMS.

Part B: Case Study Sites Evaluation

This section sets out the activities within the MICS case study sites and the progress with applying the IA approach. Table 1 details the progress made in applying the MICS IA approach to each of the case studies.

Table 1. Progress made in applying the Citizen Science IA approach to the MICS case studies. Coloured columns provide a visual indication of the progress made towards implementation: Green = complete; Orange = in progress; Red = not yet started.

Case Study		**Step 1 Context Analysis**	**Step 2 – Design & Validate ToC / IJM**	**Step 3 – Developing a PMEL / IMS**	**Comments on progress**
UK Case Studies	Riverfly, Lincolnshire Chalk Streams Project	Complete	Complete	Completed – rollout planned	The roll-out of the PMEL is currently underway. MICS team will work to help implementation of PMEL in case study during Spring 2022
	Outfall Safari, Zoological Society London	Complete	Complete	Completed – rollout planned	The roll-out of the PMEL is currently underway. The project managers are keen to implement the scheme. MICS team will work to help implementation of PMEL in case study during Spring 2022
Hungary	Creek Rákos, Geonardo	Complete	Complete	Completed – rollout planned	The roll-out of the PMEL is currently underway. Follow up workshops are to be arranged with stakeholders to discuss the implementation of PMEL in Spring 2022
Italy	Marzenego River, AAWA	Complete	Complete	Incomplete – PMEL in development	The PMEL is still under development and will be finalised in Spring 2022 ahead of the roll-out
Romania	Carasuhat Wetland, GeoEcoMar	Complete	Complete	Incomplete – PMEL in development	The PMEL is still under development and will be finalised in Spring 2022 ahead of the roll-out

In Western Europe region, citizen science activities are a popular method of citizen engagement, stakeholder collaboration, and monitoring data collection. (Tweddle *et al.,* 2012; Vohland *et al.,* 2021). The UK MICS case studies focus on existing citizen science initiatives, including: Outfall Safari and the Riverfly Partnerships (RP) Anglers' Riverfly Monitoring Initiative (ARMI). These case studies are established initiatives that were originally set up as 'contributory' citizen science projects. The UK case studies, therefore, provide the opportunity to compare the different approaches to citizen science activity set up (i.e. contributory, collaborative, or co-design) and how that influences the project impact. Combined, the existing citizen-science initiatives on which the UK case studies focus have

involved over 3000 citizen scientists over the last ten years. A brief overview of the UK case studies, and their activities is provided in this section before a detailed discussion of the application of Steps 1-3 of the citizen science IA approach.

The UK case studies can be split into two groups:

- **Group 1.** Projects in which the IA approach was applied. This included inviting stakeholders involved in these projects to workshops to discuss the impact of their activities and take part in IA activities. For these projects, an in-depth understanding of citizen science impacts was achieved that will enable a comparison to be made with the outputs of the MICS impact platform and applied to other case studies.
- **Group 2.** Projects involved in testing the usability and effectiveness of the MICS impact assessment and platform.

Table 2. Target groups into which the UK case studies were organised, links to further information about the case study and comments on reason why case studies were included in target group 1 or 2. ***Target Group 1 (in bold)*** *followed the detailed process of the Citizen Science IA approach and are included in this report.*

UK Case Citizen Science Projects	Location/ Organisation	Group	Further information	Comments/justification why in group 1 / 2
Outfall Safari	**Greater London, England, Zoological Society London**	**1**	Project Webpage Resource Pack	• Established citizen science method • The method was developed and first applied by the ZSL group in London • Outfall Safari citizen science activities have multiple impacts across all five MICS impact domains
	West Midlands, England, Trent River Trust	2	TRT 2018 audit of PSWO	• Applied method developed by ZSL
Riverfly	**East Midlands, England, Lincolnshire Chalk Stream Project (LCSP)**	**1**	LCSP Riverfly Hub Website	• Established citizen science method • Interaction between project managers and citizen scientists in determining project development • Interesting example of a contributory project that has evolved to become collaborative in nature
	Southeast, England, Surrey Wildlife Trust (SWT)	2	SWT Riverfly Hub Website	• Well established group • Volunteers engaged in contributory citizen science activities - Riverfly ARMI method
	Southwest, England, Westcountry Rivers Trust (WRT)	2	SWT Riverfly Hub Website	• Well established group • Volunteers engaged in contributory citizen science activities - Riverfly ARMI method
	Southwest, England, Farming	2	National Project Webpage	• Group has found it difficult to maintain interest / engagement

	& Wildlife Advisory Group (FWAG)			• This is an opportunity to explore the impact in a case study that has long-standing presence in the community, but people do not necessarily continue with citizen science activities.
Water with Integrated Local Delivery (WILD)	Southwest, England, Farming & Wildlife Advisory Group (FWAG)	2	Project Website	• Citizen science initiative focused on farmers

In Southern Central and Eastern Europe, citizen science is being increasingly used to help tackle environmental issues, but it remains limited in scale. For the Italian, Hungarian and Romanian case studies, there were no existing structured citizen science activities. Instead, the MICS project worked with the local teams to help build new citizen science projects. The Ground Truth 2.0 co-design light methodology (MICS deliverable D4.6, based on Wehn and Pfeiffer, 2020) was adopted and used to guide the set-up of citizen science activities for these case studies. This involved co-design workshops held with citizen scientists and other associated stakeholders. The objectives of the co-design workshops held in each of the case study sites was to build a common understanding of the environmental issues/water related challenges in the case study sites and agree which of these issues and challenges were important and should be monitored.

7. Outfall Safari, London, UK

7.1. Introduction

Outfall Safari is an established citizen science methodology based in the UK that employs citizens to locate and assess urban outfalls and identify pollution. A major threat to water quality in urban rivers is misconnected domestic appliances and the inappropriate disposal of waste. When misconnected pipes are incorrectly plumbed into surface water drains, and they send wastewater directly to rivers where they impact biodiversity and the amenity value of waterways. Yet detecting misconnections is problematic, and sewage pollution often remains a hidden problem. A surface water outfall (SWO) that carries untreated sewage in this way is described as a polluted surface water outfall (PSWO) (Figure 3).

Figure 3. Examples of PSWO and volunteers conducting assessing outfalls during an Outfall Safari survey. From ZSL (2019).

Once a PSWO is identified, it is reported to the EA and Thames Water who investigate the PSWO and work to trace the source of the pollution. The method was developed by the Zoological Society of London (ZSL), in partnership with the EA, Thames Water, the Friends of River Crane Environment, and

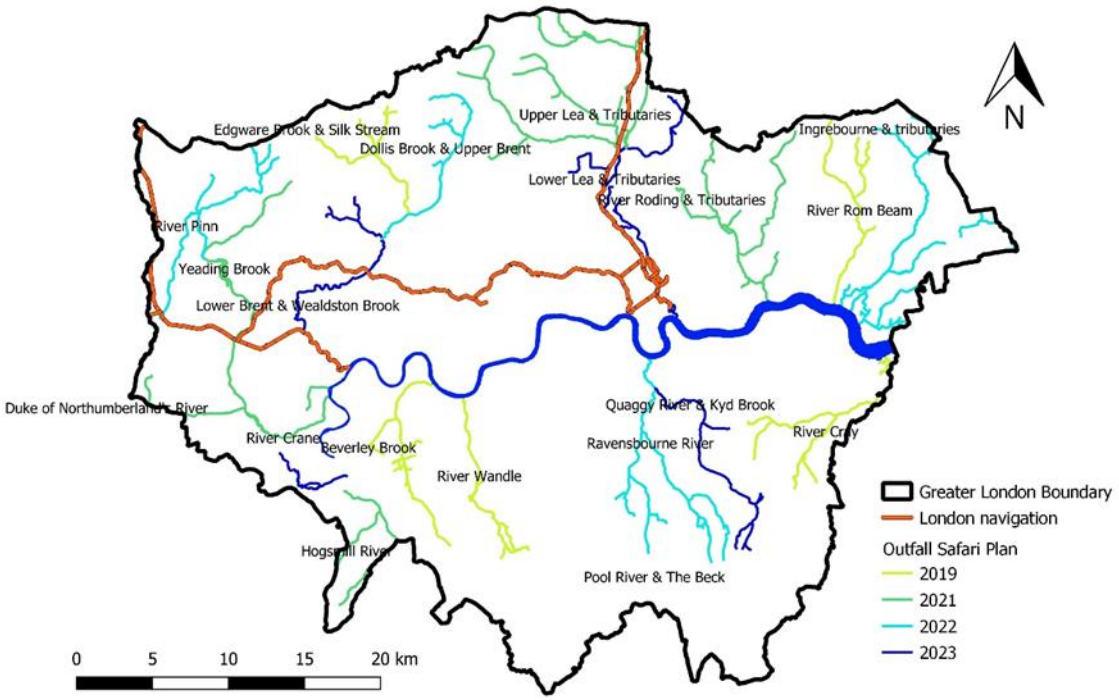


Figure 4. Map of Outfall Safaris in London. Tributaries of the River Thames within Greater London for which Outfall Safari surveys are planned (2019 – 2023). From Shaw Stewart (2020).

Frog Environmental.

The aims of the Outfall Safari are (ZSL, 2019):

i. To map the location of outfalls and record their condition;

ii. To assess and rank the impact of outfalls and report those that are polluting to the regulator and water company;

iii. To build evidence on the scale of misconnected and polluting pipes and drive an increase in investment to resolve it; and

iv. To engage communities with their local rivers and inspire change.

v. To assist environmental non-governmental organisation (NGO) and water companies in applying the Outfall Safari method in other areas of the UK, ZSL and The Rivers Trust have produced a free guide and resources package on the Catchment Based Approach (CaBA) website.

7.2. Measuring the Impact of Outfall Safari

As an established project, Outfall Safari could already demonstrate several successes. These include:

- The method has been successful in driving improvement in urban river water quality. Over 390km rivers have been surveyed in the Greater London area during 15 Safaris, and more than

2000 outfall assessed (Stewart-Shaw *pers. comm.* 2021). This has allowed Thames Water to take targeted action to mitigate PSWO, and between 2016 – 2019 over 2,000 properties with misconnections were identified and fixed (ZSL, 2019). This is equivalent to removing approximately 7.9kg/day biochemical oxygen demand loading of pollution from entering waterways.

- The project has been successful in maintaining and expanding citizen engagement. Since the project began in 2016, more than 300 citizens have been trained in the method, including 126 in 2021.
- Based on its success in tackling PSWO in London, the method has been applied in other areas of the UK, including: Alfreton Brook, Derbyshire (Trent Rivers Trust), Aylesbury, Hertfordshire (River Thame Conservation Trust), and the Forth, Stirlingshire (Forth Rivers Trust).
- The wider uptake of the initiative is promoted by ZSL and The Rivers Trust, through the CaBA.

These measures of success are useful to the project coordinators and funders and other key stakeholders, but they do not constitute an assessment of the overall impact of the project. They are focused on a single domain, the environment, are short-term. The MICS team's involvement in Outfall Safari has been about encouraging the projects coordinators, citizen scientists and other stakeholders to consider the impact of the project more broadly, both longer-term and across all domains.

7.2.1. Application of the MICS IA Approach to Outfall Safari

As outlined in Part A, Section 1.3, the first step in the IA process was to define the contextual setting for the project (Step 1 – see Figure 2). This involved liaising with the project coordinator for Outfall Safari (ZSL) and reviewing the material.

Context analysis

Context analysis ensures that the case study is well understood (e.g., the methods, potential political, economic, environmental boundaries and the stakeholders involved).

Context behind Outfall Safari:

- Of 39 rivers within the Greater London Authority boundary only one has been classified as achieving 'good' ecological potential under the Water Framework Directive (WFD, 2000). PSWO are a major contributor to poor water within London.
- Responsibility for the majority of outfalls in Greater London lies with water services company Thames Water.
- In England and Wales, water pollution incidents that fail to comply with the law or breach permit conditions are investigated, at which point formal enforcement and fines may be imposed by the Environment Agency (EA).
- Much of London's sewage network was constructed in the early 1900s or is older, and a significant proportion of existing SWO remain undocumented. This, in addition to the absence of a standardised methodology to monitor SWO, has limited the effectiveness of previous efforts to tackle PSWO.
- It was agreed that Thames Water would work in partnership with the EA to develop a long-term strategic plan for tackling PSWO. This resulted in Thames Water's Surface Water Outfall Programme (SWOP), which outlines targets for remediating PSWO
- It was recognised that outfall remediation was only sustainable if undertaken in tandem with

stakeholder engagement and education. Thames Water agreed to incorporate citizen science as means of helping to achieve targets set in the SWOP.

- Outfall Safari was developed in partnership with the ZSL, EA, Thames Water, the Friends of River Crane Environment and Frog Environmental.
- The method was first tested in the River Crane Catchment between 2014 – 2016 (Crane Valley Partnership, 2015).

This was done in collaboration with WP2, which provided guidance on the implementation of the IA approach. A key output of this process was the identification of the domains of impact for Outfall Safari and the rationale behind wishing to engender impact in these domains. These are shown in Table 3. It was expected that the Environment and Society domains would contain the majority of impacts to monitor within this case study prior to the workshops.

Table 3. Impacts for Outfall Safari identified during the contextual analysis of the case study grouped according to impact domain.

Domain	Outfall Safari Project
Science & technology	• Developed a standard method for assessing and polluting surface water outfalls • Produces a baseline of data on polluting surface water outfalls (no previous monitoring or data set of pollution from surface waterfall outfalls existed prior to outfall safari being developed)
Society	• Raises public awareness of the problems associated with misconnected home appliances and the incorrect disposal of waste. • Raises awareness regarding declining water quality. • Promotes action on the part of homeowners to identify and resolve domestic misconnections.
Environment	• Protects and improves urban river water quality. • Identifies PSWO for remediation
Governance	• Helps in the development of new building standards and policies designed to tackle existing misconnections and prevent the occurrence of misconnections in new developments (at a local and national level). • Facilitates water utilities in tackling PSWO – The identification of PSWOs by Outfall Safari in the Greater London area helps Thame's Water meet their target number of remediated PSWOs (40 polluting outfalls to be removed per year under Thames Water Asset Management Plan).
Economy	• Promotes the increase in spending in detecting and resolving issues of polluting outfalls. • Helps to reduce costs associated with remediation by enabling rapid response to PWSOs.

Impact assessment workshops

To develop a robust IA for Outfall Safari a series of workshops were organised with the project stakeholders in 2020 and 2021 (Table 4). Outfall Safari was the first MICS case study that the IA approach was applied to. The development of the IJM and workshops was first tested in the Outfall Safari. Its IJM was then used as a template and adapted for the other MICS case studies. The initial workshop held in 2020 (Workshop 1 – described in detail in Joyce *et al.,* (2020)) provided an understanding of citizen scientists' perception of how their involvement in Outfall Safari contributes to the impact. Results from this workshop helped in the contextual analysis of the case study and the development of a draft IJM for Outfall Safari (Figure 5). They also helped in the development of IA

activities for later workshops.

Table 4. List workshops organised with the Outfall Safari case study. Note: items shaded in yellow are described in MICS deliverable D4.1 (Joyce et al., 2020) but referenced in the text.

No.	Date	Title of event	Aim / Brief description of workshop	Number of attendees	Location
1	23/01/20	Understanding Citizen Scientists Perceptions of Impact	To discuss the five MICS impact domains and investigate citizens perceptions of impact	**8 attendees (non-MICS)** 1 project coordinator (ZSL) 7 citizen scientists 15 MICS partners	Cranfield University, Bedford, UK
2	03/02/21	Developing an Impact Journey with Citizen Scientists	The creation of an IJM for Outfall Safari by citizen scientists	**14 attendees (non-MICS)** 1 project manager (ZSL) 13 citizen scientists 8 MICS partners	Online
3	10/02/21	Developing an Impact Journeys with Project Managers	The creation of an IJM for Outfall Safari by the project manager and representatives involved with coordinating the project and citizen science activities	**11 attendees (non-MICS)** 1 Project coordinator (ZSL) 2 representatives from the water company (Thames Water) 5 EA representative 3 representatives from associated NGOs (The Rivers Trust, Thames21) 8 MICS partners	Online
4	17/02/21	How do we monitor the impacts of Outfall Safari?	1) Validation of the draft IJM generated by the MICS team based on the versions created by the participants of workshops 2 & 3 2) Prioritisation of impacts to monitor 3) Development of a monitoring strategy for selected impacts	**14 attendees (non-MICS)** 1 Project coordinator (ZSL) 8 Citizen scientists 2 Water company (Thames Water) representatives 1 EA representative 2 representatives from associated NGOs (The Rivers Trust, Thames21) 9 MICS partners	Online

Workshops 2 – 4 were held in February 2020 and stakeholders involved in Outfall Safari took part in IA activities as part of the event. These focused on three primary objectives:

1) The creation IJM for the Outfall Safari project
2) The selection of impacts to monitor
3) The creation of an IMS for the project

For the creation of an IJM for Outfall Safari, stakeholders were involved in both the initial development

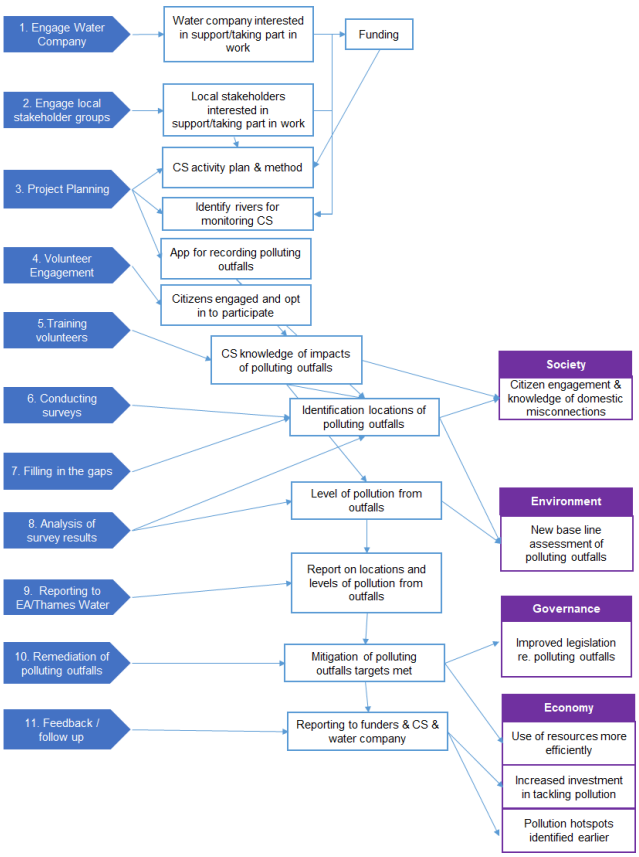


Figure 5. Draft IJM for Outfall Safari – developed as part of IA compendium.

of a draft IJM and subsequent validation of finalised version. The development took place in two workshops. In the first of these workshops (workshop 2) citizen scientists were invited to create a draft IJM, while the project coordinator and representatives from associated organisations (e.g., Thames Water, NGO, the EA) attended a separate workshop to do the same (workshop 3). From here on, the stakeholder group consisting of project managers and representatives from associated organisations is referred to as project coordinators. Before workshop 4 the two IJM created by the citizen scientist and project coordinator stakeholder groups were combined to create a single, synthesised version.

Both stakeholder groups attended workshop 4 and validated the synthesised IJM, voted for impacts to monitor and created a drafted IMS for the selected impacts. The validation of the IJM involved participants adding, amending, or removing items where necessary. Following the workshop, the draft IMS was then finalised by the MICS team and presented to the project coordinator of the Outfall Safari project.

Workshops 2 – 4 were held online via Zoom to comply with social distancing measures in place during the COVID-19 pandemic. The virtual whiteboard software MIRO was used to facilitate the workshop activities and visualise and record participants notes and comments. Prior to the workshops, the MIRO software was tested by the MICS team to ensure compatibility across devices. Despite being unable to meet in-person, all three workshops received good attendance and positive feedback on delivery.

7.2.2. Impact Workshops: Developing an Impact Journey with Citizen Scientists and with Project Managers

Overview of Workshops 2 and 3

Citizen scientists and project coordinators (including representatives from associated organisations, i.e. NGO, Thames Water, the EA, etc.) were invited to attend two separate 1½ hour workshops hosted online (Workshops 2 and 3, Table 4). By engaging with these two stakeholder groups separately it was hoped to capture their viewpoints without influence from one another. A full description of the structure of workshops 2 and 3 is provided in Annexe 1.

During both workshops, participants were split into two smaller groups and asked to answer the following questions:

Activity 1. What are the Long-Term Impact of Outfall Safari?

Activity 2. What are the Short-Term Impacts of Outfall Safari?

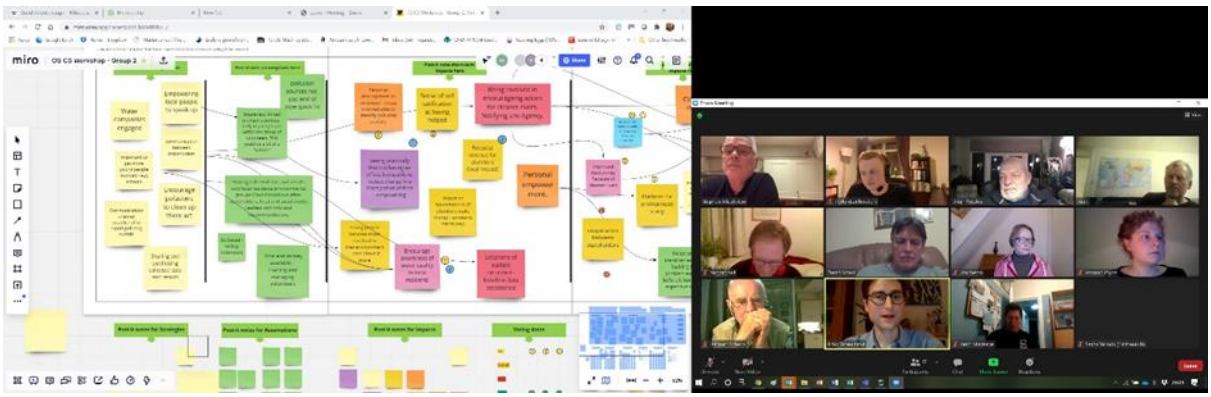


Figure 6. Screenshot taken during one of the online workshops discussing the impacts of Outfall Safari with citizen scientists. Comments and discussions were centred around the virtual whiteboard software MIRO. February 2021.

Activity 3. How are the Impacts of Outfall Safari Achieved?

The breakout group contained 3 – 5 attendees and three members from the MICS team, two members to help moderate the discussion and one person to take notes and help with any technical issues. Using virtual post-it notes the participants were able to answer the activity questions (Figure 6).

The workshop questions were structured in a way so that participants worked 'backwards in time' (Figure 7a), thinking about the long-term impacts of Outfall Safari first (activity 1) before considering the more immediate impacts of the citizen science activities (activity 2) and the strategies or actions needed to achieve them, e.g., monitoring, engage with stakeholders, establish communication links with stakeholders (activity 3). As part of activity 3, participants were also asked to consider what assumptions were being made that the strategies/actions they had identified would be successfully implemented, i.e. it is an assumption that citizens will be willing to be involved. The activity questions and answer boxes were displayed so that activity 1 was displayed on the right-hand side of the whiteboard, while activity 3 appeared on the left. During the activities, participants were asked to consider their answers in relation to the five MICS impacts domains displayed on the right-hand side of the whiteboards and were encouraged to connect their answers to the appropriate MICS domain(s). The results of the activities were then discussed in a short plenary where representatives from each group presented their answers. Once all activity questions were answered participants would have created a draft IJM that flowed from left to right (Figure 7b).

Prior to the workshop 'prompt answers' were added by the MICS team to avoid presenting the participants with blank whiteboards to fill in – which can be potentially off-putting or daunting. These prompts were formulated based on results and comments made by the attendees during the January 2020 workshop (MICS deliverable D4.1 – Joyce *et al.,* 2020). For activity 1, the prompt answers added included:

- Increased awareness - Wider understanding and engagement in tackling polluting outfalls;
- Pollution identified earlier - Tackling the problem earlier before it becomes expensive to fix.

For activity 2, the prompt answers included:

- Personal development as volunteer - those involved able to identify polluting outfalls;
- Locations of outfalls recorded - baseline data established.

While for activity 3, the prompt post-its included:

- Water companies engaged;

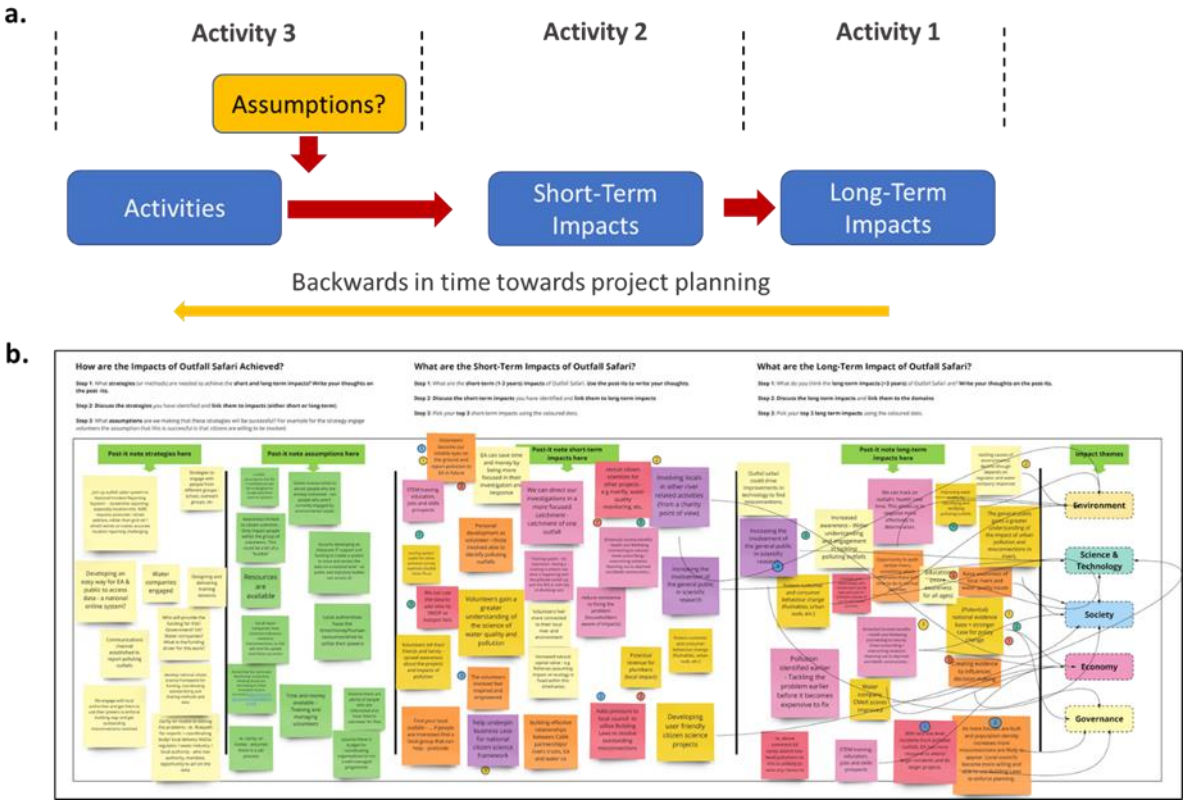


Figure 7. (a) Diagrammatic representation of how the Activities were organised during the Impact workshops; participants were asked to complete the tasks from right to left, effectively working backs in time, first considering the long- and short-term impacts of the citizen science activities associated with their project (Activities 1 and 2), then what citizen science or other activities are required to achieve them (Activity 3). Participants were also asked to consider what assumptions were being made that the activities would be successful, e.g., for the activity 'engage with local citizens' the assumption would be that citizens are interested and willing to be involved. (b) Virtual whiteboard with comments from Outfall Safari stakeholders as an example.

- Communications channel established to report polluting outfalls.

Outputs of Workshops 2 and 3

The primary output of workshops 2 and 3 was the IJM created by citizen scientists and project coordinators (example shown in Figure 7b). These two draft IJM were combined and distilled into a single, synthesised version. The steps taken during the post-processing of the draft IJM were:

Step 1. Comments made in the breakout groups in each of the workshops were combined to create two IJM: one representing the comments of citizen scientists and the other the comments of project coordinators.

Step 2. For the two separate IJM, the comments were grouped together into similar 'themes', e.g., all comments related to citizen personal development / knowledge gain were grouped together.

Step 3. For each of these theme's headings were formulated that captured the content of the comments succinctly.

Step 4. Comments and their headings were brought together into one IJM.

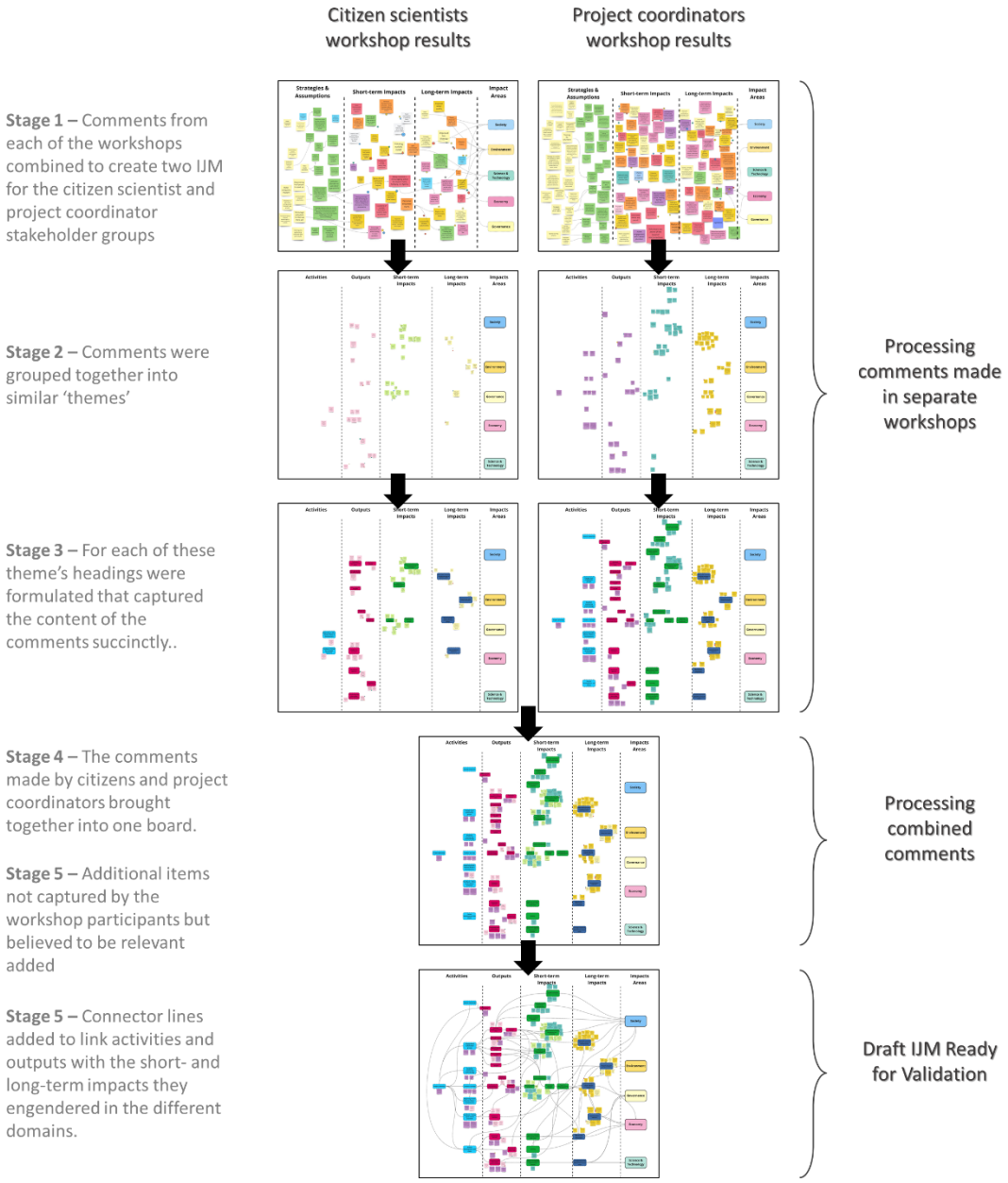


Figure 8. Flow diagram detailing the steps taken by the MICS team to generate the draft impact journey for Outfall Safari. This was achieved by synthesising the results of workshops 2 and 3.

Step 5. Items believed to have been missed by the participants of the workshop but were believed to be important to the sequence of the IJM were added by the MICS team.

Step 6. Connector lines were added to link items of the IJM together, showing how activities linked to short- and long-term impacts, and how this fed into the different MICS impact domains.

These steps are shown diagrammatically in Figure 8. This process was a group effort involving members of WP4 (RRC), WP2 (IHE Delft), and WP3 (Earthwatch) informally discussing and reflecting upon the stakeholder comments over the course of several meetings.

As part of the activities, participants were asked to link their comments to one or more of the five

MICS impact domains using a connection line. The degree to which participants carried out this task varied between groups and in later activities stakeholders focused on adding new comments to the board instead and did not link them to a domain. Consequently, the lines connecting items within the IJM are primarily devised by the MICS team. These lines represent observed expected causal relationships between the IJM and are discussed in further detail below (see Impact Workshop 4: How do we monitor the impacts of Outfall Safari?).

In total 171, individual comments were scrutinised to create the synthesised version of the IJM for Outfall Safari. All original comments were imported into an excel spreadsheet, enabling them to be 'tracked' during the synthesis process (Annexe 2). Any revisions that comments underwent during post-processing, such as being reclassified under another heading (e.g., a comment originally input as a short-term impact being subsequently redefined as a long-term impact), were recorded. Each comment was also 'tagged' with the final item heading that it had been grouped under in the synthesised IJM (Enhanced citizen scientist knowledge, Item No. 28). This enabled further analysis of the workshop results, with the aims of:

1) Highlighting the different perspectives of the two stakeholder groups (i.e. citizen scientists versus project coordinators);
2) Assessing the degree of understanding of the subject matter by the workshop participants and thus the effectiveness of the presentation material;
3) Understanding the nuances in the original comments that were later grouped under synthesised headings.

The results from this analysis are detailed below.

Comparing Perspectives of the Different Participant Groups

Workshops 2 and 3 were successful in capturing the differing opinions of citizen scientists and project coordinators regarding the impacts of Outfall Safari. Table 5 lists the short-term and long-term impacts within the synthesised IJM, and the number of comments made by the different stakeholder groups.

Table 5. Short- and long-term impacts within the synthesised IJM. The table lists their 'tag' number, whether an item was generated based on comments made by participants of the workshop or were created by the MICS team to fill a perceived gap in the IJM, and the number of comments from each stakeholder group contributing to the item.

Item type	No.	Item Title within IJM	Item generated from stakeholder comments (Y/N)	# of citizen scientist comments	# of project manager comments
Short-Term Impacts	25	Stronger community feeling / sense of place	Y	0	5
	26	Increased active involvement - cascade effect	Y	0	4
	27	Improved mental and physical health of volunteers	Y	0	1
	28	Enhanced citizen scientist knowledge	Y	7	6
	29	Upskilling	Y	0	1
	30	Improved relationships among stakeholders	Y	3	5
	31	Locations of misconnections investigated	Y	0	1

	32	Outfalls prioritised	Y	6	5
	33	Remediation of polluting outfalls	Y	0	1
	34	Targets for mitigating polluting outfalls met	N	0	0
	35	Political pressure on local MPs, etc. and water companies and EA (by citizen scientists and wider public)	N	NA	NA
	36	Application of Outfall Safari method in other urban areas	N	NA	NA
	37	Shared understanding of how to run effective citizen science activities	Y	0	1
	38	Outfalls not surveyed / accessible identified	N	NA	NA
	39	Other pollution sources identified (not just misconnections)	N	NA	NA
Long-Term Impacts	40	Community building	N	NA	NA
	41	Improved volunteer health	N	NA	NA
	42	Wider public awareness / changing attitudes of polluting outfalls	Y	2	14
	43	Improved river water quality and habitat	Y	7	4
	44	Improved Policies / Legislation	Y	2	5
	45	Changed policy priorities	N	NA	NA
	46	Improved decision making regarding polluting outfalls	Y	0	5
	47	Business Creation	Y	1	0
	48	Increased institutional knowledge in how to run effective citizen science project	N	NA	NA

Comments made by citizen scientists tended to relate to a small number of impacts. The majority of short-term comments could be grouped under the headings 'enhanced citizen scientist knowledge' (Item No. 28) and 'Outfalls prioritised' (Item No. 32), accounting for 44% and 37% of total comments. The fact that a significant number of comments related to improved knowledge indicates that personal development is a key motivation for citizen participants engaged with Outfall Safari. When asked to consider the long-term impacts of their activities, the comments made by citizens primarily focused on their environmental impact through improved river water quality and habitat (Item No. 43, 60% of comments in total).

In comparison, the comments of project managers related a wider range of impacts. Similar to citizen scientists a large number of comments could be grouped under the heading enhanced citizen scientist knowledge' (Item No. 28, accounting for 20% of comments). However, project managers also made several comments related to societal impacts of stronger community feeling / sense of place (Item No. 25, 17% of comments) and improved relationships among stakeholders (Item No. 30, accounting for 17% comments). Unlike citizens scientists, 'wider public awareness / changing attitudes of polluting outfalls' (Item No. 42) was the impact theme which received the most number of comments, 50% of the total comments.

Validating Workshop Content

Tracking the items that required reclassification under different headings within the IJM provided insights as to whether participants understood the concepts that were explained and the activities they were asked to undertake. A large percentage of reclassifications would suggest that the workshop participants did not acquire a functional understanding of the subject matter and aim of the activity.

The number of items that required reclassification varied between the two stakeholder groups. Of the 34 comments from citizen scientists related to impacts (both short- and long-term), 18 comments (53% of total) were subsequently reclassified under different headings within the IJM. In comparison, only 26 off the 70 comments related to impacts (short- and long-term) made by project coordinators (37% of comments in total) were reclassification.

A degree of reclassification is to be expected, as most workshop participants would be new to the concept of IA, especially citizen scientist participants. There are elements on reflection that could be improved to increase engagement and understanding between the participants involved, e.g., the style of content of the presentation or the introductory material. The content of the IA was adapted for the workshops to try and create a common language which all stakeholders could understand.

Recording the Nuance

Synthesis is an essential stage in the development of the IJM, particularly (but not limited to) those cases where separate workshops with multiple stakeholder groups have been held. However, the synthesis process invariably simplifies and obscures some of the details and nuance of the original comments, and investigation of these nuances can provide useful insight into the differing perspectives and motivations of stakeholders both within and between participant groups.

Consider Item No. 43 in the synthesised IJM – 'improved river water quality and habitat'. Table 6 presents the original comments that were grouped under this impact theme, divided into whether they originated from the citizen scientist participant group or the project coordinator participant group. By looking at these comments, we can gain an understanding of what 'facets' of improved river water quality and habitat the different groups may be more focused on. These comments can be seen to fall under three sub-categories:

1) Achieving improved river water quality and habitat through tackling PSWO;
2) The environmental benefits of improving river water and habitat quality; and,
3) The economic benefits of improving river water and habitat quality.

This exercise was not undertaken for all comments but serves to illustrate how the items within the IJM are broader themes within which more detailed comments are nested.

Table 6. List of comments related to the short-term impact 'improved river water quality and habitat' (IJM Item No. 43) made by citizen scientists and project coordinators.

Stakeholder Group	Comments Related to Enhanced Citizen Scientist Knowledge (IJM Item No. 28)
Citizen Scientists	*"Polluting outfalls cured"*
	"Improve water quality"
	"Improve quality of habitat"
	"Improved bio-diversity"

	"Improve the water quality of rivers in Greater London"
	"Improve water quality in the Welsh Harp to enable safe water sports"
	"Improved biodiversity Because of cleaner rivers"
Project Coordinators	*"Increased natural capital value - e.g. fisheries (assuming impact on ecology is fixed within this timeframe)"*
	"Nicer looking outfalls - better amenity value of local rivers"
	"Tackling causes of environmental decline (though depends on regulator and water company response)"
	"Healthy river habitats"
	"Learning the technology needed to do surveys - Citizen scientists"
	"Improved water quality of rivers"

Feedback on Workshops 2 and 3

Following the workshop, we invited participants to provide feedback regarding the content and scope of the workshop. The received feedback was generally positive.

Format

All participants reported difficulties in using the MIRO software which inhibited their interaction with the virtual whiteboards. During the workshop this was noted, and those experiencing problems were encouraged to ask the MICS team present to write their comments for them on the MIRO boards. This was an issue that was difficult to resolve fully due to the various devices used to access the MIRO boards by the participants – not all of which were fully compatible. This was noted for the subsequent workshops.

Valuing Their Input

In response to the question: **What will you take away from this workshop?** one attendee responded "… [I should] make more of [an] effort to maintain an interest in the subject while not actively involved in the surveys", and another said "there is still much to do to ignite the potential of [citizen science] - lots of joined-up effort needed over the years ahead". However, one participant felt the content of the workshop could have "…focused more on [citizen science] post- project monitoring of practical outcomes, feedback to [citizen scientists] and lessons learnt for future projects". This attendee indicated he had already attended the previous MICS Outfall Safari workshop in January and had already thought about their role in the citizen science project in this way before. This represents the view of a highly engaged participant, already actively involved in this and other citizen science projects. These participants tend to want to focus on 'specifics' as opposed to formulating a generalised framework for understanding (monitoring) impact.

Evaluation of the Workshop

Both workshops 2 and 3 were well attended with several of the citizens scientists in attendance having also attended workshop 1 in January 2020. This demonstrated a high level of enthusiasm amongst stakeholders for engaging with discussions around impact.

During the workshop the majority of participants understood the tasks and engaged in the discussions. Some individuals were typically more vocal than others and tended to dominate the discussions. This

suggested that more effort should be taken to promote input from quieter stakeholders in workshops.

In the case of the project coordinators stakeholder group, some representatives from affiliated organisations were much keener to push their organisations agenda compared to contribute the discussion. This requires the workshop moderators to guide the discussion back to the IA activities.

Nearly 200 individual comments were generated by stakeholders during the workshop, and in order to develop a synthesised IJM for Outfall Safari these had to be processed. This was a significant undertaking and required input from members of WP2, WP3 and WP4. A potential solution would be to develop a draft IJM prior to the impact workshop based on the contextual analysis of the project. This draft IJM could then be validated by stakeholders in a single workshop, which would reduce the time commitment from participants to attend multiple events.

7.2.3. Impact Workshop: How do we monitor the impacts of Outfall Safari?

Overview of Workshop 4

In workshop 2 all those who participated in workshops 2 and 3 were invited to attend, bringing together the various stakeholder groups involved in Outfall Safari (citizen scientists, project managers and representatives from water companies, regulatory agencies, and NGOs) (Workshop 2 Table 4). A full description of the structure of workshop 4 is provided in Annexe 1.

The aim of this 2-hour virtual workshop was to:

1) *validate* the draft IJM created by the MICS team based on the results of workshops 2 and 3 (Figure 9), and;
2) prioritise the impacts to monitor.

Attendees were split into smaller groups and asked to participate in three activities:

Activity 4. Validating the Impact Journey

Activity 5. How do we monitor the short-term impacts of Outfall Safari?

Activity 6. How do we monitor the long-term impacts of Outfall Safari?

Each breakout group contained 4 – 5 attendees and 2 – 3 members from the MICS team, two members to help moderate the discussion and one person to take notes and help with any technical issues. All activities were conducted using the virtual whiteboard software MIRO.

The first of the activities involved participants validating the draft IJM created based on the combined results from workshops 1a and 1b. Participants were asked to review the IJM and to add, adjust, or remove any items/elements. This was followed by a short discussion of the additions and amendments made to the draft IJM in a group plenary.

Activities 2 and 3 involved participants developing a draft IMS. Participants reconvened in their breakout groups to vote for the short-term impacts they believed to be the most important for the project to monitor. Attendees were provided with virtual voting stickers and asked to select three short-term impacts which they scored from 1 to 3 (1 being the most important, three the least important in their opinion). The results from each of the breakout groups were then collated to identify which impacts received the most votes. Participants were then asked to fill in a table containing the following columns:

1) The selected impact
2) The indicator to be used to assess the impact

3) The method(s) that could be used for monitoring

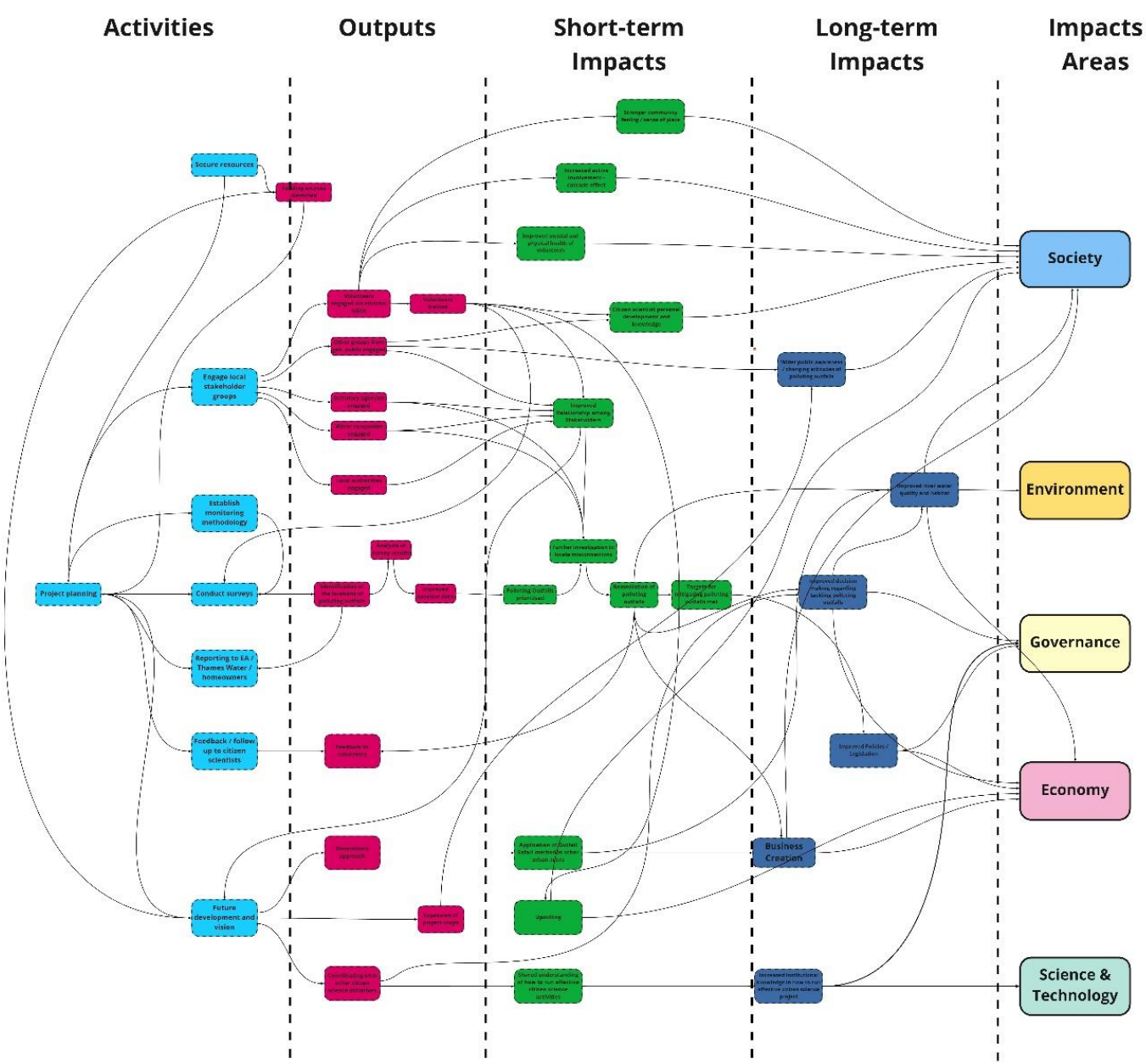


Figure 9. Draft IJM for Outfall Safari created by combining the versions created in Workshop 2 and 3 by the citizen scientist and project coordinator stakeholder groups.

4) The suggested frequency of monitoring
5) Who could be responsible for monitoring
6) The feasibility of the proposed method

Activity 3 followed the same format as activity 2, but for the long-term impacts. The draft IMS developed by the stakeholders of Outfall Safari is shown in Annexe 3.

Activities 2 and 3 were less successful than the previous IA activities, and participants found the concept of developing an IMS 'abstract' (these comments are discussed in full in – Feedback on Workshop 4). During activities 2 and 3 the MICS team therefore played a larger role in filling in the draft IMS with participants and guiding the discussion.

Following these activities, a short plenary was held with representatives from each group providing feedback, and key points of their discussion. In this group discussion the project coordinator from ZSL was invited to provide their thoughts regarding the benefits of measuring impact, and how the IJM and IMS developed during the workshop could benefit Outfall Safari.

Outputs from Workshop 4

The primary outputs of workshop 4 were: 1) a validated IJM (Figure 10) for Outfall Safari, 2) a list of short-term and long-term impacts selected by stakeholders for monitoring, and 3) a draft of the IMS created by stakeholders (Figure 15).

Validation of the Impact Journey Map

Several additions and amendments were made to the draft IJM by the stakeholders attending workshop 2. These included:

- Minor rewording of item text to improve clarity, e.g., the short-term impact 'further investigation to locate misconnections' was altered to 'locations of misconnections investigated' (IJM Item No. 31).
- The addition of two outcomes: 'outfalls that not important yet polluting' and 'Contacting householders' (IJM Item No. 23 and 24 respectively).
- The addition of three short-term impacts: 'political pressure on local MPs, etc. and water companies and EA (by citizen scientists and the wider public)', 'other pollution sources identified (not just misconnections)', and 'outfalls not surveyed / accessible identified' (IJM Item No. 35, 38, and 39 respectively).
- The addition of the long-term impact 'changed policy priorities' (IJM Item No. 45).
- The addition of connector lines between items on the map for which links were missing.

Upon reflection of these suggested changes to the IJM (post-workshop), it was decided to remove two of the short-term impacts (38 and 39) and the two outcomes (23 and 24) added by participants. It was believed that these additions were captured by items elsewhere within IJM. The outcome 'improved baseline data' (18) which was not added by participants during the validation was also removed post-workshop for the same reasons. Additionally, two long-term impacts were also added by the MICS team that filled the gap between short-term impacts and the relevant impact area, these were:

- Community building (IJM Item No. 40)
- Improved volunteer health (IJM Item No. 41)

The final, validated version of the IJM for Outfall Safari is shown in Figure 10. As noted, the lines connecting the items within the IJM represent relationships between these items. In the finalised IJM, these have been coloured to represent the different types of relationships that may exists:

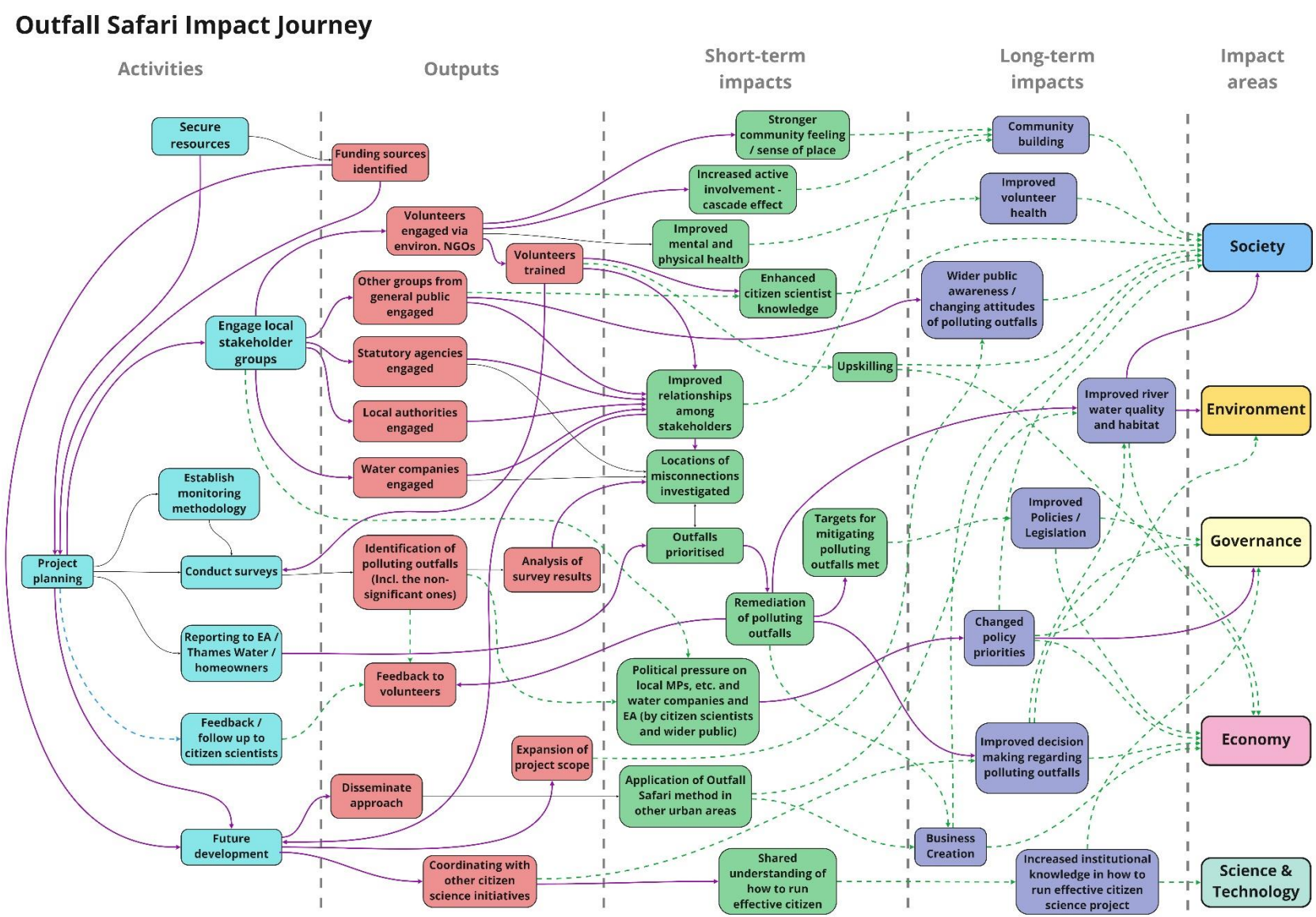


Figure 10. The validated IJM for Outfall Safari. The lines connecting items have been coloured by the MICS team to indicate different types of causal relationships: solid purple lines indicate observed causal relationships, while dashed green lines represent expected causal relationships.

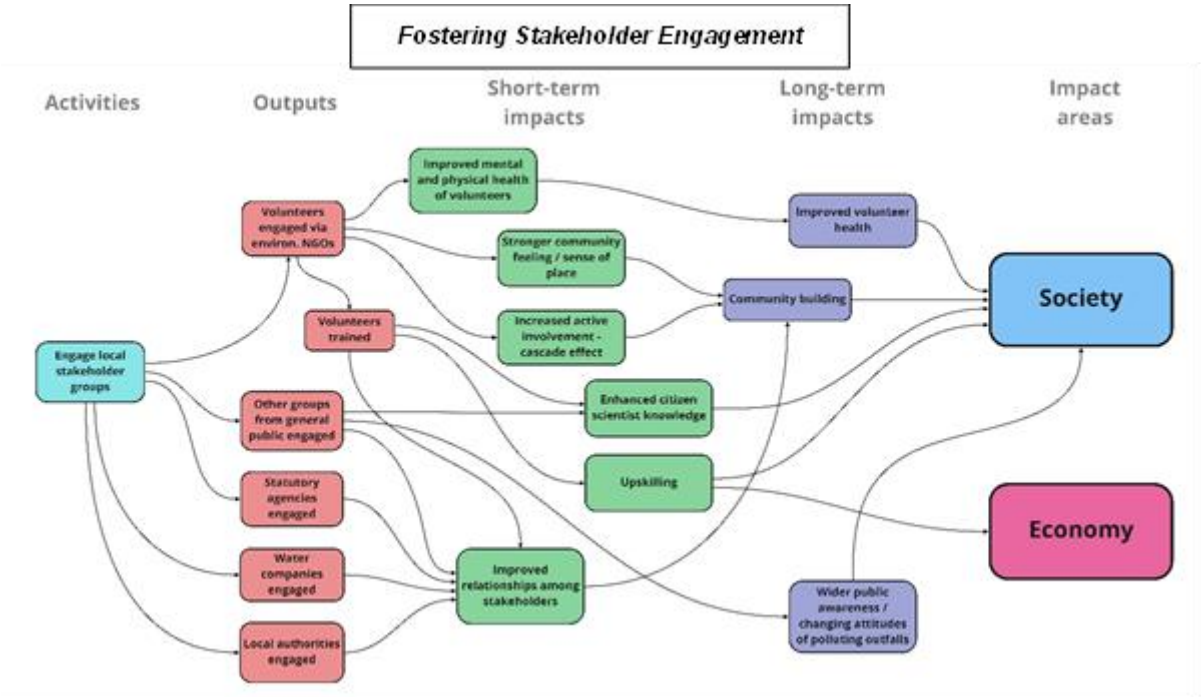


Figure 11. Impact pathways feeding into the 'Fostering Stakeholder Engagement' strategy for Outfall Safari.

- Observed causal relationships (purple lines): e.g., activities that happen; outputs, outcomes impacts that are observed in Outfall Safari (but not always measured)
- Expected causal relationships (dashed green lines): outcomes and impacts that are expected as a result of the project.

In the Outfall Safari IJM, the expected causal relationships tended to be the longer-term impacts around community building and improving policies (wider governance). These impacts are often harder to measure and will be developed into the impact monitoring strategy. However, there were

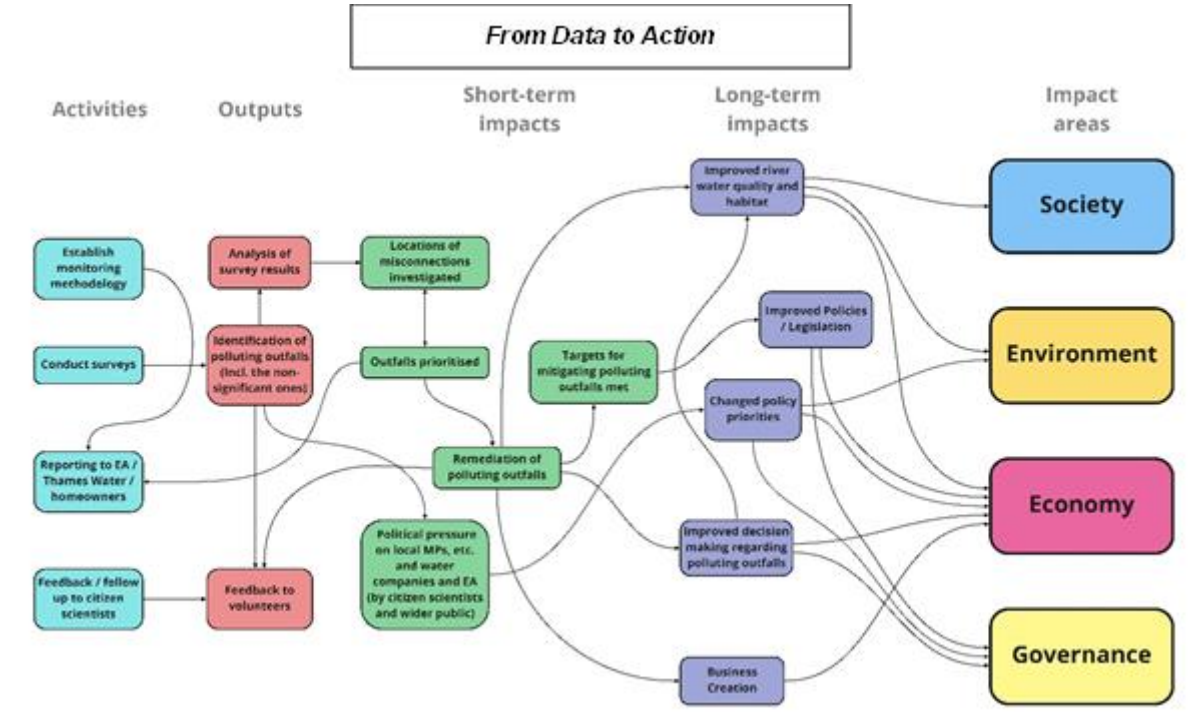


Figure 12. Impact pathways feeding into the 'From Data to Action' strategy for Outfall Safari.

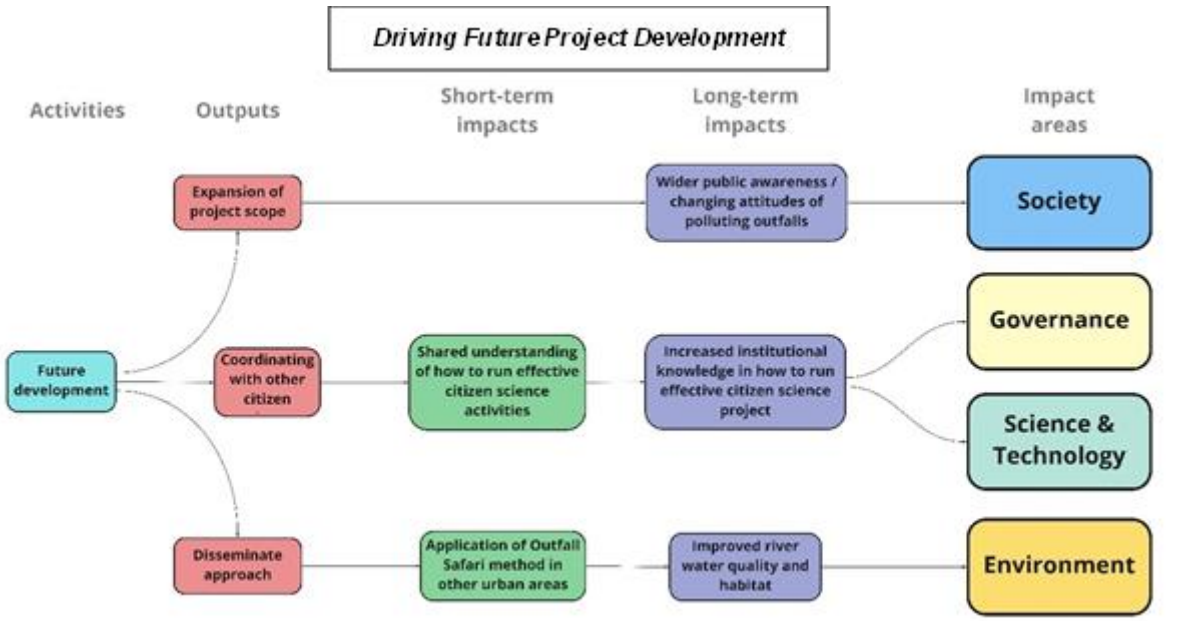


Figure 13. Impact pathways feeding into the 'Driving Future Project Development' strategy.

some expected causal relationships observed on the left side of the IJM around stakeholder engagement and feedback to volunteers. During the workshops the citizen scientists highlighted that they were not always aware with how the data they had collected had been used. This is something the Outfall Safari organisers are addressing. During the RRC conference workshop it was highlighted that we cannot just 'take' from citizen scientists, and we need to give back. The expected causal relationships may on the left side of the map may therefore be easier to measure/address than those on the right side of the board.

Visual inspection of the IJM shows that the impacts within the IJM can be grouped into three strategies, relating to the activities and outputs needed to achieve them:

- Fostering Stakeholder Engagement (Figure 11)
- From Data to Action (Figure 12)
- Driving Future Project Development (Figure 13)

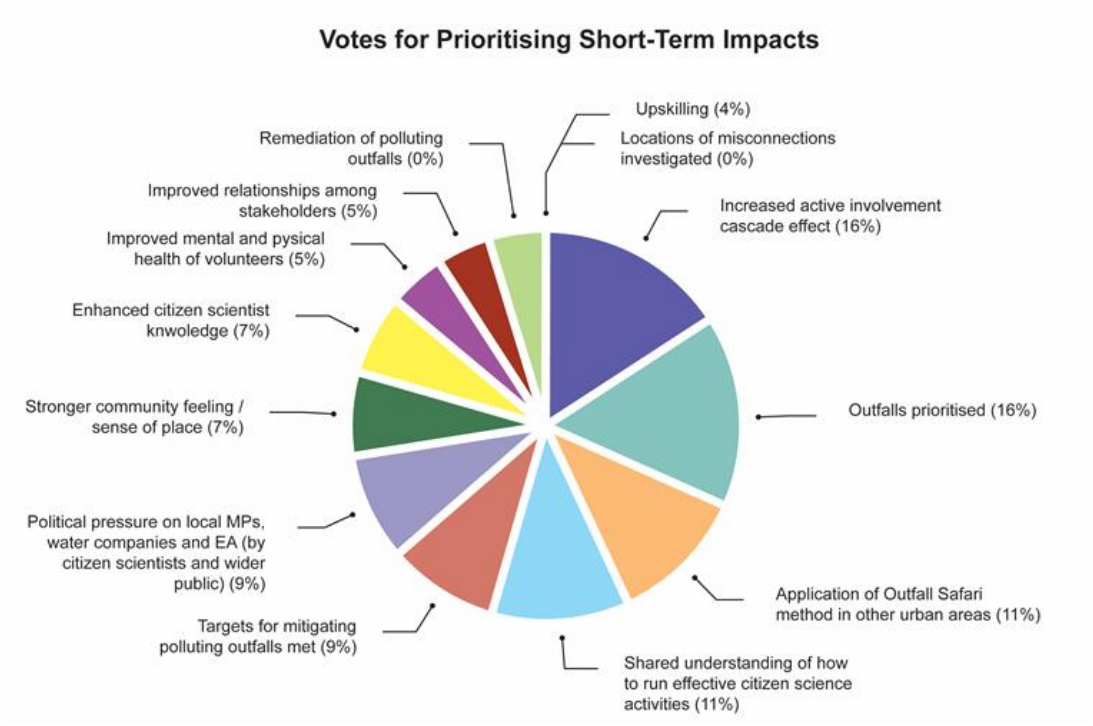
Separating the IJM into individual strategy maps helps organise and communicate the project scope and impacts.

Prioritising Impacts to Monitor

Following the validation of the IJM the workshop attendees were asked to vote for the short-term and long-term impacts they believed to be the most important and should be monitored. The results of this are shown in Figure 14.

The distribution of votes across the short-term impacts was quite even, the highest scoring impacts receiving 16% of the votes were 'outfalls prioritised' (Item No. 32) and 'increased active involvement - cascade effect' (Item No. 26). The impact of 'increased active involvement - cascade effect' was added to the IJM based on comments made by the project coordinator stakeholder group. While not recognised as an impact by citizen scientist initially (during workshop 2) the fact that it scored highly here illustrates that they see it as important.

While the majority of comments made by citizens during the development of the IJM during workshop



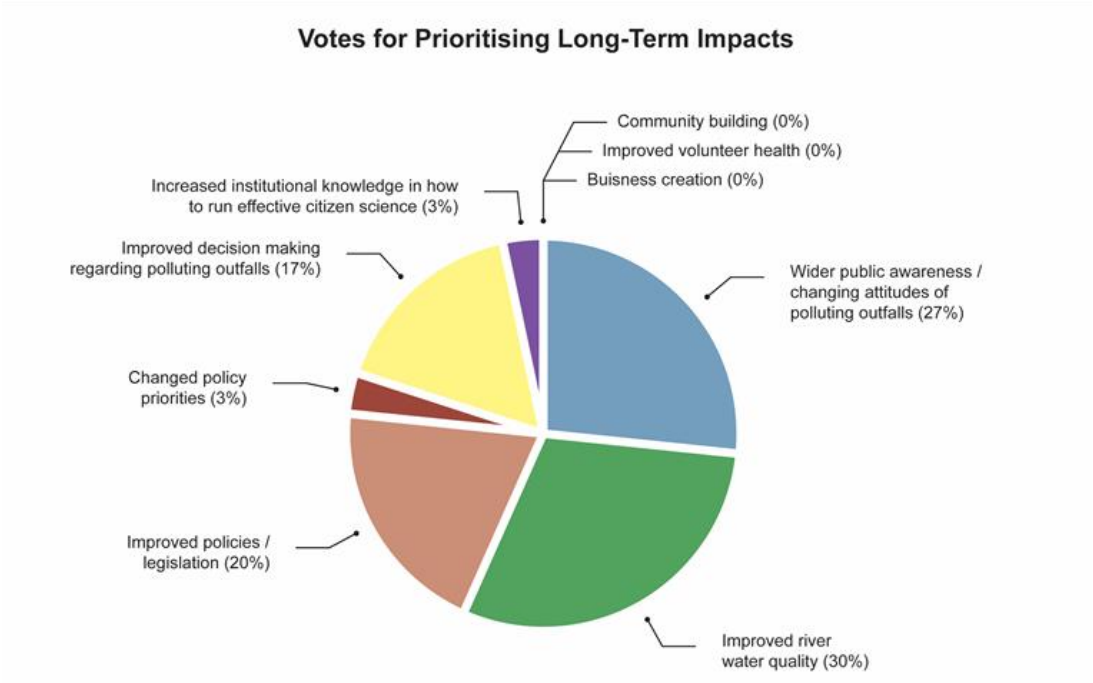


Figure 14. Results of voting for short-term and long-term impacts.

2 related to 'enhanced citizen scientist knowledge', it is interesting to note that it did not score highly during voting. This is interesting to note, as citizen clearly value the project as a means of increasing their knowledge and skills.

Voting on the long-term impacts was more concentrated, with the votes split between 4 of the 9 long-

term impacts. 'Improved river water quality and habitat' and 'wider public awareness / changing attitudes of polluting outfalls' received the highest number of votes (30% and 27% respectively), while 'improved policies / legislation' (Item No. 44) and 'improved decision making regarding polluting outfalls' (Item No. 46) also scored highly (20% and 17% respectively). While the split between votes was narrower for long-term impacts, they still feed into four of the five MICS impact domains (i.e. Society, Environment, Governance, Economy). This diversity may reflect different stakeholder groups present.

Based on the votes five short-term and four long-term impacts were selected for monitoring. The short-term impacts are:

- Outfalls prioritised (Item No. 32)
- Remediation of polluting outfalls (Item No. 33)
- Enhanced citizen scientist knowledge (Item No. 28)
- Shared understanding of how to run effective citizen science activities (Item No. 37)
- Political pressure on local MPs, etc. and water companies and EA (by citizen scientists and wider public) (Item No. 35)

The four long-term impacts of Outfall Safari selected for monitoring are:

- Wider public awareness / changing attitudes of polluting outfalls (Item No. 42)
- Improved river water quality and habitat (Item No. 43)
- Improved policies / legislation (Item No. 44)
- Improved decision-making regarding polluting outfalls (Item No. 46)

Drafting the Impact Monitoring Strategy

As noted, participants struggled to complete activities 2 and 3, which involved filling in a table to create a draft IMS. Figure 15 shows screen captures of the draft monitoring strategies formulated for three of the impacts of Outfall Safari (two short-term (15a) and one long-term (15b)). This has been edited by the MICS team following the workshop. This process involved:

Step 1. All comments (yellow post-it boxes in Figure 15) made by participants in the separate breakout groups were combined within a single draft IMS.

Step 2. Comments were reviewed and either reclassified under different column headings or removed from the IMS where necessary.

Step 3. Where multiple comments were present these were groups under summary headings (grey boxes in Figure 15).

Step 4. Items were added where gaps within the IMS existed (grey boxes in Figure 15)

While some of the comments from participants were pertinent to developing the IMS, others were not directly useable. Ultimately, the finalised IMS presented to the project coordinator of Outfall Safari was developed by the MICS team taking into account the comments of participants as opposed to developed by participants by themselves during the workshop.

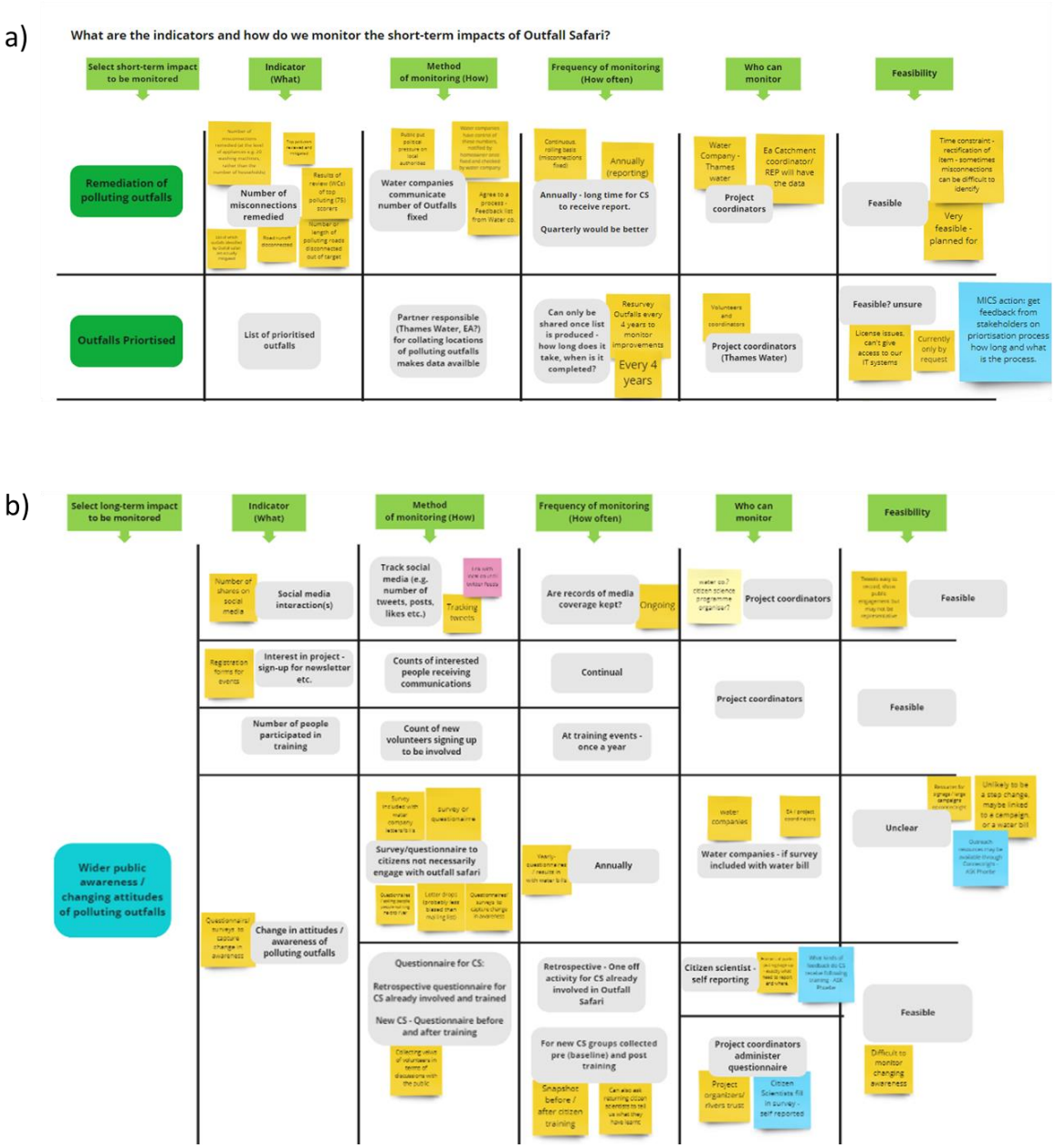


Figure 15. Examples from the draft IMS created by participants for (a) the two-short term impacts 'remediation of polluting outfalls' and 'outfalls prioritised' and (b) the long-term impact 'wider public awareness / changing attitudes towards polluting outfalls'. These have been edited by the MICS team. The yellow boxes represent comments made by the workshop participants. In instances these have been reclassified under different column headings by the MICS team (post-workshop). The grey boxes were added by the MICS team to either summaries groups of participant comments or will a gap within the IMS.

Feedback on Workshop 4

Compared to workshops 2 and 3, feedback on workshop 4 was limited, and while some of this related to similar issues experienced in the previous workshops (i.e. technical difficulties), several points were made regarding content.

Content

Several attendees expressed difficulties in fully understanding activities 2 and 3 related to the development of a draft IMS for the prioritised impacts (short-term and long-term, which they felt was "abstract". These were primarily citizen scientists who were unlikely to have thought about impact in this way before. More input was required by the MICS team during these tasks to help guide discussion and prompt answers.

Format

Participants expressed frustration during the event with the MIRO software inhibiting their ability to interact with the virtual whiteboards. As previously noted, this issue was difficult to resolve fully due to participants accessing the MIRO board through different devices, some of which had compatibility issues.

Outputs

Several project coordinators made positive comments regarding the potential use of IJM for dissemination and to support funding bids and asked to receive copies of the IJM and further information regarding the impact workshop outputs.

Evaluation of the Workshop

Stakeholders successfully completed the first activity (validating the IJM) but did not fully understand the tasks related to drafting an IMS for the project (activities 1 and 2) and were unable to fully complete them. While the concept behind the activity was explained in the presentation and the activity question was crafted to help guide the participants through process (by filling in a simplified table), thinking about impact in this way would have been unfamiliar for many of the workshop participants, particularly citizen scientists. This is understandable given that their experience of the project is of a practical nature, i.e. monitoring.

During the activities significant input from the MICS team was required to guide the discussion and help answer the activity questions. For future impact workshops an alternative approach was adopted, whereby the MICS team produced a draft IMS strategy for the impacts prioritised by stakeholders. This draft IMS could then be either validated by stakeholders at a follow-up workshop or by the project coordinator during informal discussions with the MICS team.

7.2.4. Impact Monitoring Strategy for Outfall Safari

The draft impact monitoring strategies (Annexe 3) developed by the three breakout groups in workshop 2 were combined, synthesised, and amended to create a workable IMS for the Outfall Safari project, shown in Table 7.

The IMS (Table 7) has been presented to the project coordinator of Outfall Safari who has expressed an interest in its application. The scheme will be further refined during the first half of 2022 and the MICS team will help in the application of the method. To ensure continuity the RRC will continue to support Outfall Safari in the application of the IMS following the completion of the MICS project. The RRC will also investigate whether it can be applied in other Outfall Safari citizen science projects across the UK, such as Alfreton Brook, in Derbyshire.

Table 7. IMS developed for the Outfall Safari citizen science project.

Impact selected to monitor		Monitoring Strategy				
		Indicator	**Method**	**Frequency**	**Who is involved**	**Feasibility**
Short term impacts	Remediation of polluting outfalls	Number of misconnections remedied	Water companies communicate number of outfalls fixed	Annually	Project managers	Feasible
				Quarterly		
	Outfalls prioritised	List of prioritised outfalls	List of prioritised outfalls made available	Unsure	Project managers	Feasible
	Enhanced citizen scientist knowledge	Level of citizen scientist understanding regarding PSO	Retrospective questionnaire for citizen scientists already involved	One off activity	Project managers	Feasible
				Annually - to record change over time		
			Questionnaire before and after training for new citizen scientists			
				Annually - at training event		
	Shared understanding of how to run effective citizen science activities	Number of publications (outputs from the project)	Articles (likely) recorded already through dissemination tracking	Annually	Project managers	Feasible
		External citations	Literature review			
	Local MPs, water companies and EA feel pressure (by citizen scientists and the wider public)	Number of communications to local MPs that have been taken up	Citizen scientists self-report	Annually	Citizen scientists	Feasible
		Number of signatures to project endorsed campaigns/ petitions	Counts of signatures to campaigns / petitions	Variable - depends on frequency of petitions	Project managers	Feasible
		Media coverage	Track media coverage	Continual	Project managers	Feasible
Long-term Impacts	Wider public awareness / changing attitudes of polluting outfalls	Social media interaction(s)	Track social media (e.g., record number of tweets, posts, likes etc.)	Continual	Project managers	Feasible
		Interest in project - sign-up for newsletter etc.	Counts of interested people receiving communications	Continual	Project managers	Feasible
		Number of people participated in training	Count of new volunteers signing up to be involved	At training events - once a year		
		Change in attitudes / awareness of polluting outfalls	Questionnaire gauging changing public attitude to PSO	Annually	Project managers	Unclear
			Retrospective questionnaire for citizen scientists already involved	One off activity	Project managers	Feasible
				Annually - to record change over time		

			Questionnaire before and after training for new citizen scientists	Annually - at training event	Citizen scientist - self reporting	
	Improved river water quality and habitat	Number of misconnections remedied	Water companies communicate number of Outfalls fixed	Annually	Project managers	Feasible – already done
				Quarterly		Feasible
		WFD status of rivers	Monitoring undertaken by other citizen science projects, e.g., Riverfly	Monthly, in the case of Riverfly	Citizen scientists - Riverfly volunteers	Feasible
			Statutory agency monitoring	Unsure	Project managers / citizen scientists	Feasible
		Outfalls where remediation has taken place remain non-polluting	Outfall Safari surveys	4 years – completion of survey period	Project managers / citizen scientists	Feasible
	Improved decision making regarding polluting outfalls	Institutional change (e.g., Thames Water changed procedures, policies)	Retrospective questionnaires for Water Companies	Yearly	Self-reporting by project coordinators	Feasible
			Literature search - company reports (annual)	Yearly	Project managers	Feasible
	Improved Policies / Legislation	Number of communications to local MPs that have been taken up	Citizen scientists self-report	Yearly	Citizen scientists	Feasible
		Governmental Policy change / written legislation	Policy / legislation search	Yearly	Project managers	Feasible

7.2.5. Feedback from Project Coordinator on the IA Process

Asked to provide feedback, the project coordinator of Outfall Safari provided the following remarks:

- **What your thoughts are regarding the impact workshops**: "The impact workshops have been an exciting opportunity to engage our citizen scientists and work towards quantifying their hard work in enabling the outfall safari program to be successfully implemented."
- **What were the highlights of the workshop, was there anything that came up that was unexpected**: "Highlights of the workshop were being able to properly discuss and listen to the feedback from volunteers and other project managers in an entirely different context and setting than usual. There were no particular unexpected surprises, but it was interesting to see how the groups (managers vs volunteers) had quite clearly different views regarding the importance of various aspects of the project. I expected there to be some divergence, but perhaps not so obvious."
- **Do you think the results are useful/can be used to help improve Outfall Safari?** "I think that the results will help to improve the Outfall Safari and other citizen science activities as we can work out why the project is important to the citizen scientists themselves and tailor our training sessions and project management accordingly."
- **How do you think the impact workshops/process we used to investigate impact with you and you volunteers could be improved or changed?** *"I think that a chaired discussion between*

managers and citizen scientists could be very interesting, it might allow for some new ideas to bubble up. Also, thinking about the divergence of expectations I mentioned above, perhaps it would be useful to have quantifiable polls with multiple choice answers for some of the overarching themes."

7.3. Evaluation of Measuring Outfall Safari's Impact

Applying the MICS IA approach to Outfall Safari resulted in two key outputs:

1) A model for applying the MICS IA approach within the other MICS case studies.
2) An IJM that is project-specific but contains elements that are applicable to other citizen science projects in the environmental sector.

Outfall Safari was the first case study to which the IA approach was applied. The process developed for this case therefore heavily informed the application of the IA approach to the other MICS case studies. This included development of a format and template for undertaking impact workshops, including how to convey the complex concepts of the IA approach to stakeholders with differing levels of prior knowledge and backgrounds, and an understanding of the processing that would be required to distil the participant comments into a synthesised IJM. Whilst the involvement of participants in the development of the draft IJM was valuable, highlighting the different perspectives of the two participant groups (citizen scientists and project coordinators), the time required to process the almost 200 resultant comments was significant. The process could be streamlined with the prior development of a draft IJM by the MICS team, an approach which was later adopted for the other case studies.

Feedback from project coordinators involved in Outfall Safari highlights where they see the value in IA. This can help guide how the MICS team communicates the value of undertaking the IA approach to other projects, and how the outputs of the process can be beneficial in improving impact. It also serves to inform how IJM can be presented, e.g., several project coordinators expressed an interest in using the IJM as a means of visualizing (potential) project impact to support funding bids.

Less successful among the IA activities were those that related to the creation of a draft IMS for the project. Participants of the workshop found these activities to be difficult and did not fully understand the concept of the IMS. While some elements of the draft helped inform the final IMS for the project the majority of the IMS for Outfall Safari was created by the MICS team. In subsequent workshops this activity was omitted.

Although the complexity of developing the IJM with full stakeholder involvement necessitated commitment from participants to attend multiple workshops (four in total, 2020-2021), all workshops were well attended, with several participants attending all events. This indicates that there was a high level of enthusiasm amongst stakeholders, including citizen scientists, for engaging with these discussions around impact. This is borne out by the feedback from participants, who generally valued the opportunity to explore in detail the impact of Outfall Safari.

The impact workshops found that Outfall Safari had a wider breadth of impacts than first identified during the contextual analysis of the project. While the primary domains of impact for the project were originally expected to be the Environment and Governance domains, there was also a significant number of additional impacts identified during the workshops that fed into the Society domain. Two of these ('enhanced citizen scientist knowledge' and 'wider public awareness/changing attitudes of polluting outfalls') are considered integral to the project success and targeted for future monitoring

within the IMS.

Three of the impacts selected by stakeholders to monitor as part of the IMS feed into the Governance domain and focus on lobbying for improved policies and decision making regarding PSWOs. This illustrates the interest of the stakeholders in using the project to effect change that would ameliorate the root causes of the environmental problem of PSWO, as opposed to reacting to the effects of the problem via monitoring.

The workshop served to help the different stakeholder groups involved in Outfall Safari understand one another's differing perspectives and motivations for being involved in the project and encouraged all stakeholders to think more widely about the impact of their activities beyond the immediate project aim. The process opens up better understanding for all, better integration of the citizen scientists onto the longer-term project aims and the potential for changes in the way stakeholders interact. The IA process includes both project coordinators and citizen scientists as equal contributors, and for projects of a contributory nature such as Outfall Safari, this could trigger the transition towards a 'co-design' approach, with participants helping to improve the project. This is reflected in the project coordinators comments regarding the outputs of the IA approach.

8. Riverfly Monitoring Initiative, Lincolnshire, UK

8.1. Introduction

Macroinvertebrate species, also known as riverflies (Figure 16), are key components of riverine ecological processes, and a vital link in the aquatic food chain. They are highly sensitive to changes in river water quality and are thus widely used to monitor long-term river health and identify pollution events (Moolna *et al.,* 2020).

Pollution is a key problem affecting rivers and can enter from a variety of different pathways. These include run off from agricultural land washing excess pesticide and nutrients into rivers, and the discharge of wastewater from urban areas, among others. Identifying pollution events and their source promptly helps to minimise the impact that such events may have on river water quality. This is often achieved by monitoring indicator species such as aquatic macroinvertebrates, which are highly sensitive to changes in environmental parameters, including dissolved oxygen, nutrients, and suspended solids arising from sewage and agricultural pollution (Moolna *et al.,* 2020).

In the UK, the EA is responsible for the biological monitoring of river water quality. However, this data does not provide sufficient spatial or temporal coverage to identify changes in condition at the local scale across the whole river network.

The RP was founded in response to concerns from anglers and freshwater interest groups about observed declines in riverflies (e.g., Frake & Hayes 2001) and the ecological condition of rivers in the UK. The RP is a collaborative network of environmental NGO, scientists, statutory agencies, and freshwater interest groups, coordinate several established citizen science methodologies to monitor river water quality and detect pollution events (RP, 2021). The Anglers' Riverfly Monitoring Initiative ARMI was launched by the RP in 2007 and is a simple, standardised citizen science methodology to detect perturbations in river water quality by scoring the occurrence and relative abundance of different riverfly groups (Brooks *et al.,* 2019). The primary aims of the Riverfly Partnership are to:

i. protect the water quality of rivers;
ii. further the understanding of riverfly populations, and;
iii. conserve riverfly habitats.

8.2. Measuring the Impact of Riverfly

As an established project, Riverfly can already demonstrate several successes at a national and local scale. At a national scale these include:

- The RP has expanded to include 180 organisations, representing angling clubs, conservation groups, water course managers, scientists, environmental charities, and government agencies
- The method has been applied across the UK with 56 Riverfly Hubs being established to date (December 2021). These coordinate the activities of volunteers at a catchment and reach scale.
- There are currently 2600 registered ARMI sites where regular sampling takes place.
- There are currently 3000 active Riverfly volunteers across the UK.
- Riverfly monitoring supports routine monitoring carried out by the statutory agencies, i.e., the EA, Scottish Environment Protection Agency, National Resources Wales, and Northern Ireland Environment Agency.
- Several new methods, e.g., the Urban Riverfly, which expand on the ARMI methodology, have been developed to inform on additional river stressors. These are being rolled out to interest Riverfly groups. This includes the Extended Riverfly which was launched in 2020-2021.

The LCSP Riverfly Hub can demonstrate success at a local scale:

- There are currently 39 active volunteers engaged Riverfly monitoring activities coordinated by the LCSP Riverfly Hub.
- There are 34 registered ARMI sites
- Volunteers engaged with the LCSP Riverfly were involved in developing the new Extended Riverfly methodology. The method was developed in response to feedback from LCSP Riverfly volunteers who stated that in instances where the impacts on the river were subtle little could be shown with the ARMI scheme and they felt 'demotivated'. They could also see species that they weren't being asked to identify and where 'motivated' to find out what they were. The scheme was therefore developed to be a challenging alternative to the ARMI method but also capture the subtle

Figure 16. Riverfly monitoring initiative. An example of a 'riverfly' a) Flat-bodied Up-wing (Heptageniidae); b) equipment provided to Riverfly citizen scientists: a net, bucket, riverfly identification guide, and sorting tray; c) volunteers engaged in ARMI training on the River Lea, Hertfordshire, UK. Source: J. Wheatland.

information about river stressors. The Extended Riverfly project was successfully piloted by the LCSP volunteers and has since been launched nationally (2020 – 2021).

- Riverfly data collected by LCSP volunteers has also been instrumental in tackling local pollution events. These include:
- The identification of a leaking sewage treatment works at Hemingby which was investigated.
- The identification of leaching from a rubbish dump near Nettleton Beck.
- Volunteer data from the River Bain at Biscathorpe indicated a regular sedimentation problem.

These measures of success are useful to the project coordinators and funders and other key stakeholders, but they do not constitute an assessment of the overall impact of the project. They may be focused on a single domain, such as environment, and they may be short-term. The MICS teams involvement with the LCSP Riverfly Group has been about encouraging the projects coordinators, citizen scientists and other stakeholders to consider the impact of the project more broadly, both longer-term and across the full breadth of MICS defined domains.

8.2.1. Application of the MICS IA Approach to the LCSP Riverfly Group

Development of the draft IJM for the LCSP Riverfly group first involved defining the contextual setting for both the RP at a national scale and the 'local' monitoring activities coordinated by the LCSP Riverfly Hub.

Contextual Analysis

Riverfly Partnership – National Scale

In the UK, the Riverfly Partnership (RP), a collaborative network of environmental NGO, scientists, statutory agencies, and freshwater interest groups, coordinate several established citizen science methodologies to monitor river water quality and detect pollution events.

- The scheme originated from a collaboration between the Natural History Museum and Natural England who formed the Partnership Project in 2002. In 2004 the RP was formally founded with the list of collaborators expanding to include the Freshwater Biological Association, Salmon & Trout Conservation UK, and other interested groups.
- Citizen science monitoring could be an effective means of delivering management objectives aimed at improving water quality, and that there was an opportunity to engage with the anglers who were ideally placed to monitor the health of the watercourses they fish.
- Riverfly volunteers are assigned a section of river and expected to collect monthly samples. If riverfly numbers at a given site fall below a 'trigger level' (expected population abundances) volunteers are required to notify their EA contact who will investigate the incident and identify the pollution source.
- The ARMI method is a simplified version of the Biological Monitoring Working Party sampling method used by the EA for statutory monitoring. Consequently, ARMI data complements and supports the routine monitoring carried out by regulatory authorities.
- Riverfly monitoring activities are coordinated at a regional and catchment level through Riverfly Hubs which are usually hosted by an NGO, e.g., a Wildlife Trust or Rivers Trust.
- These Hubs support and develop a sustainable network of citizen scientists through local engagement, recruitment, training, fundraising, communications, coordination of regular

meetings for volunteers, and by promoting a sense of community ownership of water quality issues.

- The ARMI method is a good example of a contributory citizen science activity, whereby volunteers are engaged in monitoring, in order to accomplish predetermined scientific objectives. However, the modifications to the ARMI method (i.e. Extended Riverfly), have occurred through feedback from citizen scientists, who have worked collaboratively with coordinators to determine the aims and objectives of these updated activities. These offer good examples of how established citizen science groups can begin to take ownership of their projects, and the transition of a project from being contributory to collaborative in nature.
- The method has been applied across the UK, with over 2600 registered ARMI sites (Figure 17)

Figure 17. Location of sites monitored by the ARMI volunteers in the UK. Grey lines represent river basins. From Brooks et al., (2019).

Lincolnshire Chalk Stream Project Riverfly Hub

- The Lincolnshire Chalk Stream Project (LCSP) was initiated in 2003 to monitor, improve and raise awareness of chalk streams in the Lincolnshire Wolds. The partnerships consist of the EA and the water services company Anglian Water (joint partner leads), Lincolnshire County Council (hosting partner), NE, Lincolnshire Wildlife Trust, Lincolnshire Wolds Countryside Service and the Wild Trout Trust.
- he LCSP was initiated in 2003 to monitor, improve and raise awareness of chalk streams in the Lincolnshire Wolds. The partnerships consist of the EA and the water services company Anglian Water, Lincolnshire County Council (hosting partner), NE, Lincolnshire Wildlife Trust, Lincolnshire Wolds Countryside Service (hosting partner), the Wild Trout Trust, Greater Lincolnshire Nature Partnership, North Lincolnshire Council, North, East Lincolnshire Council, East Lindsey District Council and West Lindsey District Council.
- The LCSP has been a Riverfly Hub Coordinator since 2013. Figure 18 shows the current sites were Riverfly monitoring coordinated by the LCSP occurs.
- Yearly meetings serve to bring all participants together and are an opportunity for the LCSP coordinator to provide feedback and for volunteers to voice any issues or concerns.
- The involvement of the EA is the LCSP projects means there is a professional level of interactions with volunteers.
- After several years of using the ARMI some volunteers expressed an interest in expanding their knowledge of different taxa groups (Bartle & Boulton, 2017). In parallel to this the EA were keen to develop a more challenging survey that would incorporate more taxa groups that would provide more details regarding the river condition other than water quality (Richard Chadd and Dr Chris Extence).

- To reinvigorate interest in Riverfly activities the EA developed a new methodology – the Extended Riverfly (described in. This new method was devised by members of the EA working with the LCSP.
- The Extended Riverfly method was successfully piloted from 2015 by LCSP. The method has since been adopted by the RP as one of its Riverfly Plus 'Projects' and applied by other Riverfly Hubs across the country.

Figure 18. Locations of sampling sites for riverfly monitoring activities coordinated by the LCSP Riverfly Hub.

- The LCSP is an example of a contributory project that has developed over time into one that is collaborative, as citizen scientists have guided the development of new methodologies and expanded the scope of the monitoring objectives. This has been achieved through a healthy dialogue between citizen volunteers, the project coordinators, and representatives of the statutory agency (EA).

Table 8 summarises impact domains in which the LCSP Riverfly Group seeks to engender impact(s) and the rationale behind focusing on these domains.

Table 8. Impacts for LCSP Riverfly monitoring activities identified during the contextual analysis of the case study grouped according to impact domain.

Domain	LCSP Riverfly Project
Science & technology	• *To further the understanding of riverfly populations.* • *To stimulate scientific research to answer key questions about issues affecting riverflies.*
Society	• *To raise public awareness of riverflies, their importance to aquatic conservation and ecological function.* • *To raise awareness regarding declining water quality.* • *To involve people in monitoring and recording riverflies.*
Environment	• *To protect and improve river water quality.* • *To conserve riverfly habitats.* • *Improve the conservation status of riverfly species by securing healthy and sustainable populations.* • To guide restoration and management objectives.
Governance	• *To increase and promote knowledge about positive management techniques.* • *To inform and influence the debate of current issues.* • *To complement the monitoring conducted by statutory agency of river water quality - Riverfly data feeds into reporting for the WFD.*

Economy	• *To reduce the costs associated with remediation through rapid response to pollution incidents.* • *Promotion of good river management practices helps to safeguard economic activities that depend on river health, e.g., leisure, fisheries, drinking water abstraction etc.*

Impact workshops

Unlike Outfall Safari, where stakeholders were involved in developing and validating the IJM for the project, prioritising impacts to monitor, and helping in the development of the IMS for the selected impacts, it was decided to adopt a simplified approach for the LCSP Riverfly group. Stakeholders would only be involved in the validation of the IJM and the prioritisation of impacts, while the MICS team would create the draft IJM and develop the IMS based on the impacts selected by the workshop participants. This simplified approach was adopted for several reasons:

1) Reducing the number of IA activities meant they could occur within a single workshop. This reduced the time commitment needed from stakeholders.
2) The IJM created previously for Outfall Safari could be used a starting point for developing the IJM for the LCSP Riverfly group; certain elements would be common to both and those that were project specific could be identified based on a contextual analysis of the case study;
3) Removing the input of participants in the development phase of the IJM reduced the number of stakeholders comments and the time required to interpret and process them;

Following the contextual analysis of the Riverfly project the IJM created for Outfall Safari was reviewed to see if any items were applicable to Riverfly. These were often generic elements that would be widely applicable to most citizen science projects in the environmental sector, e.g., 'engage local stakeholders' or 'agree a monitoring strategy'. Activities, outputs and impacts specific to the LCSP Riverfly case study identified in the contextual analysis were then added to the draft IJM.

The draft IJM developed for the LCSP Riverfly group is shown in Figure 19.

Items within the IJM created for the LCSP Riverfly group were recorded in an excel spreadsheet so that their origin and any suggested changes to them made to them could be tracked. This included recording whether items were modified or adopted from the Outfall Safari IJM, where it was created by the MICS team, or whether it was an addition/alteration made by Riverfly stakeholders during the validation process. This information is summarised in Table 9 and shown in full in Annexe 4. The IJM created for the LCSP Riverfly group consisted of 20 unique items (activities, outcomes, short-term, and long-term impacts). Of these ten were adapted or directly adopted from the IJM created for Outfall Safari.

To validate the draft IJM created for the LCSP Riverfly group and identify impacts to monitor for the case study, a workshop was held with the stakeholders engaged with the project. Details of this event are shown in Table 10. Prior to the workshop the draft IJM was circulated to the Riverfly volunteers and other stakeholders involved in the project via email. This was done to give them the opportunity to familiarise themselves with the IJM prior to the event.

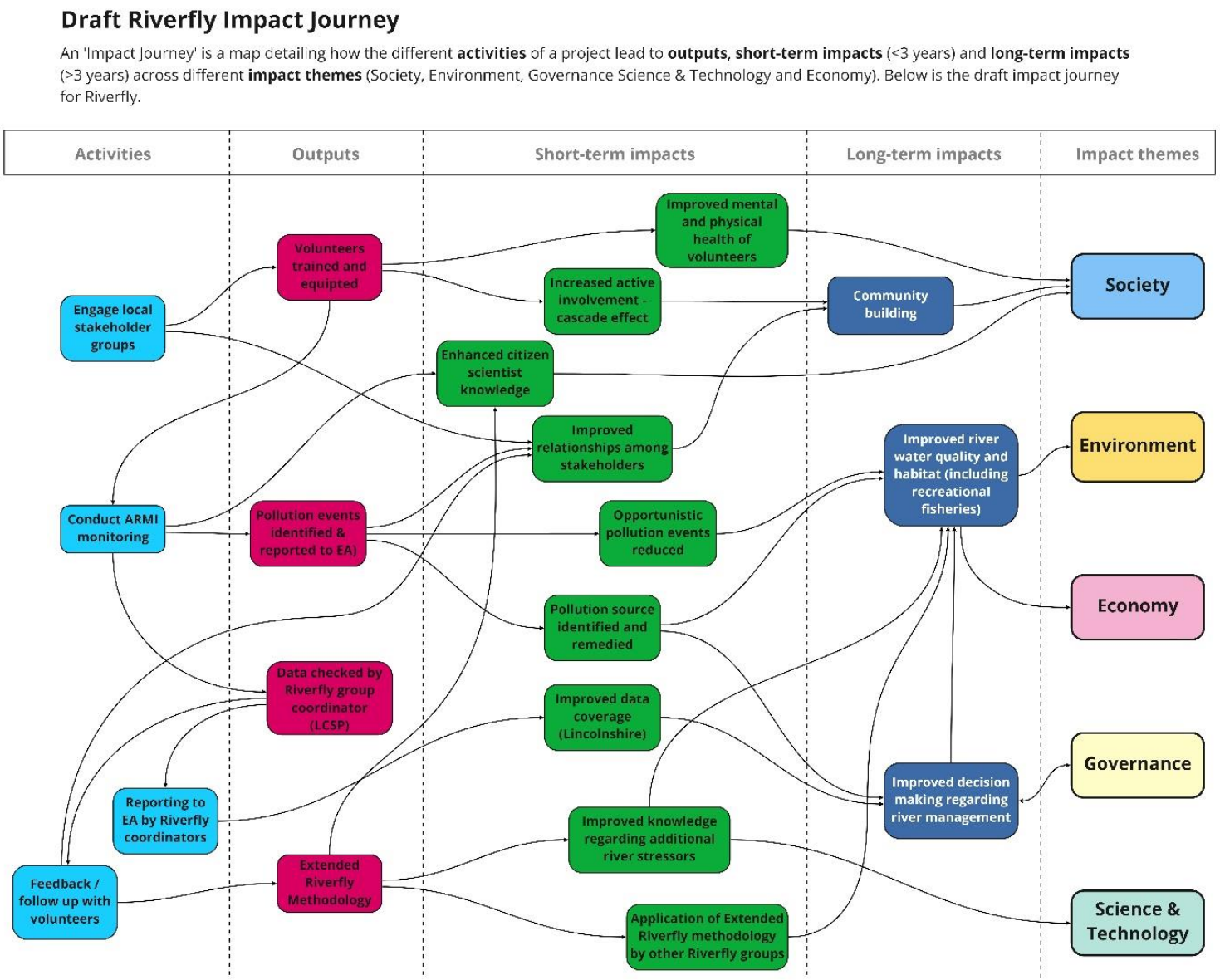


Figure 19. Draft IJM developed for the

Table 10. List workshops organised with the LCSP Riverfly group.

No.	Date	Title of event	Aim / Brief description	Number of attendees	Location
1	20/05/21	Measuring the Impacts of Riverfly	1) To validate the draft impact journey developed for Riverfly by the MICS team, 2) to select impacts to monitor, and 3) begin to develop a draft IMS	3 attendees (non-MICS) 1 project coordinator (LCSP) 1 citizen scientist 1 representative from the statutory agency (EA) 6 MICS team members	Online

8.2.2. Impact Workshop: Measuring the Impacts of Riverfly

Overview of Workshop

Stakeholders engaged with Riverfly monitoring activities coordinated by the LCSP were invited to attend a 2½ hour virtual workshop hosted on 20/05/21. Annexe 5 provides an overview of the proposed structure, content, and activities for the event.

Table 10 provides details of the stakeholder groups present, the number of attendees and location of the event. It was anticipated that 5 - 8 Riverfly volunteers would attend the extent in addition to the project coordinator and a representative from the EA. However, the event received a limited turnout, with only 1 citizen scientists in attendance, the project coordinator and national Riverfly representative. The project coordinator commented that it was "… hard to sell the workshop to my volunteers…", and that prior to the event one citizen had commented that they did not consider themselves "...smart enough..." to participant. This reticence to partake in the workshops is likely due to two factors:

1) Citizen scientist had a lack of understanding regarding how measuring impact could be beneficial to the project.
2) Content sent to citizens in advance of the workshop (i.e., the draft IJM which they had the opportunity to familiarise themselves with) was too complex, and thus off putting.

Despite the low turnout the workshop was informative, with the citizen in attendance being highly motivated and engaged with the project. Additionally, the national riverfly representative from the EA was also associated with the local work, as well as having been instrumental in the development of the Extended Riverfly methodology along with the LCSP Riverfly coordinator.

The workshop was initially planned to be split into two parts similar to the Outfall Safari events. The first part of the workshop would entail three activities during which participants validated different elements of draft IJM (Figure 20), while during the second half participants would be asked to prioritise impacts of importance to them and take part in activities designed to help formulate a monitoring strategy for these selected impacts. However, due to the low turnout it was decided to omit activities related to the formulation of an IMS, as it would be difficult to have comprehensive input without other LCSP citizen scientists.

The reformatted workshop consisted of the following activities:

Activity 1. Verify the Impacts Identified in the Draft Impact Journey;

Activity 2. Verify how are the Impacts of Riverfly Achieved;

Activity 3. Vote for Impacts to Prioritise;

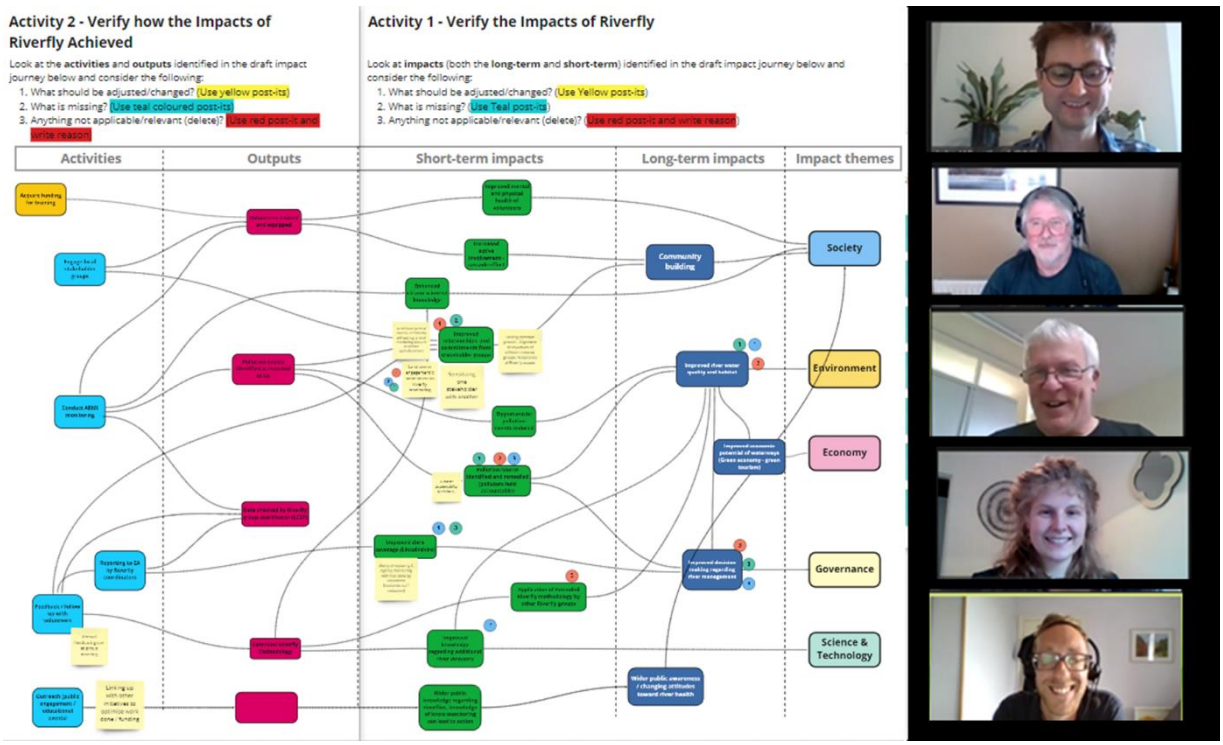


Figure 20. Screenshot taken during the impact workshop with the LCSP Riverfly group. This workshop was held online. Participants can be seen editing the draft IJM displayed in MIRO.

For these activities, the virtual whiteboard software MIRO was used, enabling participants to interact with a pre-loaded version of the draft IJM, and make comments, amendments, and alterations by using virtual post-its. The small size of the group enabled a more informal discussion regarding the various aspects of the IJM.

Outputs of Workshop

Despite the low turnout the event was successful. The primary outputs of this workshop were:

1) a validated IJM (Figure 21) for LCSP Riverfly;
2) a list of short- and long-term impacts selected for monitoring.

Validation of the Impact Journey Map

Several additions and amendments were made to the draft IJM by the stakeholders attending the workshop. These included:

- The addition of two project activities: 'acquire funding for training' and 'outreach (public engagement / educational events)' (IJM Item No. 1 and 6).
- Several suggested amendments / comments related to the short-term impacts: 'improved relationships among stakeholders', 'pollution source identified and remedied', 'improved data coverage (Lincolnshire)', and 'improved knowledge regarding additional river stressors' (Item No. 15, 17, 18 and 20 respectively) (listed in Table 10).
- And the addition of the long-term impact 'improved economic potential of waterways (Green economy - green tourism)' (Item No. 25).

Following the workshop, these additions, amendments, and the general comments made by

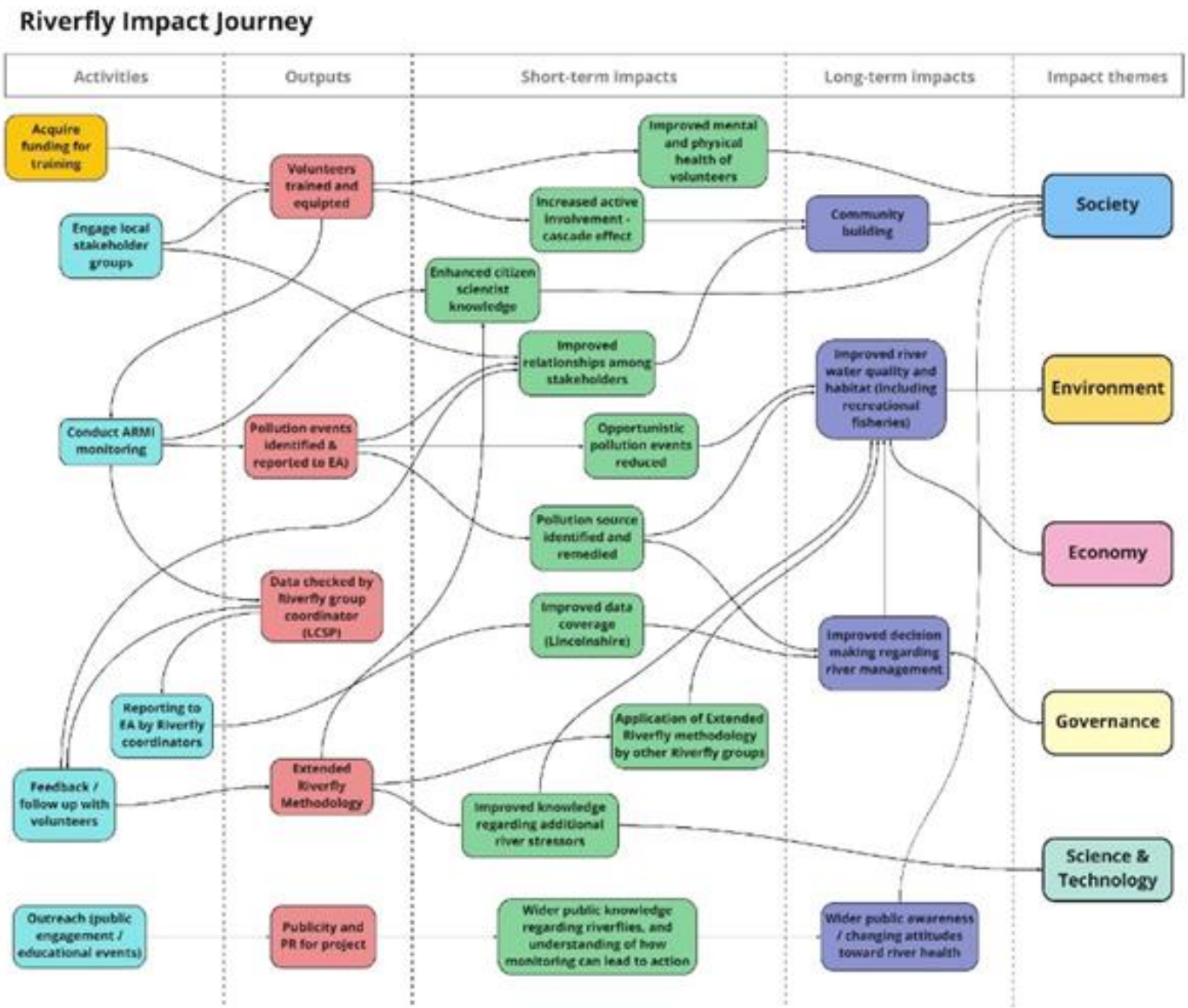


Figure 21. The finalised IJM for the LCSP Riverfly group validated by project managers and citizen scientists who participated in the workshop.

stakeholders were reviewed. It was decided to omit the amendments/expansions suggested for the short-term impacts (15, 17, 18 and 20) as it was believed that these additions were captured adequately elsewhere. One of the comments: 'worry of replacing Environment Agency monitoring with that done by volunteers [outcome: staff reduction]' related to the potential impact riverfly monitoring has on the regulatory agency.

Both the activities impacts were retained in the final IJM as they represented elements of the project not captured in the draft IJM. Additionally, for the activity 'outreach (public engagement / educational events)' the MICS team expanded upon this and added associated outcomes and impacts to fill the gap made in the IJM with the addition of this new item:

- Output: 'publicity and PR for project' (Item No. 11).
- Short-term impact: 'wider public knowledge regarding riverflies and understanding of how monitoring can lead to action' (Item No. 21).
- Long-term impact: 'wider public awareness / changing attitudes toward river health' (Item No. 26).

Table 10. Comments made by participants of the LCSP Riverfly group impact workshop.

Item Type	Participant comments	Related to IJM Item (name and Item No.)
Activities	*'Acquire funding for training'*	Acquire funding for training (1)
	'Annual feedback given at group meeting'	Feedback / follow up with volunteers (5)
	'Linking up with other initiatives to optimise work done / funding'	Outreach (public engagement / educational events) (6)
Short-term impacts		
	'In different parts of country community will vary e.g., a lot of monitoring sites are on private agricultural land'	Improved relationships among stakeholders (15)
	'Finding common ground - Alignment of objectives of different interest groups. Acceptance of Riverfly outputs'	Improved relationships among stakeholders (15)
	'Sensitizing one stakeholder with another'	Improved relationships among stakeholders (15)
	'Greater accountability (polluters?)'	Pollution source identified and remedied (17)
	'Worry of replacing E. Agency monitoring with that done by volunteers [outcome: staff reduction]'	Improved data coverage (Lincolnshire) (18)
	'Landowner engagement/commitment to Riverfly monitoring'	Improved knowledge regarding additional river stressors (20)
Long-term impacts	*'Valued at £9million for Lincolnshire per year. Includes tourism for people coming to the area which comes from its reputation for having a good environment'*	Improved economic potential of waterways (25). Item subsequently combined with Item No. 23: Improved river water quality and habitat (including recreational fisheries)

Several suggestions were made to expand/add to the economic impacts of the project. Comments included: "…[ecotourism] valued at £9million for Lincolnshire per year. Includes tourism for people coming to the area which comes from its reputation for having a good environment". It was suggested

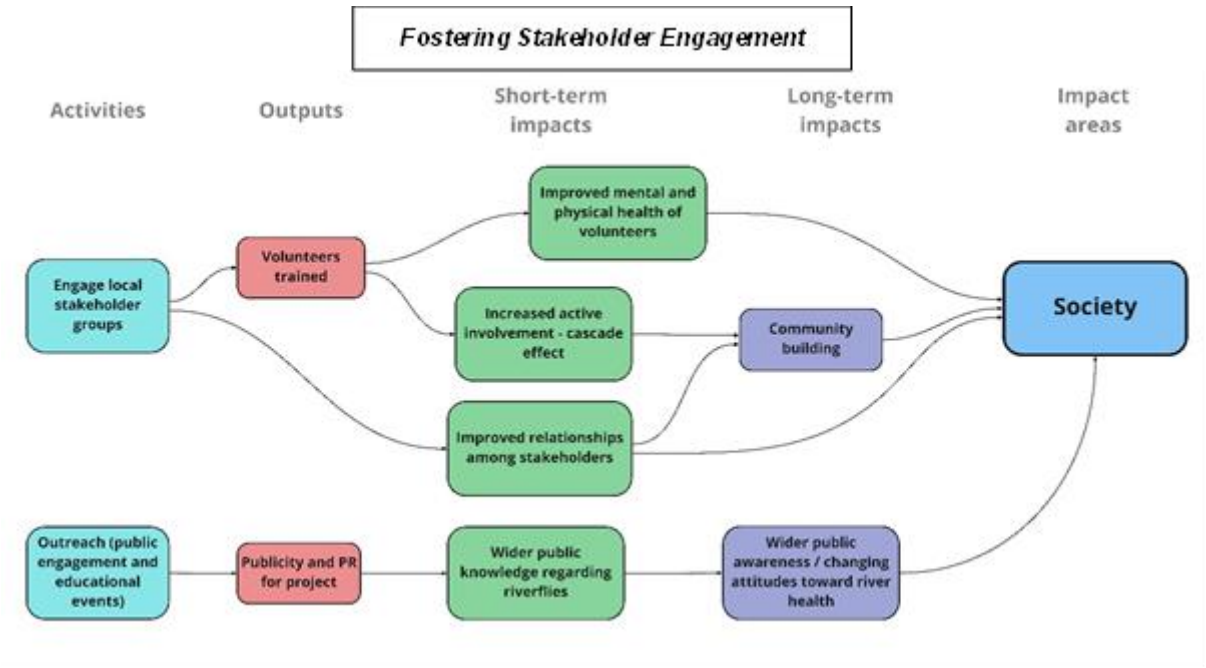


Figure 23. Impact pathways feeding into the Fostering Stakeholder Engagement strategy LCSP Riverfly Hub.

to add a long-term impact ('improved economic potential of waterways (Green economy - green tourism)') to represent this. However, these could be seen to fall within the larger heading of 'improved economic potential of waterways', and the item was removed from the final IJM.

Visual inspection of the finalised IJM of the Riverfly group reveals that the impacts can be grouped into two strategies, relating to the activities and outputs needed to achieve them. These are:

- Fostering Stakeholder Engagement (Figure 22)
- From Data to Action (Figure 23)

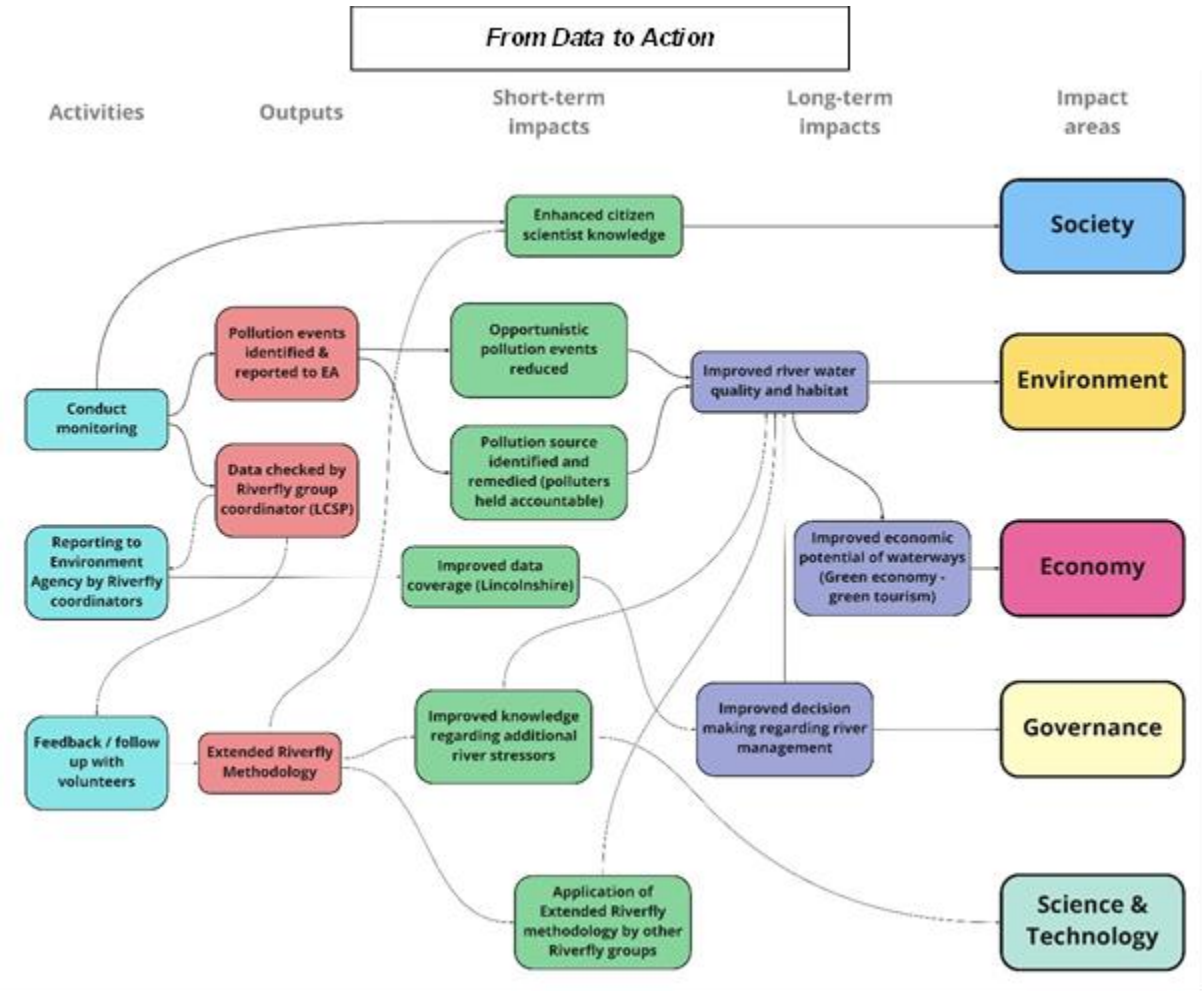


Figure 24. Impact pathways feeding into the From Data to Action strategy for the LCSP Riverfly Hub.

Prioritising Impacts to Monitor

The final task of the workshop was for attendees to vote for short-term and long-term impacts they believed to be most important and should be monitored. The small group may it possible to track which stakeholder voted for which impacts. The results of this are shown in Table 11.

*Table 11. Results of voting for impacts related to the LCSP Riverfly activities. *Item added during the workshop by participants, later merged with Item No. 26: 'wider public awareness / changing attitudes toward river health'.*

Item Type	Impact	Citizen scientist	Project coordinator	EA representative	Total No. of Votes
Short-term impacts	Improved mental and physical health of volunteers				0
	Increased active involvement - cascade effect				0

	Enhanced citizen scientist knowledge				0
	Improved relationships among stakeholders	●	●		2
	Opportunistic pollution events reduced				0
	Pollution source identified and remedied	●	●	●	3
	Improved data coverage (Lincolnshire)	-	●	●	2
	Application of Extended Riverfly methodology by other Riverfly groups	●			1
	Improved knowledge regarding additional river stressors			●	1
	Wider public knowledge regarding riverflies, and understanding of how monitoring can lead to action	Added after the workshop by MICS			
Long-term impacts	Community building	●	●	●	3
	Improved river water quality and habitat (including recreational fisheries)	●	●	●	3
	Improved decision making regarding river management	●	●	●	3
	Improved economic potential of waterways (Green economy - green tourism)*				
	Wider public awareness / changing attitudes toward river health	Added after workshop by MICS			

The citizen scientist, project coordinator and statutory agency representative generally voted for similar impacts. All three voted for the long-term impacts:

- Community building (Item No. 22),
- Improved river water quality and habitat (including recreational fisheries) (Item No. 23); and,
- Improved decision making regarding river management (Item No. 24).

Differences in voting occurred when participants were asked to indicate which of the short-term impacts they wished to prioritise for monitoring. All three voted for 'pollution source identified and remedied' (Item No. 17), and the citizen scientists and project manager also voted for 'improved relationships among stakeholders' (Item No. 15). However, while the project manager and statutory agency representative voted for the short-term impact 'improved data coverage (Lincolnshire)' the citizen scientist opted to vote for 'application of Extended Riverfly methodology by other Riverfly groups'. The low number of participants makes it difficult to draw conclusion regarding the reasons by the different voting habits of the Riverfly stakeholder groups. However, it is interesting to note that the citizen scientist voted for the 'application of Extended Riverfly methodology by other Riverfly group', which may reflect a feeling of ownership and pride in the methodology they helped in developing and the wish to see it applied to other areas. In comparison, the EA representative was more interested (and stated so during the workshop) in what additional information the Extended Riverfly methodology regarding rivers stressors in the Lincolnshire area.

Based on these votes 7 impacts were selected to monitor. These included the five short-term impacts:

- Improved relationships and commitments from stakeholder groups
- Pollution source identified and remedied (polluters held accountable)
- Improved data coverage (Lincolnshire)
- Application of Extended Riverfly methodology by other Riverfly groups
- Improved knowledge regarding additional river stressors

Two of the long-term impacts were also selected by the Riverfly stakeholders for prioritisation:

- Improved river water quality and habitat
- Improved decision making regarding river management

Feedback on the Workshop

At the end of the workshop, an informal discussion was held with the attendees to ask their thoughts about the content and delivery of the workshop.

Content and communication

In addition to the comments made to the project coordinator prior to the event regarding the complexity of the draft IJM (which was circulated in advance of the workshop), the citizen scientist who attended the event stated that "…terminology used in these workshops is often a bit overwhelming/intimidating and not suitable for all".

How IA (and IJM) can Support Citizen Science Projects

Several comments were made regarding the potential use of IJM for dissemination and to support funding bids. This included comments made by the representatives of the EA who stated: "… [this graphical representation of the pathways to impact helps to] summarise the business case for the Riverfly project and helps to justify associated costs and spending…".

Expectations

The comments of participants suggested insufficient understanding regarding what the IA and MICS could offer the case study. It was perceived that MICS "… WANT information from them… [project manager quoting a volunteer]" rather than also having something to offer the project. This could be due to the way in which the event was advertised, however, stakeholders involved in the Outfall Safari workshops received a similarly worded invite and these workshops received a high turnout. This, in turn, could have been due to the fact that those citizens who attended the OS impact workshops were previously engaged in other MICS events and where therefore familiar with impact investigation. It was felt by the event organisers that this sentiment was also shared by those who attended the event; several times participants stated "... [we] hope you got what you need from the workshop...".

It is also to be expected that this series of case studies and validation events have been organised to test the work of MICS as well as contribute to the citizen science projects themselves, so having a dual purpose. Where the application of the IA is solely aimed at and by the citizen science project itself, there will only be a single purpose.

Evaluation of the Workshop

As discussed in the previous sections the poor attendance to the impact workshop held with the LCSP Riverfly Group was likely due to the manner in which the draft IJM was communicated to the project

stakeholders. The MICS team created the draft IJM for the LCSP Riverfly Group based on the contextual analysis of the project. This draft IJM was then circulated to citizen scientists via email prior to the event with the view of promoting discussion during the workshop. While care was taken to adapt the terminology of the IA approach and create a common language between citizen scientists, the project coordinators / partners, and MICS, the feedback from stakeholders would indicate that this was not as successful as it could have been with several stating it was too complex. In hindsight, it would have been more rational to present the draft IJM to citizens during the workshop, where time could be spent explaining the terminology and content of the IJM. Given the complexity of IA careful consideration should be taken when deciding what material is communicated with stakeholders to avoid confusion and alienation. For future workshops it is recommended that the IJM be presented to stakeholders during the impact workshop where it can be explained in a controlled manner.

Additionally, there may have been a disincentivising element in seeing a completed IJM, and confusion as to why they were being asked to 'validate' something that had already been created for them. There may be a benefit of developing IJM with stakeholders rather than just validating a draft IJM already created, as it engages stakeholders in actively discussing impacts of their project, encouraging them to think laterally. This may provide them with a better sense of having contributed to the IJM.

8.2.3. Impact Monitoring Strategy for the LCSP Riverfly Group

As noted, the activities related to developing a draft IMS were omitted from the workshop due to low turnout. The IMS was therefore created by MICS based on the impacts selected by stakeholders during the workshop. Table 12 details the monitoring scheme developed for the impacts selected for Riverfly.

Table 12. IMS developed for the LCSP Riverfly project.

Impact selected to monitor		**Monitoring scheme**				
		Indicator	**Method type(s)**	**Frequency of measurement**	**Responsibility - Who is involved**	**Feasibility**
Short-term impacts	Improved relationships and commitments from stakeholder groups	Quantity and quality of interactions amongst stakeholders	Track interactions	Continually	Project managers	Feasible
	Pollution source identified and remedied (polluters held accountable)	Number of pollution incidents that have been identified and remedied	Count the number of events where trigger breaches have occurred for which remediation action has been successfully carried out	Yearly	Statutory agency	Feasible
	Improved data coverage (Lincolnshire)	Number of Riverfly surveys submitted (per time unit) that are valid	Count number of surveys	Continually – however, report Yearly	Project managers	Feasible - extractable from digital system
		Number of sites with active volunteers	Count the number of sites with active volunteers and the length of time that	Continual – however, report Yearly		Feasible

			records cover (should already be recorded)			
		Number of new monitoring sites established and number of established monitoring sites that are 'active/inactive' on list (per time unit).	Count the number of new sites added to list need to be check by Riverfly Hub manager (Will) and agreed by EA	Yearly		
	Application of Extended Riverfly methodology by other Riverfly groups	Number of Hubs that have held training events in Extended Riverfly methodology (in time unit)	Count the number of Hubs that have held training events and frequency of training events	Twice a year	Project managers – LCSP and RP at national level	Uncertain – depends upon how (and if) Hubs report training activities
		Number of groups with members actively applying Extended Riverfly methodology (in time unit)	Track number of volunteers submitting Extended Riverfly results to National Database	Twice a year	Project managers – LCSP and RP at national level	May be difficult to collate – requires feedback from RP at national level
	Improved knowledge regarding additional river stressors	Number of papers/reports produced by statutory agency using the Riverfly data set	Track for papers and reports produced by statutory agency drawing on (among other sources) the riverfly data set	Twice a year	Project managers, request to statutory agencies	Feasible
		Number of scientific papers produced using Extended Riverfly data set	Track for papers (literature search) drawing on (among other sources) the Extended Riverfly data set	Yearly	Project managers	Feasible
Long-term impacts	Improved river water quality and habitat	WFD status of rivers	Statutory agency monitoring of water quality and biodiversity (invertebrates, fish etc.); existing CS initiatives at the same sites (e.g., FWW)	Unsure – depends on frequency with which EA conducts monitoring and reports	Project managers	Feasible
		Number of pollution incidents reported	Track number of pollution events report	Twice a year	Project managers	Feasible
		River Habitat Survey score	Track River Habitat Survey score	Once a year	Project managers	Feasible
	Improved decision making	LCSP – Number of incidents where results of Riverfly are used to inform	Record, count and track the number of times Riverfly data has been used	Twice a year	Project managers	Feasible

	regarding river management	management decision				
		EA - Number of incidents where results of Riverfly are used to inform management decision	Record, count and track the number of times Riverfly data has been used	Twice a year	Project managers / statutory agencies	Feasible

8.2.4. Feedback from Project Coordinator on the IA Process

Asked to provide further feedback, the project coordinator of Outfall Safari provided the following remarks:

- **What your thoughts are regarding the impact workshops?** "I think the results will be useful in helping to focus effort on the benefits for volunteers/organisers as well as the obvious benefit in informing possible improvements in the way in which we structure the program in Lincolnshire. This could help with presenting the Riverfly volunteer initiative as a more rounded, appealing project when applying to funding and engaging with volunteers."
- **What were the highlights of the workshop? Was there anything that came up that was unexpected?** "Unfortunately, we only had one of our volunteers attend. I feel that some saw it as a 'theory exercise' that didn't relate directly to what they were doing practically. Taking part in the process has a direct benefit for us as an organisation but there was no incentive for volunteers to be part of it i.e. they weren't gaining knowledge or seeing any direct change to their volunteering as a result of it."
- **Do you think the results are useful/can be used to help improve the Riverfly activities the LCSP coordinate?** "I think maybe some of the language used, in particularly on the website, is particularly scholarly, which is right for the reporting, but not engaging if you want volunteers on board. I'm not saying it should be any way 'dumbed down' it just needs to be inspiring to foster engagement."
- How do you think the impact workshops / process we used to investigate impact with you and your volunteers could be improved or changed? *"I think the element that really helped me was that the workshop forced me to think more holistically about the Riverfly project. On a day-to-day basis my concern is always about the results of volunteer work and what that means for the state of the chalk streams. Having done the workshop it made me evaluate more what benefit the volunteers are getting and how I may need to improve how I communicate those benefits better. Also, from an EA perspective the benefits of the project are more long term than to spot specific areas for concern which I need to take into account."*
- **General comment**: "It's a shame that the workshops had to be online because of covid-19 restrictions, I do feel that we could have had better engagement if we'd been able to get volunteers in a room to chat through the different questions."

8.3. Evaluation of Measuring Riverfly's Impact

Riverfly was the second case study to which the MICS IA approach was applied. It offered the opportunity to trial the simplified approach adopted for the IA activities, whereby participants were only involved in the validation of the IJM drafted for the project and selection of impacts to include in

the IMS. The development of the draft IJM was conducted by the MICS team prior to the impact workshop, and the IMS was created following the impact prioritisation. This simplified approach streamlined the IJM development process and reduced the amount of time need for the MICS team to process stakeholder comments.

The approach did succeed in producing a good discussion around the validation of the IJM but the number of participants who attended the workshop was lower than that of Outfall Safari. It was felt that this was due to stakeholders being deterred during communications sent out prior to the event, which displayed the draft IJM. This was perceived to be too complicated by some stakeholders but seeing the draft IJM already created also likely disincentivised their participation. This was borne out from the feedback received from stakeholders present at the workshops. This helps to inform how complex material and content should (or should not be) communicated to stakeholders during the IA approach.

The impacts selected by stakeholders involved in the workshops were more tightly focused on impacts feeding into the Environment domain. This may be reflective of the small size of the participant group, but it may also be an accurate reflection of the effect of a more rigorously scientific citizen science project which does not have public engagement as one of its primary objectives.

While a more tightly focused IJM may show impacts in fewer domains, cautions must be exercised when drawing conclusions about the relative impact of one project over another based on this alone. The IJM used in conjunction with contextual analysis and the results of a well targeted IMS will provide information on the relative weight of the different impact pathways.

9. Marzenego River, Venice, Italy

9.1. Introduction

Within the Marzenego River Basin (Figure 25), urbanisation, intensive agriculture, and channel modification have resulted in increased flood risk, poor water quality, and loss of biodiversity in the rivers entering the Venice Lagoon. To address these challenges, a series of NBS related to river and wetland restoration have been implemented along the Marzenego River and its tributaries.

The Italian case study focuses on two wetland NBS at Oasi Lycaena and Oasi di Noale (Figure 26), a river restoration scheme to reconnect sections of the tributary Rio Draganziolo with its floodplain (Figure 27), and a site proposed for future restoration at the Noale Oasis wetland. Citizen science activities have been embedded with the project with the following aims:

i. To establish a long-term monitoring scheme to generate an evidence base which will enable the evolution and efficiency of the NBS projects to be assessed;

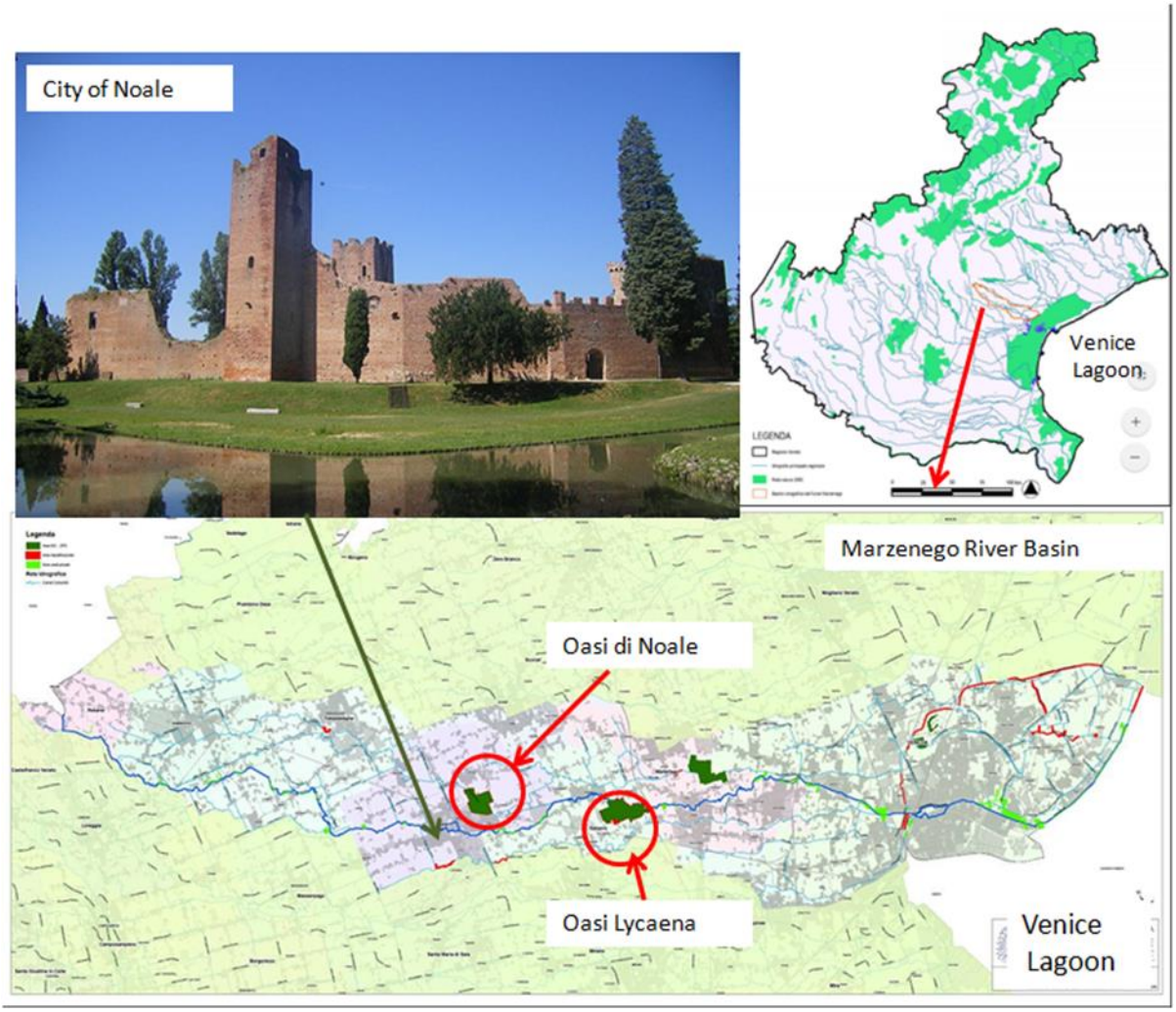


Figure 25. The location of the Marzenego River Basin within the Veneto Region. Note the location of the two wetlands, Oasi di Noale and Oasi Lycaena, within the Basin indicated on the map. The top left photo shows the river as it flows past Rocca dei Tempesta (Noale castle), Noale (maps and photo courtesy of Drainage Authority Acque Risorgive).

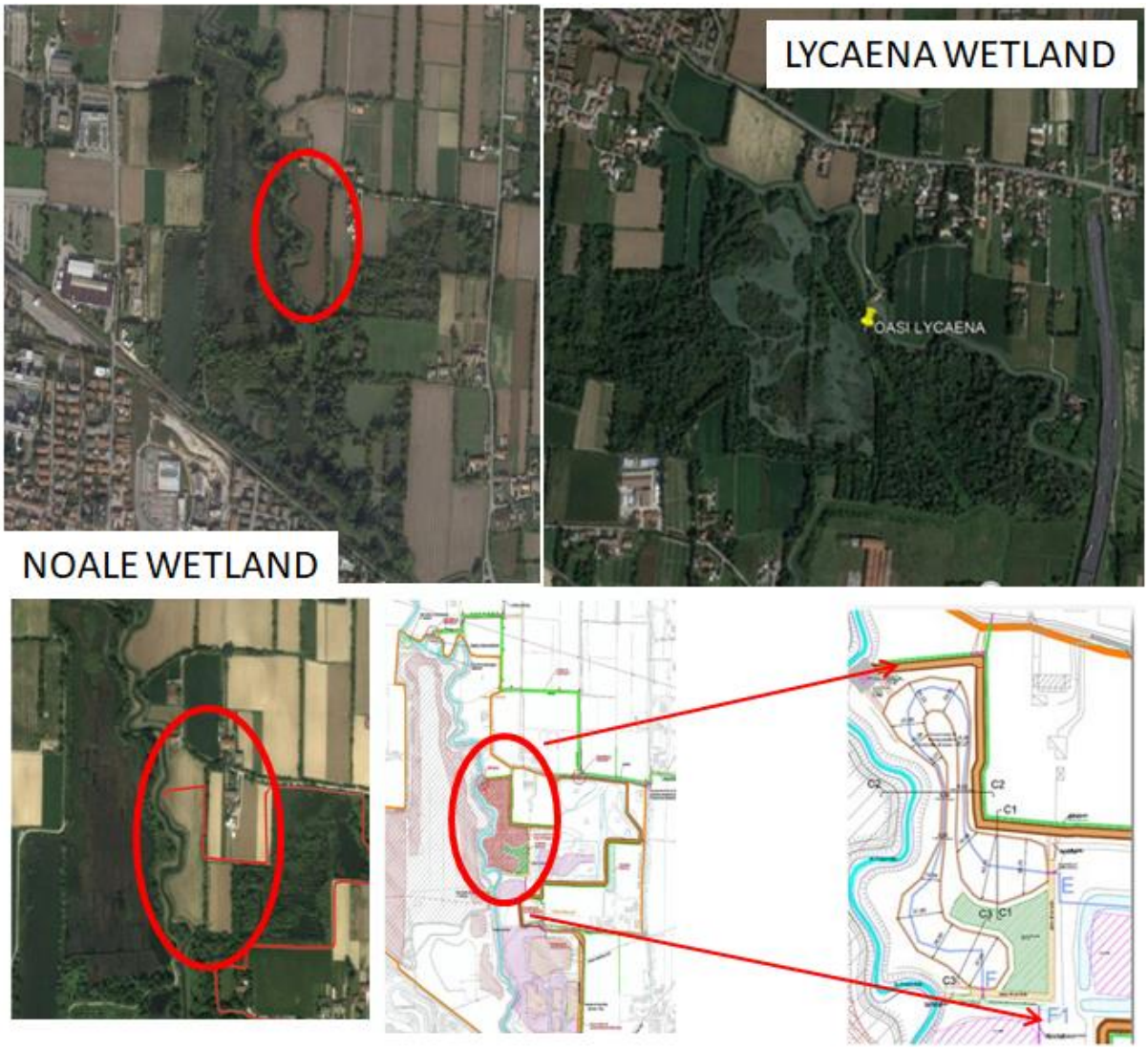


Figure 26. Top row: aerial images of the Lycaena and Noale Wetlands; Bottom row: aerial imagery and map show the restoration project in Noale wetland, transformation from arable field to wetland (map and photos of courtesy Acque Risorgive).

ii. To improve upon the existing participatory process (River Contract);

iii. To reengage with those stakeholders previously active through the River Contract scheme and increase the level of participation by engaging with new citizen scientists; and

iv. To raise awareness regarding NBS and address the lack of knowledge regarding environmental issues.

9.1.1. Summary of the NBS Project

The Marzenego River originates in the north-western part of the province of Treviso in the Venetian Region, Italy (Figure 25). The river flows through a highly heterogeneous landscape, characterised by agricultural, industrial, and urban land use as well as sites of cultural and historical importance before draining into the Venice Lagoon at Mestre.

The Marzenego River and its tributaries have been historically managed for flood control, with large sections of the river being channelised, over-deepened and embanked (Miguez *et al.,* 2017). However, these traditional approaches to flood risk management are increasingly ineffective due to changes in land use within the catchment that have reduced stormwater storage within the floodplain and exacerbated surface runoff. Additionally, intensive agriculture and urban activities have resulted in increased concentrations of nutrients, pesticides, sediments, and pollutants within the watercourse, resulting in poor water quality.

In response to these increasing pressures, the current Eastern Alps District Basin Authorities Flood Risk Management Plan proposes an NBS-based approach. Table 13 lists the primary forms of NBS implemented as part of this project and the water-related challenges they help to address.

The restoration, creation, and conservation of wetlands and riparian habitats were selected to tackle issues related to water quality, acting to filter and store nutrients, sediment, and pollution. Sections of the Marzenego river and its tributaries were also restored, involving re-meandering, widening, and reconnecting the channel with the floodplain. Both actions help to mitigate flood risk by slowing the flow and storing stormwater. The objectives of the FRMP were aligned with the provisions of the Floods Directive (2007/60/EC), that the measures must be compatible with the objectives of the broader WFD (2000/60/EC), to improve the river within a context of integrated catchment management. Implementation of the NBS was overseen by the local drainage authority Acque Risorgive.

Table 13. List of the types of NBS implemented within the Marzenego River case study and the 'water challenges' they help address.

Nature-based solutions	**Water Challenges**									
	Surface water quality				Ground water quality		Floods	Water availability		
	Nutrients	Sediments	Pesticides	Other chemical & emerging pollutants	Nitrates	Pesticides	Upstream watershed	Lower river flows	Lower groundwater levels	Droughts
Riparian buffer strips/Riparian zone restoration	●	●	●				●	●	●	●
Wetland restoration/ conservation	●	●						●	●	●
Construction of artificial wetlands	●	●		●			●	●	●	●
Reconnecting rivers to floodplains	●	●					●			

The Oasi Lycaena and Oasi di Noale (Figure 26) are former clay quarries that succeeded to semi-natural wetland conditions following their abandonment in the 1970s. Prior to restoration the sites had already developed into areas of significant biodiversity value, with both sites being designated Sites of Community Importance (SCI) under the Habitats Directive 92/43/EEC and Special Areas of Conservation (SAC) under the Birds Directive 79/409 /EEC (NAPEA, 2021; Urban Nature Atlas 2021). The Oasi di Noale has strong community engagement, originating in the 1970s with the Committee

Figure 27. The restored section of the tributary Rio Draganziolo. a) aerial image of the section of the Rio Draganziolo; where restoration occurred; b) pre-restoration; c) post restoration; d) image showing the construction of the two-stage channel and remeandering; e) photograph of the site post-restoration.

for the Realisation of a Wildlife Protection Oasis to Locate in Noale Caves following the local municipality's aborted proposal to build a landfill on the site.

Between 1998 and 2006, Acque Risorgive carried out work to reconnect both wetlands with the main river channel. This involved excavating new channels between Marzenego river and its tributaries the Rio Roviego (at Oasi Lycaena) and Rio Draganziolo (at Oasi di Noale) to connect them with the wetlands. Further work was conducted at the Oasi di Noale to improve its ability to function as an NBS for water quality, i.e. improving its filtration and storage potential for nutrients and sediment (Urban Nature Atlas 2021). This work included the creation of additional ponds, the planting of reedbeds and the creation of wooded wetland areas. At both sites, pedestrian paths and amenities were built to promote access to the public. Following these works the Oasi Lycaena and Oasi di Noale wetlands cover a total area of 60 and 40 hectares respectively.

The Rio Draganziolo is a tributary stream that flows for 20km before joining the Marzenego at Noale (Figure 27). Morphologically much of the river retains a semi-natural character, exhibiting well-defined meanders. However, sections of the Rio Draganziolo have been dredged and are over-deepened, and the river is disconnected from its floodplain (Water Museum of Venice 2020hy). Following an assessment of the river conducted in 2010 Acque Risorgive identified a suitable site at Trebaseleghe where restoration works could occur. This included the creation of a two-stage channel over 1 ha and re-meandering of the river (Figure 27). To further accelerate natural recovery, native herbaceous marsh species (helophytes) and tree and shrub species were planted, creating a wet woodland community of black alder, white poplar, and willows (Willow white, gray willow, basket willow), with margins of sedges and Common Reed.

Restoration activities along the Marzenego river and its tributaries are ongoing, and a recent proposal has been made to expand the Noale Oasis to improve its functionality as a wetland NBS. This includes creating a new wetland on 2 ha of former agricultural land, connecting this new wetland to existing ponds, and creating channels to link these with the river Rio Draganziolo. Paths and amenity structures are also planned to promote public use for recreation and education. This work will create a further 14 ha of wetland. Similar to the Oasi Lycaena and Oasi di Noale this wetland NBS will filter and store nutrients, sediment and pollution in addition to storing flood water. It has been estimated that the project will lead to a reduction in the nitrogen load to Rio Draganziolo of 4.3 t / year.

Monitoring of the functioning and efficiency of the ecosystem services provided by the wetland and riparian complex created by these NBS projects is necessary in order to fully realise the potential of these existing and proposed NBS. However, to date, no monitoring has been implemented and there remains an evidence gap regarding their performance and effectiveness.

9.1.2. Previous Citizen Science

In Italy citizen science is recognised as being important but is many applied at a local scale to address local issues, e.g., ecosystem restoration and issue-specific ecosystem-related actions. Prior to the MICS project local stakeholders were engaged with the Marzenego River NBS project through a participatory process Contratto di fiume (River Contract). The contract is a voluntary agreement between local authorities and private landowners as a form of negotiated and shared planning procedure (Cialdea & Cacucci, 2017), and which has been applied across Italy since 2007. This agreement adopts a rules-based approach in which the criteria of public utility, economic performance, social value, and environmental sustainability are treated equally to ensure appropriate restoration options are selected to address local and wider issues within the River Basin.

The Marzenego River Contract was initiated in 2012 with the support of Acque Risorgive. The scheme met with initial success with a total of 30 individuals (including private citizens, local school groups, and farmers) signing the Contract. However, the Contract came to a standstill in 2017 since when no citizen science activities have been associated with the scheme.

Separate to the Marzenego River Contract initiative, a scheme run by a local high school focuses on water quality monitoring within the Lycaena wetland. This scheme has been running since 2015 and was established as part of the high school curriculum in collaboration with Acque Risorgive.

The following sections provide a summary of the co-design process and subsequent citizen science activities coordinated by MICS within the Italian case study. Full details regarding the co-design workshops and citizen science monitoring can be found in the MICS deliverable D4.2 (Gumiero *et al.,* 2020).

9.2. Co-Design of the Citizen Science Activities

Several face-to-face and online workshops were held to co-design citizen science activities with key stakeholders involved in the Marzenego River NBS project. Table 14 lists all the co-design workshops held within the Italian MICS case study, the number of stakeholders in attendance and the location of the event. A key aim for MICS was to (re)engage with the stakeholders involved with these citizen science initiatives, and to learn from the previous experience of the River Contract initiative in order to improve the participatory process.

Table 14. List of co-design workshops held with stakeholders associated with the Marzenego River NBS project. Note: rows highlighted in yellow are described previously in MICS deliverable D4.2 (Gumiero et al., 2020).

No.	Date	Title of Event	Number of attendees	Location
1	3/12/19	Co-design for Marzenego River	28 attendees (9 MICS team members)	Noale, Venice
2	14/07/20	Co-design summary of the Noale meeting results	8 attendees (5 MICS team members)	Online
3	21/07/20	Co-design for water quality	7 attendees (5 MICS team members)	Online
4	23/07/20	Co-design for Vegetation/biodiversity	9 attendees (2 MICS team members)	Online

The different stakeholder groups engaged in the co-design process and subsequent citizen science activities are documented in Table 15. Primary and secondary school students were engaged indirectly through teachers, and it was agreed that separate events and monitoring activities would be organised to accommodate their availability.

Table 15. List of stakeholders engaged during the co-design process for the citizen science activities associated with the Marzenego River NBS project.

Stakeholder type	Groups engaged
Citizens	• Local community and cultural heritage groups • Angling clubs • Sailing and canoeing clubs • Cycling clubs • Environmental associations (including former signatories of the Marzenego River Contract) • School groups (primary and secondary school students)
Scientists	• University of Bologna
Public sector actors – legislative (policy makers)	• Veneto Region Authority • AAWA
Public sector actors - executive (local authorities; RBO; implementing agencies)	• Drainage authority (Acque Risorgive) • Municipalities of Martellago, Noale and Venice • Regional environmental agency (Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto - ARPAV) • Utility company (VERITAS)

Industry/Private sector	• Farmers union (Confederazione Italiana Agricoltori - CIA)

Participants of the co-design workshops identified three environmental aspects of the Marzenego River they believed should be monitored:

1) Water quality
2) Habitat quality and biodiversity
3) Flood risk

Of these, flood risk was recognised as being difficult to monitor within the timeframe of the project. It was therefore decided to prioritise establishing methodologies for monitoring water quality, biodiversity, and landscape quality.

The methods to be used, the tools, and the frequency of monitoring of the environmental targets (water quality, habitat, and biodiversity) were agreed by all stakeholders during the final co-design workshop. The discussion resulted in the agreed methodologies outlined in Table 16 and implemented by the citizen scientists over the following 15 months.

Table 16. List of the methods used to monitor the environmental parameters selected for the citizen science activities within the Italian case study.

Parameter of Interest	Indicator to measure	
Water quality	Physical	Turbidity
		Water level
	Chemical	Conductivity/ salinity
		Nutrients
	Biological	Microbiology (E. coli)
Habitat quality and biodiversity	Aquatic vegetation	
	Riparian vegetation	

9.3. Undertaking the Citizen Science Activities

Despite disruptions to the monthly monitoring schedule due to COVID-19 restrictions, between October 2020 and August 2021 over 120 water quality samples and about 30 samples for microbiological analysis were collected. Twenty habitat assessments – 15 riparian vegetation and 5 aquatic vegetation surveys – were also completed.

Twenty sites were selected for repeat water quality sampling, with 6 sites targeted for microbiological analysis to determine presence of Escherichia coli, and 4 sections of river for riparian habitat assessment.

Eight groups of citizens, including school groups of various ages, actively participated in the sample collection, analysis, and survey activities. Activities and methodologies were adapted to the differing abilities of the groups, requirements of the school curricula, and limitations imposed by COVID-19 precautions. Primary school children were engaged as class field trips, where groups of around 20 students would visit the NBS locations and participate in simple data collection exercises. Older high

school students carried out laboratory analysis of water samples collected by members of the school faculty. In total, 324 students participated in the NBS monitoring activities.

Citizens undertook their sampling activities usually in small groups of 2-3, and after receiving training were able to do this relatively independently and reliably. About 50 people participated in at least one of the meetings, of which a core group of 10 became very active citizen scientists, participating in multiple activities and helping to coordinate the involvement of others.

The Acque Risorgive, the Regional Agency for Environmental Protection and Prevention of Veneto (Agenzia Regionale per la Protezione Ambientale Veneto – ARPAV) and the Noale municipality also continued to actively support the MICS project and the citizen scientist monitoring activities.

A full list of the citizen science events held within the Italian case study is given in Table 17. Of these, Events No. 5 – 7 are described in MICS deliverable D4.2 (Gumiero *et al.,* 2020). A summary of these is provided below, along with a description of Events No. 8 – 13.

Table 17. List of citizen science activities held with the Italian case study. Note: rows highlighted in yellow are described previously in MICS deliverable D4.2 (Gumiero et al., 2020).

No.	Date	Title of Event	Number of attendees	Location
5	31/08/20	Water quality monitoring		Noale
6	19/09/20	Water quality monitoring / Habitat quality mapping (riparian vegetation)		Martellago
7	02/10/20	Water quality monitoring – School group		Mirano
8	11/02/21	Feedback meeting: what we have done and what we will do	6 attendees (5 MICS team members)	Online
9	25/05/21	Feedback meeting: MICS results and experience (Schools group)	343 students (18 classes), 25 teachers and 3 technicians (3 MICS team members)	Online
10	19/06/21	Habitat quality and biodiversity – Aquatic and riparian vegetation		Trebaseleghe / Draganziolo restored flood plain
11	20/06/21	Habitat quality and biodiversity – Aquatic and riparian vegetation		Noale Wetland
12	22/07/21	Impact Monitoring Workshop: Impacts Evaluation of MICS Project	**18 attendees:** 4 school teachers 1 statutory agency representative 1 representative from Acque Risorgive 2 representatives municipality government 10 volunteers (affiliated with local groups interest groups	

13	04/08/21	Water quality monitoring – held to coincide with statutory agency monitoring (ARPAV)		All study area
1	3/12/19	**Co-design** for Marzenego River	**28 attendees** (9 MICS team members)	Noale, Venice
2	14/07/20	**Co-design** summary of the Noale meeting results	**8 attendees** (5 MICS team members)	Online
3	21/07/20	**Co-design** for water quality	**7 attendees** (5 MICS team members)	Online
4	23/07/20	**Co-design** for Vegetation/biodiversity	**9 attendees** (2 MICS team members)	Online

9.3.1. Water Quality Monitoring

Training events (Events No. 5 and 6) for water quality monitoring were held in August, September and November of 2020 and are described in detail in D4.2 (Gumiero *et al.,* 2020). The main objectives of these events No. 5 and 6 were: 1) train the trainers for citizen science activities; 2) Define the experimental design in detail; 3) identify 'expert citizens' suitable and willing to coordinate the monitoring activities of smaller groups of citizens. These activities were supported by World Wide Fund for Nature (WWF) Italy, who manage dissemination activities for the Noale wetland

For monitoring nutrients and turbidity, citizens used the water chemistry kits supplied by Freshwater Watch (FWW). Full details regarding the sampling method and kits can be found in the FWW methods manual (FWW, 2021). After conducting the tests, participants added their data to the FWW database, in addition to photographs and supplementary notes.

For microbiological analysis (E. coli) citizen scientists employed HyServe Compact Dry TC kits that are user friendly, low-cost, and produce reliable results (Farnham *et al.,* 2017).

A separate event was held to train student groups in water quality monitoring in November 2020 (Event No. 7). During this meeting two professors expressed an interest in organising an experiment as part of the monitoring campaign. The aim of this experiment would be to test the reliability of the HyServe kits used for microbiological (E. coli) analysis. Students would compare the results obtained by citizen scientists during the field surveys using the kits with those obtained through analysis of water samples under laboratory conditions. Further meetings were arranged with the professors, a representative of the national environmental agency (ARPAV) and a citizen with experience using the HyServe kit to formalise the experimental program. During the subsequent experiments, it was also possible to validate the FWW kits used and to develop a reliable 'home' method of sterile water collection and incubation at a temperature of 37 +/- 1 degrees, with the use of simple and inexpensive instruments. The results obtained during these experiments were presented by the students in an online meeting (Event No. 9) held on May 25th (Figure 28).

Figure 28. Photographs and screenshots of the water quality monitoring activities held with school groups and the online event to discuss the results of their work.

During August 2021, citizen science activities associated with water quality were scheduled to coincide with statutory agency monitoring (Event No. 13). Citizen scientist groups were allocated sections of the river to collect water samples. Sampling occurred in the lower part of the Marzenego in the morning of the 5th August, in the Martellago area at midday, and in the Noale in the early afternoon. The Noale oasis was sampled by the WWF on the same day, while samples were obtained from the Lycaena oasis on August 2nd.

9.3.2. Habitat Mapping and Biodiversity

Activities associated with aquatic and riparian vegetation mapping were initially scheduled to begin in 2020 but were postponed due to the COVID-19 restrictions. Volunteers surveyed only a single case study site during the training event at Martellago (Training Event No. 6) during the training event at Martellago (Training Event No. 6), and additional training sessions were carried out in June 2021 (Events No. 10 and 11)

The first of these took place at the restored floodplain at Trebaseleghe (restored in 2010), while the second event was held at the newly created wetland at Noale Oasis (Figure 29). At the first event, citizen scientists received an introduction to the characteristics and functioning of riparian habitats, including the types of vegetation that would be identified and mapped as part of the methodology of the citizen science monitoring activities. Citizen scientists were shown how to identify 12 target species of aquatic vegetation with the aid of an identification guide and had the opportunity to practice under the guidance of an expert (Figure 29 Annexe 7). The second event at the Noale Oasis focused on the method for identifying and mapping riparian vegetation using the mobile application RiVe (Annexe 8). At this event, it was also decided which citizens would be responsible for coordinating the sampling activities in the various areas: 1) Noale and 2) Lycaena wetlands, 3) Draganziolo and Trebaseleghe floodplain, 4) Marzenego river.

Figure 29. Photographs taken during training events 11 and 13 - Training on aquatic and riparian vegetation – at the Trebaseleghe / Draganziolo restored flood plain and Noale wetlands respectively.

9.3.3. Reflections on Citizen Science Activities

Throughout the co-design process, citizen science activities and impact assessment process for this case study, it has been recognised that engaging with local interest groups such as cultural and environmental associations present an effective means of reaching larger networks of people. In many cases, the citizens who attended events were representatives and fed material back to the other members of their respective associations. The total number of citizens engaged, therefore, is higher than the number who attended the meetings.

Successful collaboration with these local associations has depended greatly on building rapport through inclusivity, active ongoing communication and delegation of responsibility. Including local partners in the organisation of events and preparation of communication materials and supporting them in their own productions improves both dissemination and the perceived inclusiveness of the process.

The COVID-19 pandemic had the potential to significantly disrupt local collaboration through the loss of communication and action (particularly outdoor field activities which are an effective means of engaging citizens and retaining interest). To mitigate this risk, other engagement tools such as virtual simulations, online meetings, e-mails, and newsletters were employed during periods where more severe COVID-19 restrictions did not allow field activities to take place. These were most successful when they offered variety in the information presented, e.g., first-hand accounts from local citizen

scientists as well as in-depth articles, and when local associations were actively involved in their production.

Of particular interest in this case study was the development of the experimentation programme for high school students which arose organically out of the involvement of educators, regulatory bodies and the MICS team researchers. Opportunities for collaboration between researchers and citizens give the possibility to develop positive and unexpected synergies. This experience also highlights the considerable potential that can be developed by working with local high schools: a citizen-science avenue that should be encouraged where possible.

9.4. Measuring the Impact of the Marzenego River NBS Project

9.4.1. Application of the MICS IA Approach to the Marzenego River NBS Project

Unlike Outfall Safari, for which the IJM was developed from a blank canvas with stakeholders a draft IJM for the Italian case study was developed by the MICS team and later validated by stakeholders engaged with the Marzenego River NBS project. For the development of the draft IJM a review of the IJMs created previous for other MICS projects (i.e., Outfall Safari and Riverfly) was conducted to see if any items were pertinent to the Italian case. These were often generic elements of citizen science project, e.g., 'engage local stakeholders' or 'agree a monitoring strategy'. New items were then created that captured the activities, outputs and impacts specific to the Italian case. This involved a group effort with members of WP4 (WP4 lead – RRC and the Italian project coordinator – AAWA) and WP2, evaluating the contextual information about the Italian case during which the IA compendium was also completed. Table 18 summaries impact domains in which the Italian case study seeks to engender impact(s) and the rationale behind focusing on these domains. The Italian case study is shown to have impact in all five of the MICS impact domains.

Table 18. Impacts of the monitoring activities associated with the Marzenego River NBS project grouped according to impact domain.

Domain	Marzenego River NBS project
Science & technology	• To provide evidence for the effectiveness of the NBS put in place along the Marzenego river in e.g., reducing flood risk, removing nutrients and pollutants etc. • To develop new methods / verify the reliability of existing methods used for monitoring (through experiment conducted in partnership with schools involved in project).
Society	• To raise public awareness of sustainable river management practices including NBS. • To engender a sense of ownership of NBS within community. • To reconnect people with nature • To reach out to new generation of citizen scientists (school students).
Environment	• To provide evidence for the effectiveness of the NBS put in place along the Marzenego river in e.g., reducing flood risk, removing nutrients and pollutants etc. • To monitor the biodiversity of newly implemented NBS. • To guide restoration and management decisions • To help in the identification of new sites to implement NBS.
Governance	• To promote the uptake of co-design (bottom up) citizen science projects. • To increase collaboration between citizens and local governmental authorities and statutory agencies so as increase transparency and trust in the decision making process.

Economy	• To reduce the costs associated with statutory monitoring through citizen science monitoring • To reduce the costs associated with remediation through rapid response to pollution incidents (adoption of an alarm /trigger system has been suggested similar to that employed by the UK case study, Riverfly).

The draft IJM developed for the Marzenego River NBS project is shown in Figure 30.

An additional difference from both previous UK case studies was that the Italian IJM was dramatically simplified to contain fewer items. This was done to make it easier to read and accessible to project stakeholders. For example, in the Outfall Safari IJM, the activity 'engage local stakeholder groups' has six causal relationships, of these five relate to having engaged with specific stakeholder groups, i.e. 'volunteers engaged', 'statutory agency engaged', 'local authorities engaged', etc. While useful for developing a complete picture, these fall comfortably under the main heading 'stakeholders engaged'.

Similar to the UK case studies, items within the IJM created for Marzenego River NBS project were recorded in an excel spreadsheet so that their origin and any suggested changes made to them could be tracked. This included recording the origin of the item (i.e., created by the by the MICS team, modified, or adopted from IJM created for other MICS projects, or suggested by project stakeholders), whether it underwent any modifications or alterations during the validation process, and if it was retained in the final IJM. This information is summarised in Table 19 and shown in full in Annexe 9.

Table 19. Items identified in the IJM developed for the Marzenego River NBS project.

Item Type	Item Number	IJM Title
Activities	1	Engage local stakeholders (citizens and local authorities)
	2	Involvement of schools
	3	Monitoring activities
	4	Common projects between the different schools
	5	Data processing
	6	Methods adaptation and validation
	7	Environment training/education
Outcomes	8	More suitable and reliable methods
	9	Quick collection of many environmental datasets and measurements
	10	Scientific evidence on the effectiveness of NBS
	11	Restart River Contract
	12	Monitoring activities defined
	13	Improved citizen scientist understanding of data
	14	Early warning system
Short-term impacts	15	Increased collaboration of local stakeholders with local Authorities
	16	Enhanced environmental databases

	17	Increased citizen awareness for environment (es. riparian vegetation, water and NBS)
	18	Improved data interpretation
	19	Early identification of problems
	20	Increased connection between groups of active/sensitive citizens
	21	Increased connection between different schools via joint project
	22	Develop a network between different schools
	23	Increased (theoretical) knowledge
	24	Reduced cost monitoring for regional environmental authority
Long-term impacts	25	Increase in bargaining power based on evidence gathered
	26	Increased environmental databases (as official monitoring extension)
	27	Official monitoring extension
	28	Improved knowledge of freshwater ecosystems and NBS
	29	Evidence on the importance of NBS
	30	Improved flood risk management
	31	Authorities increase decision-making skills
	32	Increased recognition of the scientific role of secondary schools in environmental management
	33	Community building
	34	Greater confidence in the authorities
	35	Increased confidence in science
	36	Modify individual behaviours
	37	Increased uptake of NBS to tackle environmental issues
	38	Identification of sites to be protected
	39	Improved wetlands (NBS), river quality and riparian vegetation

To validate the draft IJM created for the Marzenego River NBS project and identify impacts to monitor for the case study a workshop was held with the stakeholders engaged with the project. During the preparation for the workshops the case study lead (AAWA) expressed an interest in involving younger project participants (i.e. school groups) in the IA approach. However, it was decided that there would be significant challenges in involving students in the IA workshops. Instead education professional would be invited to attend the event as a means of capturing the school groups perspective on the project impact

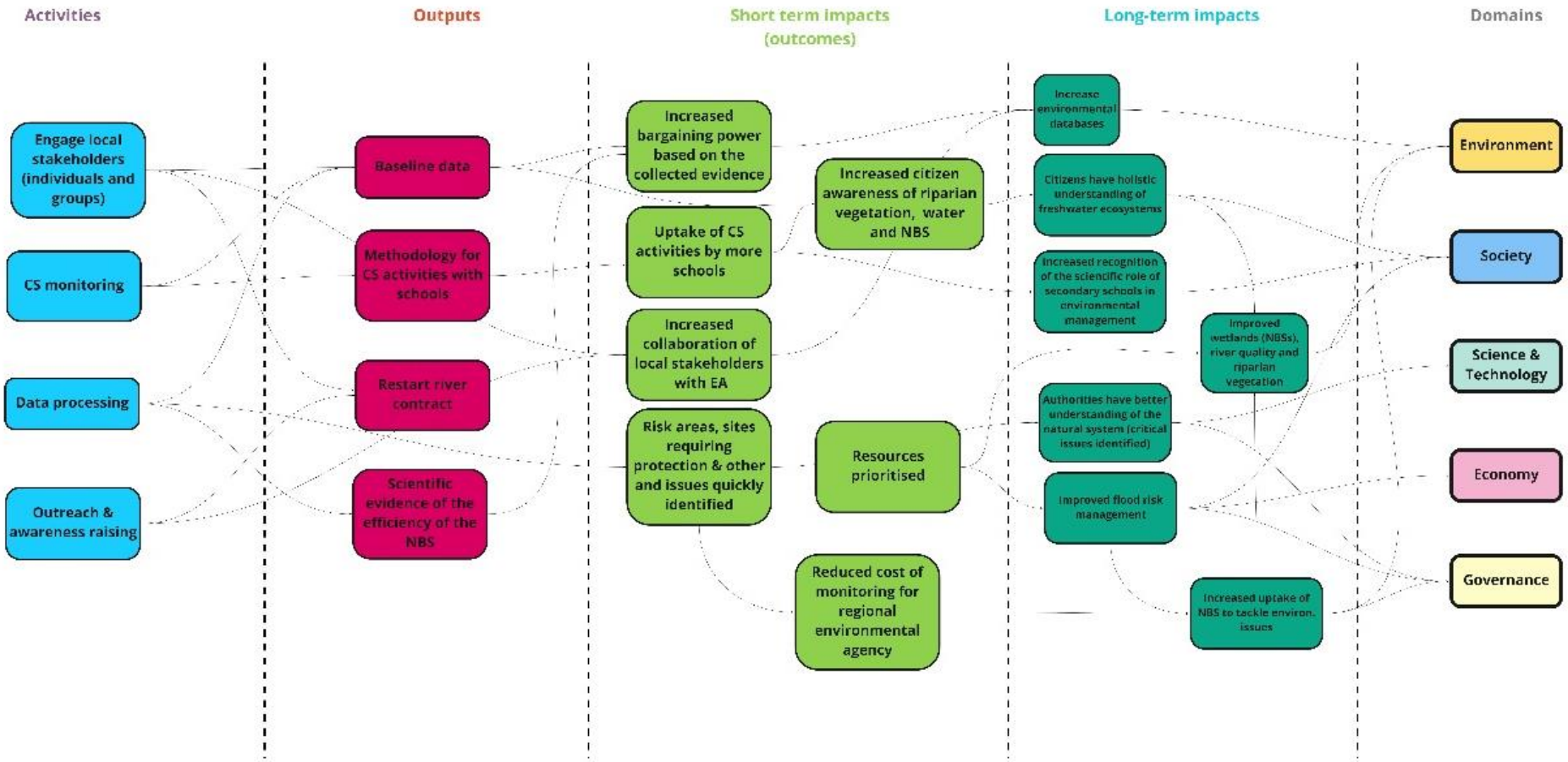


Figure 30. Draft IJM developed by the MICS team for the Marzenego River NBS project.

9.4.2. Impact Workshop: Investigating the Impacts of the Marzenego River NBS Project

Overview of Workshop

Stakeholders involved in citizen science activities associated with the Marzenego River NBS project were invited to attend a 2-hour face-to-face workshop hosted on the 21/07/21. A total of 18 stakeholders attended the event representing several groups:

- Education professionals
- The regional environmental agency (ARPAV)
- The drainage authority (Acque Risorgive)
- The municipal government
- Citizen scientists involved in project monitoring
- Citizens associated with local interest groups

Figure 31. Photographs taken during the impact workshop held with the stakeholders involved in the Italian case study.

- WWF Italy

Tables 17 lists the details of the events, the attendees and location. The workshop content and activities centred on the validation of the draft IJM created for the Marzenego River NBS Project shown in Figure 30. A full description of the workshop structure and schedule is provided in Annexe 10.

Activity 1. The participants were split into four smaller groups and worked through four activities:

Activity 2. Validating the short-term impacts identified in the draft Impact journey;

Activity 3. Verifying and validating the long-term impacts identified in the draft Impact journey;

Activity 4. Verifying how the impacts of Marzenego have/will be achieved;

Activity 5. Voting for impacts to prioritise (activity completed following the workshop).

Large written copies of the draft IJM were given to each of the groups who annotated them (adding, amending, and removing items) while answering the activity questions (Figure 31).

In addition to amending and validating the draft IJM as described in the Outputs of the Workshop below, the four groups also had a wider discussion around some of the items in the IJM, and some key points raised include:

- **Group 1 (composed of citizens' associations):** Participants agreed on the need to have an effective communication network both between citizens and with institutions to ensure that logistical details are well understood by the parties involved, and more generally to promote the feeling of working together towards common goals.
- **Group 2 (composed of four teachers):** The four teachers appreciated the interaction that took place between the different schools thanks to their participation in a common project. This partnership between different schools was a completely new opportunity and given the results, they would like to maintain it in the coming years. One of the teachers pointed out that CS activities have multiple benefits by addressing real problems and improving understanding. Carrying out practical outdoor activities provided greater interest for students, and also promoted a sounder understanding of the theoretical concepts.
- **Group 3 (composed of citizens' associations):** the spokesperson of the group expressed the importance of feeding data and results back to the citizen scientists involved in data collection in a timely fashion. Similarly, they underlined the importance for those who participate to understand the general framework of the project as well as its final objectives, e.g., how will the collected data be used? Promoting understanding of the rationale behind the work as well as sharing results should increase citizen scientist retention by demonstrating in practical and real terms the value of their effort towards the project. This group also emphasised the opportunity presented by NBS and citizen science projects for wider engagement, for example through publishing regular updates or results in local media.
- **Group 4 (composed of the environmental agency, the Acque Risorgive and the two municipalities):** This group understood the value of sharing data with citizens, but emphasised the importance of robust data verification processes before publication, particularly where data originates from citizen science projects. There is a risk that an “early warning system” can be complicated and potentially dangerous if the necessary checks are not carried out as it could create false alarms or misinterpretations. They acknowledged that this is a difficult subject and suggested educating citizens on the importance of verification and the nature of data processing and compilation, as well as carefully designing citizen science methodologies

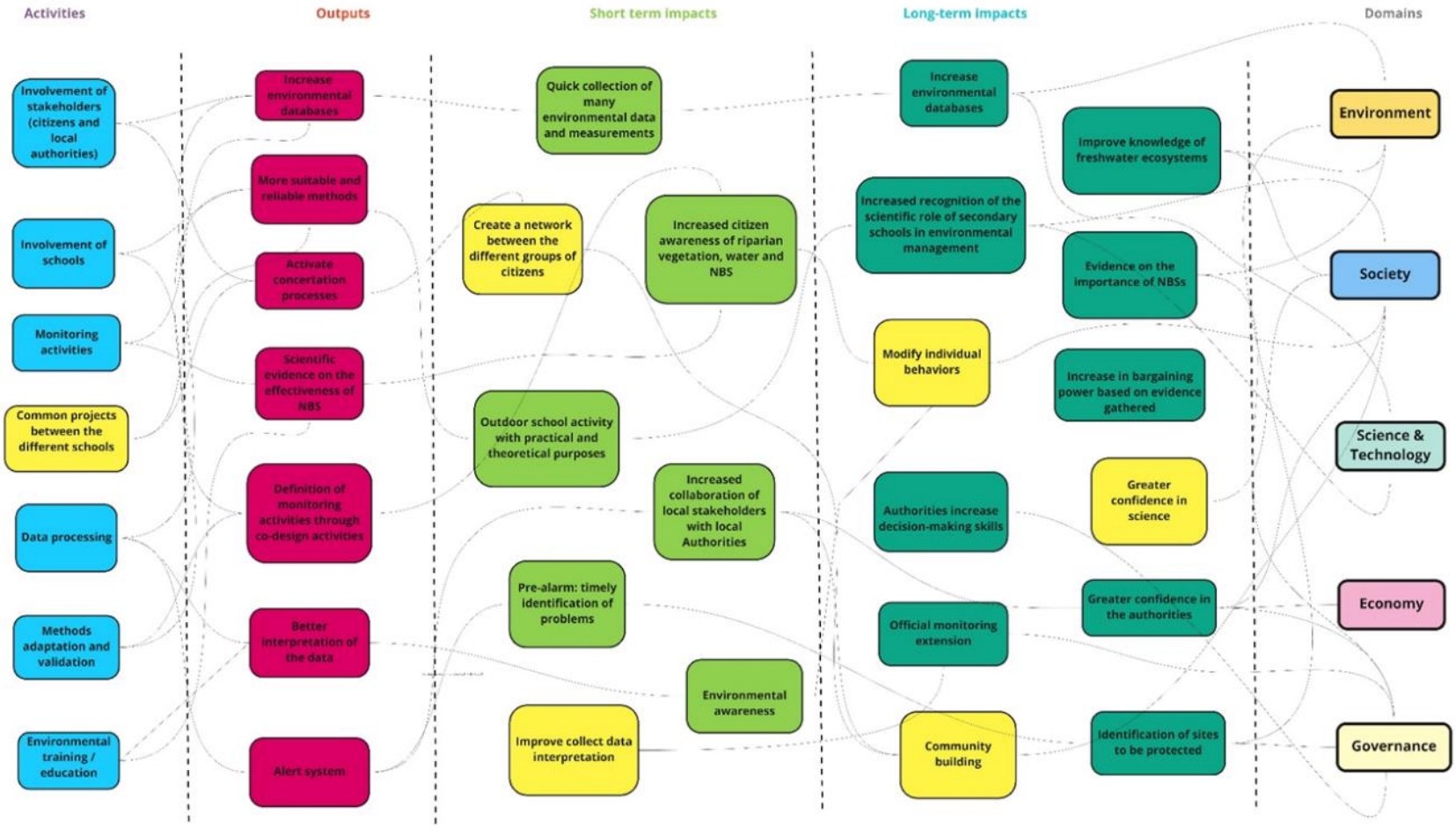


Figure 32. The edited version of IJM for the Italian case study. Items in yellow boxes were added to the map during the impact workshop.

to be as reliable as possible from the outset.

Following the completion of the first three activities, representatives from each group presented their results and details of the topics discussed. The final task of the workshop (Activity 4) was selecting short- and long-term impacts, from the journey map, to monitor. As the previous activities had overrun, it was agreed to carry out Activity 4 after the workshop and participants cast their votes by email (15 of the 18 participants responded by email to cast their votes).

The edited IJM for the Italian case study containing the comments made by stakeholders at the event is shown in Figure

Outputs of the Workshop

The primary output of the workshop was a validated IJM (Figure 33) for the Marzenego River NBS Project.

Validation of the Impact Journey Map

The workshop was an informative event, and participants enthusiastically discussed the IJM created for the project, making several suggestions as to how it could be amended/altered for improvement. These included:

IJM activities:

- The division of the project activity 'engage local stakeholders (individuals and groups)' (IJM Item No. 1) to distinguish engaging schools' groups as a separate activity ('involvement of schools' IJM Item No. 2)
- The addition of the activity 'common projects between the different schools' (Item No. 4)

IJM outputs:

- The addition of the outputs:
- 'More suitable and reliable methods' (Item No. 8) – based on evidence gathered by schools' projects.
- 'Better interpretation of the data' (Item No. 13)
- 'Early warning system' (Item No. 14) – related to developing a pollution 'trigger level' that defines when the environmental agency takes action.

IJM short-term impacts:

- The addition of four short-term impacts:
- 'Improved data interpretation' (Item No. 18)
- 'Increased connection between groups of active/sensitive citizens' (Item No. 20)
- 'Develop a network between different schools' (Item No. 22)
- 'Increased (theoretical) knowledge (Item No. 23)
- The removal from the IJM of 'reduced cost of monitoring for regional environmental agency' (Item No. 24)
- The reclassification of 'increased bargaining power based on the collected evidence' (Item No. 26) as a long-term impact

IJM long-term impacts:

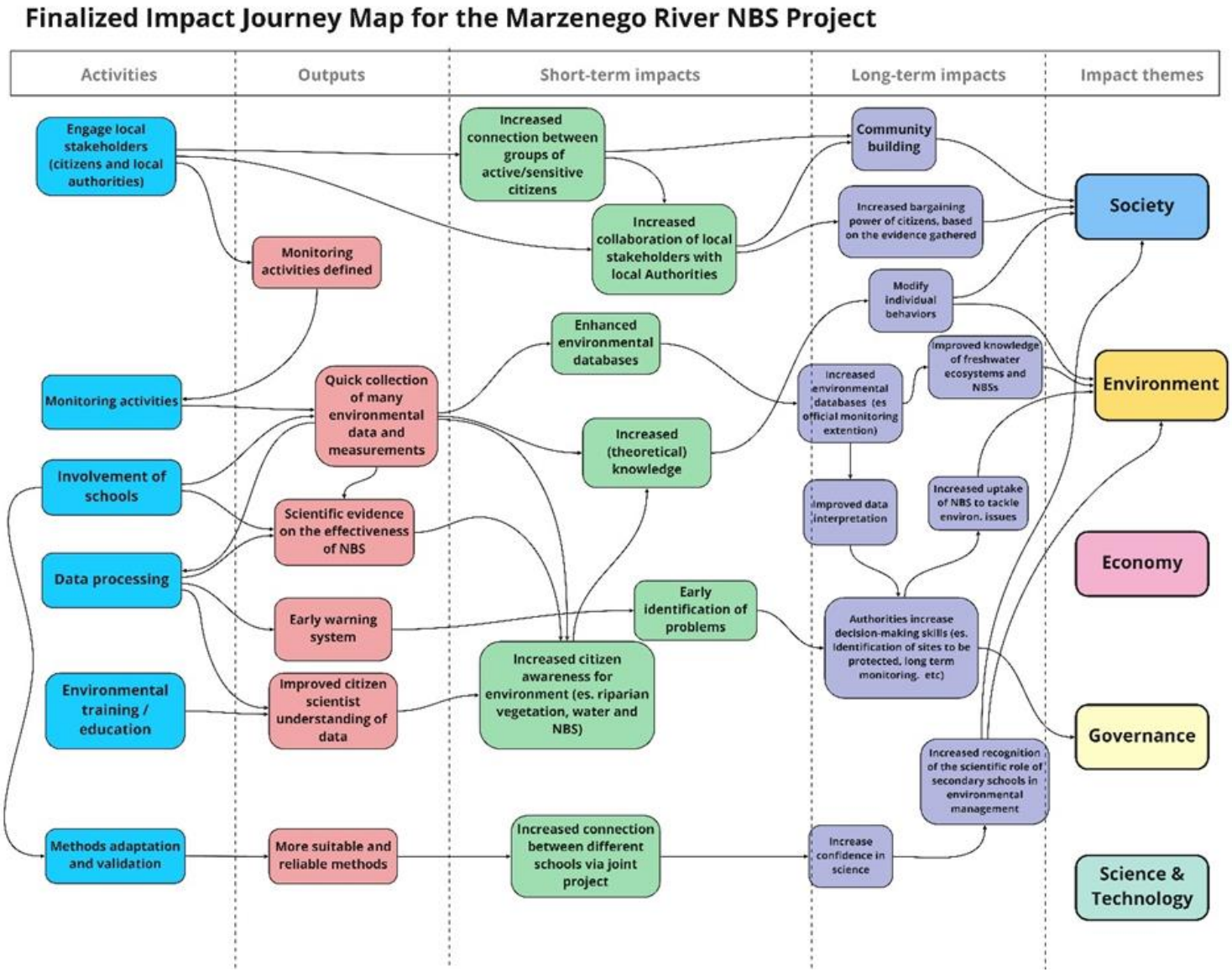


Figure 33. The validated IJM for the Marzenego River NBS Project.

- The addition/expansion of other existing items to create seven new long-term impacts:
- ‘Official monitoring extension’ (Item No. 27)
- ‘Evidence on the importance of NBSs’ (Item No. 29)
- ‘Community building’ (Item No. 33)
- ‘Greater confidence in the authorities’ (Item No. 34)
- ‘Increase confidence in science’ (Item No. 35)
- ‘Modify individual behaviours’ (Item No. 36)
- ‘Identification of sites to be protected’ (Item No. 38)
- The removal of two long-term impacts:
- ‘Improved wetlands (NBSs), river quality and riparian vegetation’ (Item No. 39)
- The merging of ‘improved flood risk management’ (Item No. 30) with ‘Authorities increase decision-making skills’ (Item No. 32)

These changes, additions and removals are documented in full in Annexe 9.

Of the long-term impacts suggested by the stakeholders, four of these were either removed or merged with items with which they were closely related (e.g., ‘greater confidence in the authorities’ was merged with ‘increase confidence in science’ (Item No. 35). The majority of the short-term were retained other than ‘develop a network between different schools’ which was seen to be closely related to the existing item ‘uptake of citizen science activities by more schools’. These were subsequently merged to create the more general ‘increased connection between different schools via joint project’ (Item No. 22).

In addition to these changes suggested by attendants of the workshops several alterations were made to the IJM during the processing of the workshop results by the MICS team. These included:

- The reclassification of ‘quick collection of many environmental data and measurements’ (Item No. 9) previously a short-term impact as an activity.
- The reclassification of ‘enhanced environmental databases’ (Item No. 15) previously an activity as a short-term impact.

Prioritising Impacts to Monitor

Voting for impacts to prioritise occurred via email, with 15 of the 18 stakeholders who attended the workshop responding. It should be noted that voting occurred prior to a final review of the workshop comments by the MICS team, and thus the creation of the finalised IJM. Therefore, some of the impacts that stakeholders voted for were moved, removed, or merged with other items within the final IJM. Figure 34 shows the results of the voting and a full breakdown of the participant votes is provided in Annexe 10.

The workshop was attended by various stakeholders engaged with the Marzenego River NBS project, which can broadly be grouped into three categories:

1) Citizen scientists
2) Representatives of governmental and statutory agency bodies and NGO
3) Education professionals

A third of all votes for short-term impacts fell into the category of ‘increased citizen awareness of riparian vegetation, water and NBS’ with votes coming from all three participant groups. The next most significant short-term impact amongst the citizen scientist participant group was ‘increased connection between groups of active/sensitive citizens’, whereas the other two participant groups highlighted ‘outdoor school activity with practical and theoretical purposes’ (merged in the final IJM

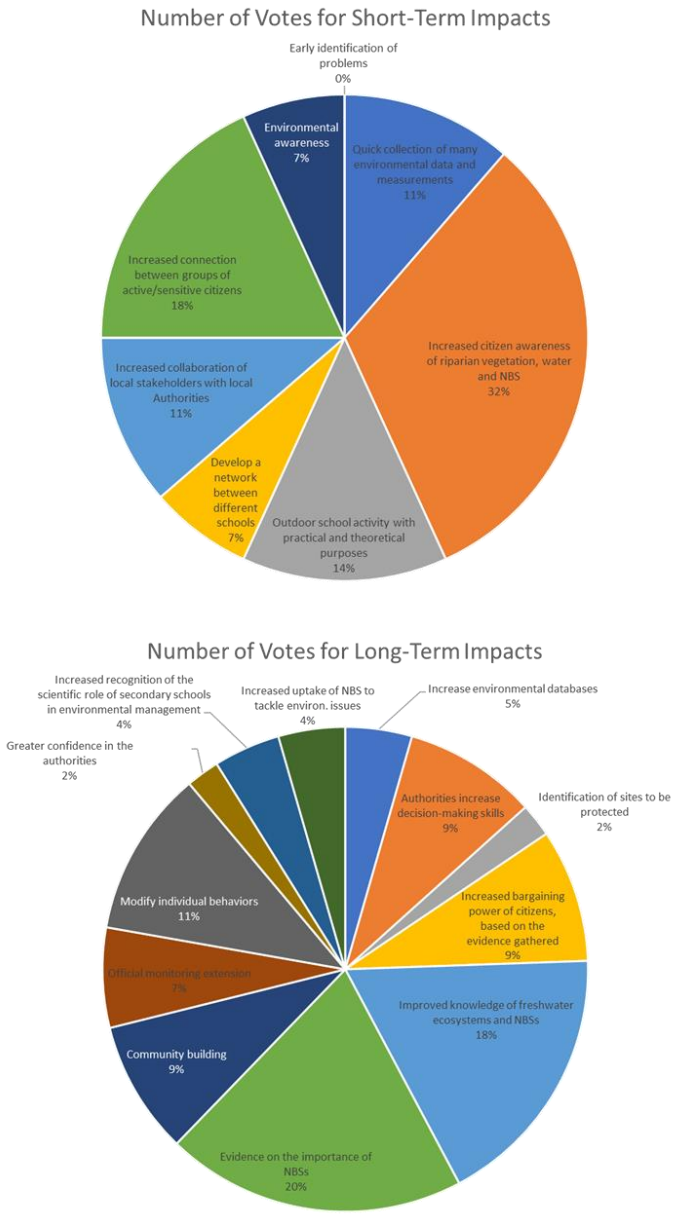


Figure 34. The results of voting for the impacts identified in the draft IJM developed for the Italian case study.

into 'increased connection between different schools via joint project') as the next most significant short-term impact.

The spread of votes for long-term impacts was wider, particularly among representatives of governmental and statutory agency bodies and NGOs. Among citizen scientists there were calls for 'improved knowledge of freshwater ecosystems and NBS' and 'evidence on the importance of NBS'. Both of these relate to increased knowledge of ecosystem function, but the former can be thought of increased personal knowledge while the latter has an external focus, i.e. building a wider evidence base. Education professionals also identified 'evidence on the importance of NBS' as an important long-term impact, with a relatively high number of votes also going to 'modify individual behaviours'. While representatives of governmental and statutory agency bodies and NGOs voted for similar

impacts as the other two stakeholder groups they also prioritised additional impacts, including ‘increase environmental databases’ and ‘authorities increase decision-making skills’.

Based on these votes ten impacts were selected to monitor. These included the six short-term impacts:

- Increased citizen awareness of riparian vegetation, water and NBS.
- Increased connection between different schools via joint project.
- Increased connection between groups of active/sensitive citizens.
- Increased collaboration of local stakeholders with local Authorities.
- Develop a network between different schools.
- Enhanced environmental databases.

The long-term impacts selected included:

- Improved knowledge of freshwater ecosystems and NBSs.
- Modify individual behaviours.
- Authorities increase decision-making skills.
- Community building.

Feedback on the Workshop

During the event, participants provided feedback on IA activities and various elements of the project.

IJM and IA Activities

Some of the attendees found the draft IJM complex and further explanation was required during the initial breakout sessions. Workshop moderators were able to explain the nuances of the IJM to participants on an individual bases.

Commitment to the Project

The education professional present at the workshops appreciated the new connection between the different school classes and expressed their intention to maintain it for future projects.

Following the workshop, a WhatsApp group was created to enable stakeholders to share news and information on the project. This has prompted the project team to consider other more effective tools of communication that are longer-lasting and other forms of social media.

A topic of concern and debate for the stakeholders related to the continuity of citizen science activities beyond the lifetime of the MICS project, and questions were raised as to which organisation would be best suited to oversee these activities and facilitate collaboration between the various stakeholder groups, i.e. citizen scientists, the statutory agency, NGO, the local municipality, and other interest groups. There was a general agreement that the most suitable body to take on this role was the local municipality. A benefit of the municipality taking on this role would be to embed citizen science and principles of NBS within the local government structure. However, it was recognised that a "political" body such as the municipality cannot ensure continuity for the project.

Value of Community Building

Several members of the workshops also expressed their thoughts regarding the impact citizen science has on the community and how the project has helped to engender a feeling of a community among

those involved and a sense of ownership for the territory in which they live.

Data Management and Relationships with the Statutory Agency

There was less agreement on the management of the data collected, as it was possible to see from the outputs that the authorities, in particular the environmental agency, were concerned about the real-time availability of raw data for an "early warning" system to avoid false alarms.

9.4.3. Impact Monitoring Strategy for the Marzenego River NBS Project

Based on the impacts selected by stakeholders involved in the impact workshops the MICS team are supports the Marzenego River NBS project to develop an IMS.

9.5. Evaluation of Measuring the Marzenego River NBS Project's Impact

The primary outputs for the Italian case study were:

- The engagement of a wide range of stakeholders, including school groups.
- Revitalisation of the citizen scientists network associated with the River Contract scheme.
- The commitment from schools to continue citizen science monitoring activities and its embedding within the curriculum.
- A baseline dataset of water quality measurement and habitat extent that informs of the current functioning of the implemented NBS.

The COVID-19 pandemic caused significant disruption in the Italian case study, but the impact workshops had significant value in re-engaging citizen scientists as contributors of information, as opposed to recipients of training. Participants appreciated the opportunity to become involved in the project's evaluation beyond the co-design phase and the citizen science activities phase. The process of working through the derivation of the IJM also provides citizen scientists with an overview of the effect of their activities and how their activities influence decision-making. This forms an important part of providing feedback, which is crucial to maintaining the motivation of citizen scientists.

The impacts selected by participants engaged in the Marzenego River NBS Project can be grouped into two themes, impacts generating knowledge and/or awareness, and those that improve collaboration between stakeholders. Two of the short-term impacts focused on improving awareness and knowledge of NBS among all stakeholder groups (citizen scientists, discission makers and other interest groups). Based on the results of a survey conducted by the MICS team for the deliverable D5.4 which reviewed NBS application across Europe, lack of knowledge regarding the effectiveness of NBS was identified as a significant barrier to the uptake of NBS within Southern Europe (MICS deliverable D4.5 - Wheatland *et al.*, 2020). It is therefore unsurprising that increased awareness of NBS is represented as an important impact by stakeholders and included in the IMS.

During the co-design process and impact workshops issues related to stakeholder communication were highlighted as being an important barrier to the continuity of citizen science in the region. It is therefore unsurprising that several impacts related to improved stakeholder engagement were selected to be incorporated into the IMS. For the 'River Contract' initiative this was seen to be the primary reason for its lack of impact and longevity. Critical to this was the lack of a suitable organisation to oversee and guide citizen science activities and facilitate the collaboration between stakeholders.

10. Creek Rákos, Budapest, Hungary

10.1. Introduction

Tributaries of the Danube that flow through Budapest have been heavily modified to mitigate against flooding. These urban rivers are often confined within artificial, concrete channels along much of their length and suffer from urban pollution resulting in poor water quality and a lack of biodiversity. Restoration of these rivers has been a topic of discussion for the last 20 years; however, it has always been considered as a low priority, and limited action has been taken.

Proposals have been put forward that utilise NBS to address environmental and social challenges related to the Creek. These include improving the connectivity of the river, wetlands, and groundwater, increasing stormwater storage within the floodplain, and tackling biodiversity loss, in

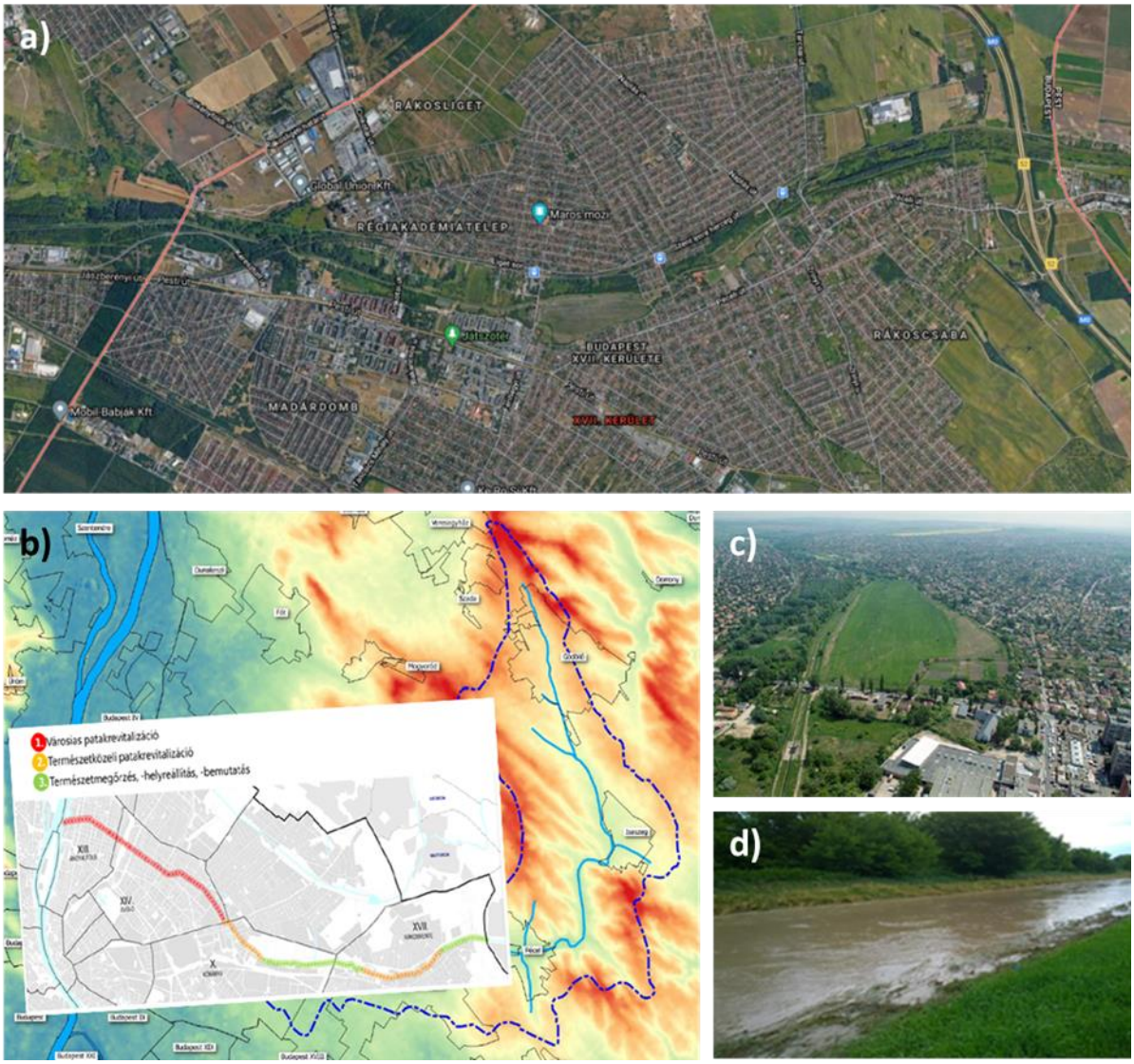


Figure 35. (a) Overview of the relief and the watershed of Creek Rákos (Source: Budapest Municipality); (b) Satellite view of the section of Creek Rákos in Budapest District 17, where the project takes place (Source: GoogleMaps); (c) Creek Rákos with relatively wide unbuilt valley surrounded by mostly low- and high-density residential areas in the outskirt of Budapest (Source: ittlakunk.hu); (d) the regulated Creek was just able to carry away the flash flood of 2016 June (Source: ittlakunk.hu)

addition to improving access to green space within densely populated areas, and improving the economic and tourism potential of the city.

Citizen science activities have been embedded within the project with the following aims:

i. To collect baseline data regarding the current condition of the Creek to help support the selection of sites suitable for future restoration and NBS; and

ii. To raise awareness and support for NBS within the local community and decision-makers.

10.1.1. Summary of the Proposed NBS

Creek Rákos is a tributary of the river Danube that has its headwaters in the Gödöllő Hills northeast of Budapest (Figure 35). Along its 44km length, the Creek passes through a mixed landscape of semi-rural and suburban and urban areas. Upon entering Budapest, it flows through Districts 17, 10, 14 and 13 before joining the Danube.

In response to large scale flooding in the 1970s, the Creek has been heavily modified, and within Budapest it is channelised and confined within an artificial, U-shaped concrete channel to increase its retention capacity. This, in addition to increased pollution from urban run-off impacting river water quality, has resulted in the degradation of the Creek with the loss of habitat and biodiversity. Concerns have also been raised regarding the longevity of the traditional flood prevention measures within Budapest, with increased risk of flooding predicted due to extreme rainfall events associated with climate change (Buzási 2014).

Restoration options for the Creek have been previously discussed, but limited action has been made to date (Rákos Creek Citizen Science Project, 2020). There are limited options for restoration along those sections of the Creek in Districts 10, 14 and 13; however, suitable sites can be found in District 17. Here, the channel has a close-to-natural riparian zone and there are options to improve the horizontal connectivity, i.e. reconnect the Creek with its floodplain, and to remove the concrete bed. Table 20 details the types of NBS that have been proposed for the Creek and the types of water related challenges they help to address.

Table 20. List of the NBS that have been proposed to be implemented along the Creek Rákos and the 'water challenges' they will help to address.

Nature-based solutions	**Water Challenges**									
	Surface water quality				Groundwater quality		Floods	Water availability		
	Nutrients	Sediments	Pesticides	Other chemical & emerging pollutants	Nitrates	Pesticides	Upstream watershed	Lower river flows	Lower groundwater levels	Droughts
Riparian buffer strips/Riparian zone restoration	●	●	●				●	●	●	●
Reconnecting rivers to floodplains	●	●								

Ponds and basins	●	●		●	●		●			

In response to increased interest in the Creek from local communities as a potential area for recreation, an urban regeneration project has been implemented by the Budapest Municipality. The main element of the project was the construction of a 'Green Corridor', including the creation of cycle lanes and pedestrian paths along 23km of the Creek through District 17 and into Budapest city centre. While the ecological restoration of the Creek is not an objective of the project, baseline data will be collected using citizen science monitoring to establish the current condition of the Creek and identify suitable sites for future restoration.

10.1.2. Previous Citizen Science

In Hungary citizen science is in its infancy and environmental management focuses on ecosystem protection and infrastructure-related interventions. No citizen science activities existed in the case study site prior to the MICS project. The following sections provides a summary of the co-design process and subsequent citizen science activities related to the 'Rákos-Patak Civil Tudomány Projekt' or 'Rákos Creek Citizen Science Project'.

10.2. Co-Design of the Citizen Science Activities

The co-design process has been described previously in MICS deliverable D4.3 (Kozák *et al.,* 2020), but is briefly summarised below.

Four co-design workshops (Events No. 1 – 4) were held with various stakeholders interested in citizen science and restoration of Creek Rákos. Table 21 list of all the co-design workshops held within the Hungarian case study, the number of stakeholders in attendance and the location of the event.

Table 21. Summary of co-design workshops held in the Creek Rákos case study. Note: rows shaded in yellow are events that have been described previously in MICS deliverable D4.3 (Kozák et al., 2020).

No.	Date	Title of Event	Number of attendees	Location
1	15/01/20	1st Co-design workshop (Group A: public sector)	36 attendees 2 organisers 3 expert advisors 1 Industry/private sector 13 Public sector - legislative 12 Public sector – executive 5 Educational institutions	Vigyázó Sándor Culture House Pesti út 113., 1173
2	01/02/20	1st Co-design workshop (Group B: civil society)	20 attendees: 3 organisers 2 expert advisor 8 Citizens 2 Educational institution 5 NGO representatives	Hall of Baptist Community 1173 Bp. Pesti út 165. I. floor

3	03/03/20	2nd Co-design workshop (both groups)	21 attendees: 3 organisers 3 expert advisors 1 Public sector – legislative 1 Public sector – executive 2 Educational institutions 4 Citizens 6 NGO representatives 1 Industry/private sector	City Hall 1173 Budapest, Pesti út 165
4	07/07/20	3rd Co-design workshop (both groups)	20 attendees: 2 organisers 4 expert advisors 1 Public sector – legislative 1 Public sector – executive 3 Educational institutions 5 Citizens 4 NGO representatives	Maros Cinema 1172 Budapest District IX. U. 2

The co-design workshops were attended by citizens, representatives of local NGOs, local municipal authorities, and statutory agencies. However, at later events, representatives for public institutions attended less frequently, with the local municipality representatives only attending in small numbers (1 – 2 persons). The different stakeholder groups engaged in the co-design process and subsequent citizen science activities are documented in Table 22.

Table 22. List of stakeholders engaged during the co-design process for the citizen science activities associated with the Creek Rákos Citizen Science Project.

Stakeholder type	**Examples**
Citizens	• Local community • Scout groups • School groups (primary and secondary school students • ZÖLD XVII Környezetvédelmi, Természetvédelmi és Városfejlesztési Egyesület (GREEN XVII Association for Environment, Nature Conservation and Urban Development)
Scientists	• Hungarian Academy of Sciences, Centre for Ecological Research • Budapest University of Technology and Economics • Magyar Biodiverzitás-kutató Társaság (MBKT - Hungarian Biodiversity Research Society)
Public sector actors – legislative (policy makers)	• Municipality of Budapest District 17 • Municipal environmental counsellor of Budapest District 17 • Vice-head of the environmental committee
Public sector actors - executive (local authorities; RBO; implementing agencies)	• Municipality of Budapest 17 • Main municipality of Budapest

	• Budapest Sewage Works Plc. • Budapest Főváros Városépítési Tervező Kft. • Geonardo Environmental Technologies
Industry/Private sector	• Chamber of Commerce Trade and Industry • Public transport company • Hungarian state railways • Rauch Hungária Ltd. (juices) • Rákosmente Kft. (gardening works)

Stakeholders involved in the co-design process identified three aspects of the Creek Rákos that participants believed should be monitored:

- Water quality
- Habitat quality
- Biodiversity

The co-design process agreed the methods to be used to monitor the selected targets (water quality, habitat, and biodiversity), the tools, and frequency of monitoring. The agreed methodologies are outlined in Table 23. These were implemented by the citizen scientists over the following 16 months.

Table 23. List of the methods used to monitor the environmental parameters select for the citizen science activities within the Italian case study.

Parameter of Interest	Indicator to measure	
Water quality	Physical	Temperature
		Turbidity
	Chemical	pH
		Salinity
		Nutrients (nitrite, nitrate, ammonium, orthophosphate)
		Dissolved Oxygen
	Biological	Macroinvertebrates (riverfly)
Habitat mapping (naturalness assessment)	Naturalness of identified habitat type	
Indicator species mapping	Bats	
	Amphibians	
	Mantis and grasshoppers	
	Black woodpeckers	

Physical and chemical parameters for water quality were chosen that were easily measurable by citizen scientists with training and equipment. Water quality is a key ignition point for the implementation of the nature-based solutions in the creek because this is the major objective of the WFD. In addition to using physical and chemical indicators, macroinvertebrate (riverfly) monitoring was selected as a biological indicator. Macroinvertebrates are highly sensitive to changes in

environmental parameters, including dissolved oxygen, nutrients, and suspended solids arising from sewage and agricultural pollution. Different groups of macroinvertebrates can tolerate different levels and types of pollution. Therefore, the presence and relative abundance of different macroinvertebrate groups will provide information about the ecological condition of the Creek.

Habitat mapping / naturalness assessments and indicator species monitoring were selected as activities to inform on the ecological status of the Creek's riparian zone. These activities would also help raise awareness about the sites selected for restoration. Based on advice from the Hungarian Biodiversity Research Society (Magyar Biodiverzitás-kutató Társaság – MBKT) it was originally suggested that a single order of insect be included in the indicator species monitoring scheme, however, local citizens called attention to the existence of an endemic species of grasshopper Acrida ungarica present within the Creek valley.

Black woodpeckers (Dryocopus martius) and bats were chosen as an indicator species, being easily identified based on sound (the later with the use of a bat detector), without requiring significant ornithological expertise. Their presence is an indicator for structured woodland, with a variety of tree ages and conditions that support deadwood niches. These habitats support biodiverse fungal and invertebrate communities.

10.3. Undertaking Citizen Science Activities

Figure 36 shows the locations of sampling sites associated along the Creek Rákos. Citizen science activities took place at a total of six sites: one site was selected for repeat water quality sampling, two sites were selected for habitat mapping, and three sites were selected indicator species mapping.

The COVID-19 pandemic significantly impacted the citizen science activities planned for the Hungarian case study. Social distancing restrictions during late 2020 to 2021 prevented citizens engaging in several of the activities, and monitoring was instead conducted by the project coordinator.

Despite the difficulties generated by COVID a total of 28 separate events were organised as part of the Creek Rákos citizen science monitoring program, this included: 23 training and monitoring events, and four awareness raising webinars, and one impact monitoring workshop (results of impact workshop described in Section 5.4.2).

During this time the GREEN XVII Association for Environment, Nature Conservation and Urban

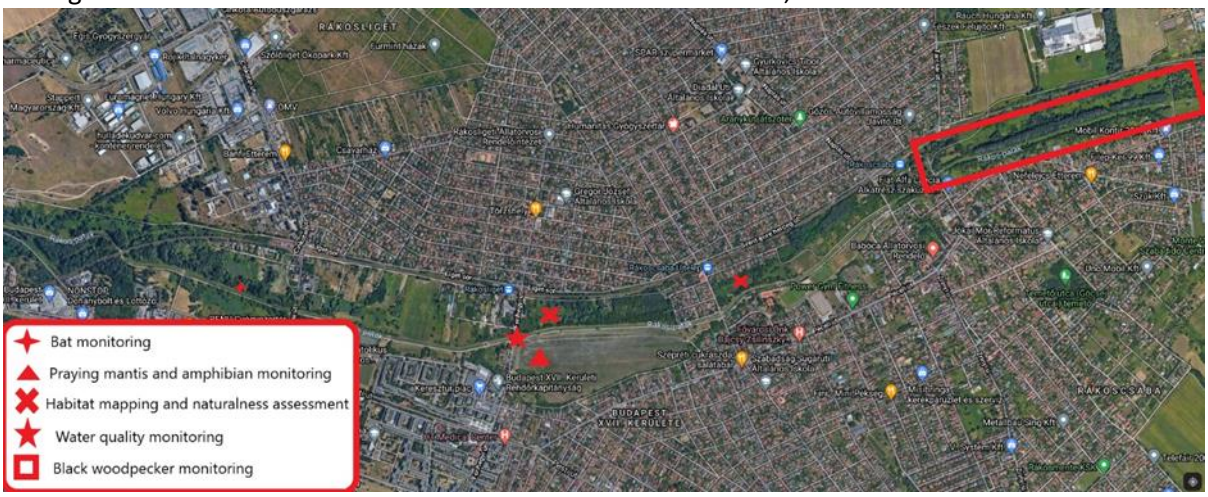


Figure 36. Location of sampling sites for indicator species monitoring (bats, praying mantis, amphibians and black woodpecker), and habitat mapping.

Development (ZÖLD XVII Környezetvédelmi, Természetvédelmi és Városfejlesztési Egyesület) and the MBKT, and local NGO have continued to support the citizen scientist monitoring activities. This has involved providing guidance and advice in the selection of sampling sites and attending events to instruct citizens in sampling methods.

A full list of the citizen science events held within the Hungarian case study is given in Table 24. Of these, Events No. 5 – 11 are described in MICS deliverable D4.3 (Kozák *et al.,* 2020). A summary of these is provided below, along with a description of Events No. 12 – 27.

The summary of the citizen science activities can be found below, for a full description please see Annexe 11.

Table 24. Summary of the citizen science events held in the Creek Rákos case study. Note: the numbering of these events is continued from Table 21. Note: rows shaded in yellow are events that have been described previously in MICS deliverable D4.3 (Kozák et al., 2020).

No.	Date	Title of Event	Number of attendees	Location
5	06/08/20	Indicator species – Bat monitoring	15 attendees	Site 1
6	04/09/20	Indicator species – Amphibian monitoring	5 attendees 2 teachers 3 students	Site 5
7	19/09/20	Indicator species – Black woodpecker monitoring	8 attendees (Teachers and representatives from NGOs)	Site 6
8	27/09/20	Indicator species – Praying mantis and grasshopper monitoring	20 attendees (Range of participants, including school students and pensioners)	Site 3
9	04/10/20	Habitat mapping and naturalness assessment	15 attendees (Range of participants, event age limit 16+ years)	Sites 3 and 4
10	22/10/20	Water quality – Physical & chemical monitoring	20 attendees	Site 2
11	23/10/20	Water quality – Biological monitoring		Site 2
12	11/12/20	Water quality – Physical & chemical monitoring		Site 2
13	22/01/21	Water quality – Physical & chemical monitoring		Site 2
14	26/02/21	Water quality – Physical & chemical monitoring		Site 2

15	03/03/21	Awareness-raising webinar - Discussion about the Creek Rákos and potential restoration	30-40 people attendees	Online
16	10/03/21	Awareness-raising webinar - Finding the black woodpecker, introducing the species and learning how to detect on the field	30-40 people attendees	Online
17	30/03/21	Water quality – Physical & chemical monitoring		Site 2
18	15/04/21	Awareness-raising webinar - 'Long live Creek Rákos' introduction of the preliminary Creek Rákos ecological restoration concept	30-40 people attendees	Online
19	29/04/21	Water quality – Physical & chemical monitoring		Site 2
20	04/06/21	Water quality – Physical & chemical monitoring		Site 2
21	09/06/21	Awareness-raising webinar - introducing examples and background for natural methods for natural water retention and water course restoration	30-40 people attendees	Online
22	19/06/21	Impact Monitoring Workshop Title: Creek Rákos Citizen Science Project: Where are we, where are we going to go?	8 attendees: 2 Citizen scientists 1 representative of the local council 2 members of the co-design group 3 MICS team members	
23		Water quality – Physical & chemical monitoring		Site 2
24		Habitat mapping and naturalness assessment		Sites 3 and 4
25		Water quality – Biological monitoring		Site 2
26	27/08/21	Water quality – Physical & chemical monitoring		Site 2
27		Water quality – Biological monitoring		Site 2
28		Indicator species – Praying mantis and grasshopper monitoring		Site 3
29	18/09/21	Water quality – Physical & chemical monitoring		Site 2
30	09/10/21	Indicator species – Black woodpecker monitoring		Site 6
31		Habitat mapping and naturalness assessment		Site 5
32		Water quality – Biological monitoring		Site 2

10.3.1. Water Quality Monitoring

Several training events for assessing water quality based on chemical and physical parameters were held in October and December 2020 and monthly throughout 2021. The aim of these activities was to provide citizens with training and experience in using the sampling kits and also to kick start regular water quality monitoring, with the aim of a year-long dataset between December 2020 and 2021.

The initial event (Event No. 10) was organised in October 2020 near to the Budapest Sewage Works. Using colourimetry toolkits of the HACH company, citizens were able to measure basic physical and chemical. While this event was well attended, with over 20 people participating, subsequent events (Events No. 12 – 14, 17, 19 – 20, 23, 26 and 29) were organised to occur at a location on the Creek (Site 2) to make the event more visible among other users of the area. Due to social distancing restrictions associated with the COVID-19 pandemic some of these events were only attended by a small core group of citizens scientists.

Three training exercises were held with stakeholders for assessing water quality using biological indicators, i.e. macroinvertebrates. These took place at the same sampling location as chemical and physical water quality monitoring (Site 2).

At the initial event held in October 2020 (Event No. 11) the method was demonstrated by the Danube-Ipoly National Park's mobile citizen science bus, the so called Danube Water Bus (Dunavirág Vízibusz). The DIPNP team provide an experience-focused water testing program, in which participants are taught how to collect and identify macroinvertebrates. Citizens were taught how to collect macroinvertebrates via kick-samples and identify different groups of invertebrates based on distinguishing features, e.g., the presence and number of tails and pairs of legs, appearance of gills and presence or absence of a case (specifically for identifying cased caddisfly larvae). To do this,

Figure 37. Photographs taken during the water quality monitoring events held along Creek Rákos during 2021.

Figure 38. Photograph taken during the habitat mapping event in 2021.

citizens were provided with a simple yes/no identification sheet. This event was highly successful, particularly with families with young children.

During three of the events held for monitoring biological indicators (Events No. 11, 22 and 32) a demonstration was given by a representative of the Danube-Ipoly National Park showing fish species identification for monitoring water quality. These were hands-off demonstrations were participants took notes or observed.

Follow up riverfly monitoring events were held in August and October 2021 (Events No. 27 and 32). Similar to Event No. 11, these were well received by the local community, particularly families with young children. At Event No. 27 a school group participated in the event.

10.3.2. Habitat Quality Monitoring

Habitat mapping and naturalness assessments were conducted with citizens during three events at four locations, in October 2020 and June and October of 2021. The aim of these events was to provide citizens with an understanding of the habitat types present along the Creek and to demonstrate the use of a simple categorisation system widely used as a metric of naturalness in Hungary: Map Database of Habitats of Hungary (Magyarországi Élőhelyek Térképi Adatbázisa – MÉTA). Training was also given in how to conduct pre-site visit desk assessments, with a demonstration of how aerial imagery and historical maps enable an understanding of changes in an area over time.

Event No. 9 consisted of visiting two sites along the Creek Rákos: Nyilas Meadow and wooded wetland (Sites 3 and 4 respectively) (Figure 38). The Nyilas Meadow on the southern bank of the Creek was identified by an entomologist as an appropriate site for indicator species mapping – praying mantis and grasshopper. The assessment followed a simple approach with participants asked to measure species diversity within a 5 x 5m quadrate and fill in a naturalness assessment form. This form was prepared for laypeople to be involved.

A repeat survey at the Nyilas Meadow site was held in June 2021 (Event 9) with a separate group, while a new site upstream of the Szabadság sugárút road bridge (Site 5) was mapped by the citizen scientists in August 2021.

10.3.3. Biodiversity Monitoring

Training for identifying and recording the different species selected as indicators for ecosystem quality was held across six separate events in August and September 2020 (Events No. 5, 6, 7 and 8) and

Figure 39. Photographs taken during the indicator species monitoring activities (praying mantis and grasshoppers) activities held along Creek Rákos during 2021.

August and October 2021 (Events No. 28 and 30). These activities were supported by the MBKT, who provided guidance on the selection of sites for observations and assistance with the identification of species during the activities with citizen scientists.

A single event was organised for bat monitoring in August 2020 (Event No. 5) (Figure 39). This took place at an artificial pond, close to Creek Rákos (Site 1). The pond was selected as being an ideal location for bat monitoring; it had a large surface water area and well-established tree line and reed bed, conditions which bats prefer for foraging. Citizens were provided with bat detectors and instructed on how to identify different species based on their call frequency.

The event organised for assessing the presence and abundance of amphibians was held in September 2020 (Event No. 6) and was aimed at high school students. Five volunteers, two teachers and three students participated in the activity accompanied by a herpetologist expert from the MBKT. Participants took part in a simple counting exercise in which they walked along a 700m section of the Creek (Site 5) and recorded the number of frogs jumping into the water for both banks.

Monitoring activities associated with recording praying mantis and grasshoppers took place over two events in September 2020 and August of 2021 (Events No. 8 and 28). Participants sectioned off a 10 x 10m area and walked along in a chain recording any observations and taking photos of the two insect groups of interest. At the second event held in August an enthusiastic citizen scientist took the lead and led a mantis monitoring event. Both these events took place at Site 3, the Nyilas Meadow.

Two events were organised for recording the presence of black woodpeckers (Dryocopus martius) (Events No. 7 and 30). These were both led by an ornithologist. The site selected (Site 6) for monitoring Black woodpecker was chosen on the basis that it was a near-to natural wetland remnant with reeds and old trees. It was also an area previously identified for restoration (riparian). Citizens learnt how to identify woodpeckers based on sound alone, and how to track and record data observations on a smartphone application. Once identified, GPS coordinates of the sighting were recorded.

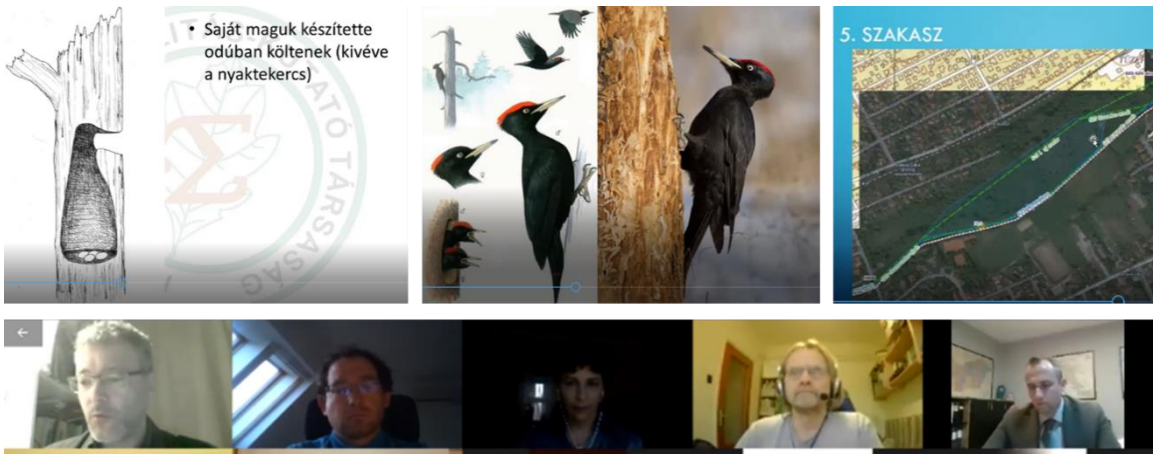


Figure 40. Screen captures taken during the online webinar on Black woodpeckers and indicator species held as part of the awareness raising activities.

10.3.4. Outreach and Awareness Raising

Awareness raising of the ecological condition of the creek and potential benefits and sites for implementing restoration and NBS were a critical component of the project. Several events were organised to achieve these goals (Figure 40). These took the form of online webinars which focusing on different subjects:

- Discussion of the potential restoration options for Creek Rákos (03/03/21);
- Presentation describing the concepts of ecological restoration in relation to Creek Rákos (15/04/21);
- Presentation outlining how NBS can be used for water management along Creek Rákos with emphasis on water retention and water course restoration (09/06/21).

The events focused on presentations from invited speakers followed by a short discussion at the end of the session. All the events were well attended, with 30 – 40 people usually present. These included members of the local community, and citizen scientists associated with the project.

10.3.5. Reflections on Citizen Science Activities

During the co-design workshops, participants often focused on the action that could be taken to restore the Creek, and stakeholders were less vocal upon the potential (citizen science) activities that could be implemented to obtain baseline data needed to support ecological restoration. This was likely due to a desire to see change occur and support for the proposed restoration and NBS. Management of the discussion by the workshop organisers was therefore required to guide stakeholders towards selecting aims, objectives and activities for the citizen science project that would meet the overall ambition.

The activities of the citizen science project reached a peak in 2021, though the pandemic situation did not make it easy. Some monitoring activities were able to continue during the 2021 COVID-19 lockdown, however, due to social distancing these only occurred in small groups. Following the lifting of restrictions, the project was able to attract new participants, and regular events were organised between June to October. A key success of the project was engaging with new citizen scientists, especially a new school group. The project intends to analyse the results obtained during the monitoring campaign of 2020-2021 and communicate what this says about the current condition of

the Creek and the potential for future restoration with the local citizen science community. This means the continuation of monitoring activities among the various stakeholders and monitoring of the impact too.

Local NGOs are interested in continuing to support citizen science monitoring. The school group has also committed to coordinating future water quality monitoring. It is hoped that the local authority will take into account the water quality data and the ecological revitalisation concept recommendation that has been created out of the co-design, with the help of the local expert group.

10.4. Measuring the Impact of the Creek Rákos Citizen Science Project

10.4.1. Application of the MICS IA Approach to the Creek Rákos Citizen Science Project

Similar to the Italian case study, the IJM for the Creek Rákos Citizen Science Project was developed by the MICS team and later validated by stakeholders engaged with the project. The draft IJM was developed following the same process followed for the Italian case study. This involved:

1) Reviewing the IJMs created previously for other MICS projects, and adopting / adapting any generic items pertinent to the Hungarian case study;
2) Reviewing the contextual information about the Hungarian case (during which the IA compenidum was also completed); and
3) Creating new items based on this contextual review that captured the activities, outputs and impacts specific to the Hungarian case.

Table 25. Impacts of the monitoring activities associated with the Creek Rákos Citizen Science Project grouped according to impact domain.

Domain	**Creek Rákos Citizen Science Project**
Science & technology	NA
Society	• To raise public awareness environmental issues, pollution, flooding etc. • To engender support towards sustainable environmental (river) management. • To promote positive attitude towards the environment and reconnect people with nature. • To engender a sense of ownership of the Creek within community.
Environment	• To establish baseline environmental data for the Creek Rákos. • To guide restoration and management decisions. • To identify sites suitable for restoration and the implementation of NBS.
Governance	• To promote understanding among decision makers regarding sustainable and ecologically friendly (river) management strategies. • Through increased support from general public put pressure on decision makers to take positive action towards restoration. • To promote the involvement of citizens within the decision making process (co-design).
Economy	NA

Table 25 summaries impact domains in which the Hungarian case study seeks to engender impact(s)

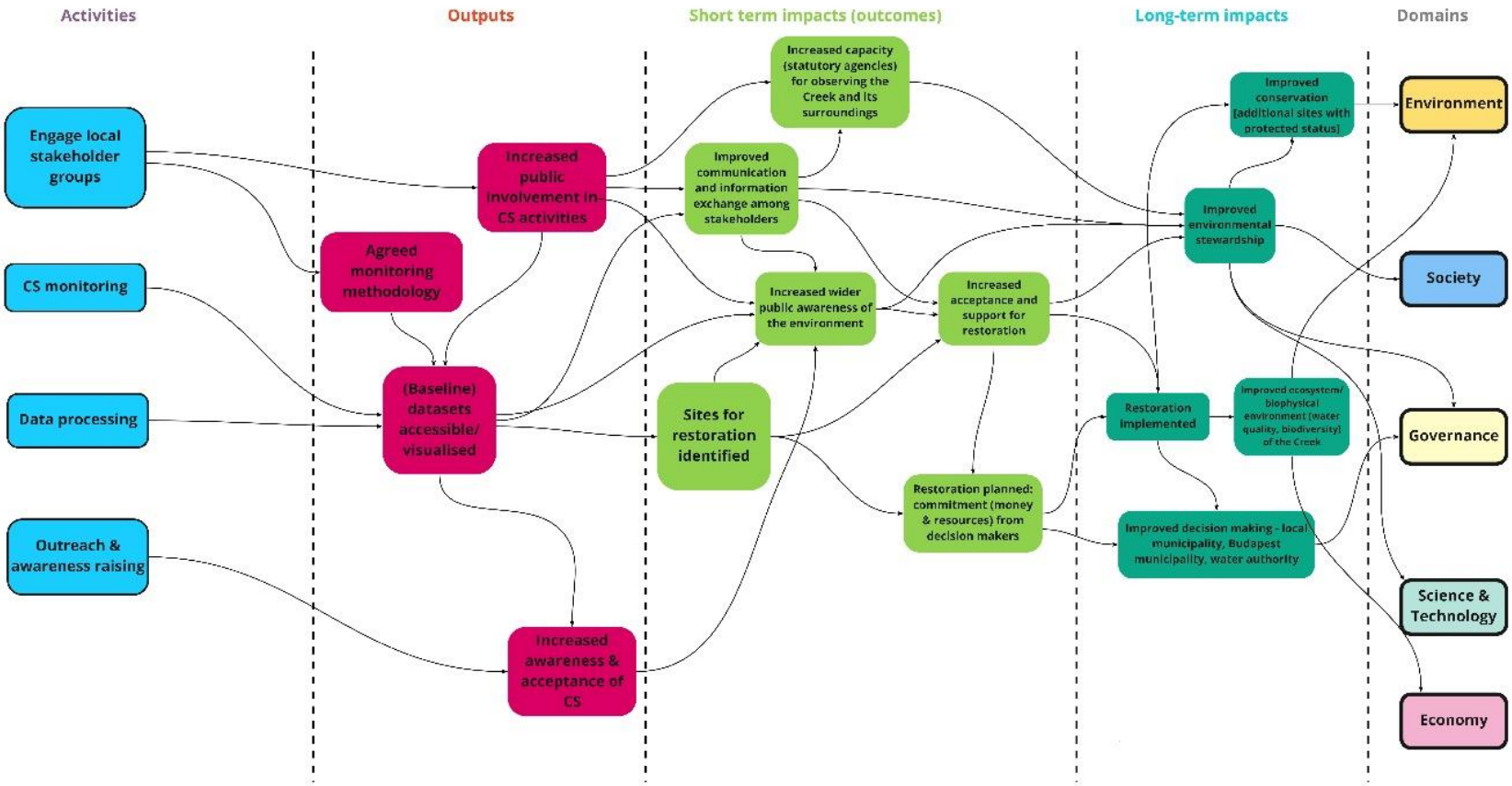


Figure 41. Draft IJM created for the Creek Rákos Citizen Science Project.

and the rationale behind focusing on these domains. This was created during a review of contextual information about the Creek Rákos project and the completion of the IA compendium for the case study.

The draft IJM developed for the Creek Rákos Citizen Science Project is shown in Figure 41.

The creation of the IJM was a collaborative process involving members from WP4 (WP4 lead – RRC and the Hungarian project coordinator – Geonardo) and WP2. As with the IJM created for the Marzenego River NBS project, care was taken to minimise the content of the Hungarian IJM to capture the key elements of the project to ensure it was easy to read by the project stakeholders.

Items within the IJM created for Creek Rákos Citizen Science Project were recorded in an excel spreadsheet so that their origin and any suggested changes made to them could be tracked. This included recording the origin of the item (i.e. created by the MICS team, modified, or adopted from IJM created for other MICS projects, or suggested by project stakeholders), whether it underwent any modifications or alterations during the validation process, and if it was retained in the final IJM. This information is summarised in Table 26 and shown in full in Annexe 12.

Table 26. Items identified in the IJM developed for the Creek Rákos Citizen Science Project.

Item Type	Item Number	IJM Title
Activities	1	Engage local stakeholder groups
	2	CS monitoring
	3	Data processing
	4	Outreach & awareness raising
Outcomes	5	Increased public involvement in CS activities
	6	Agreed monitoring methodology
	7	(Baseline) datasets accessible/ visualised
	8	Dataset (water quality and species list)
	9	Increased awareness & acceptance of citizen scientists
	10	Species list
Short-term impacts	11	Improved communication and data exchange among stakeholders
	12	Increased public acceptance and support for restoration
	13	Commitment for restoration by decision makers (including local municipality) incl. money & resources
	14	Sites for restoration identified
	15	Enhanced monitoring of Creek and surroundings by agency
	16	Increased wider public awareness of the environment
	17	The local municipality deals with the issue on all "fora"
Long-term impacts	18	Improved conservation [additional sites with protected status]
	19	Improved environmental stewardship
	20	Restoration implemented

	21	Improved ecosystem/ biophysical environment [water quality, biodiversity] of the Creek
	22	Improved collaboration of the local municipality, Budapest municipality, water authority

To validate the draft IJM a workshop was arranged with the stakeholder involved in the project. During this workshop the IJM was presented to stakeholders for validation, giving them the opportunity to make additions, amendments and/or remove items from the IJM.

During the preparation for the workshop the project coordinator (Geonardo) expressed concern that IA workshop would be less well received by citizens. To make the IA workshop more appealing to citizen scientists it was decided to run the workshop back-to-back with a citizen science training event. The workshop would be held in the morning while the training event would take place in the afternoon.

10.4.2. Impact Workshop: Investigating the Impacts of the Creek Rákos Citizen Science Project

Overview of Workshop

Stakeholders engaged in the Creek Rákos citizen science project attended a 3-hour face-to-face workshop held outdoors on 19/06/21 (Figure 42). A total of five stakeholders attended the event representing different groups:

- Citizen scientists
- A representative of the local council
- Members of the co-design team

Full details of the stakeholder groups present, the number of attendees, and the location can be found in Table 24.

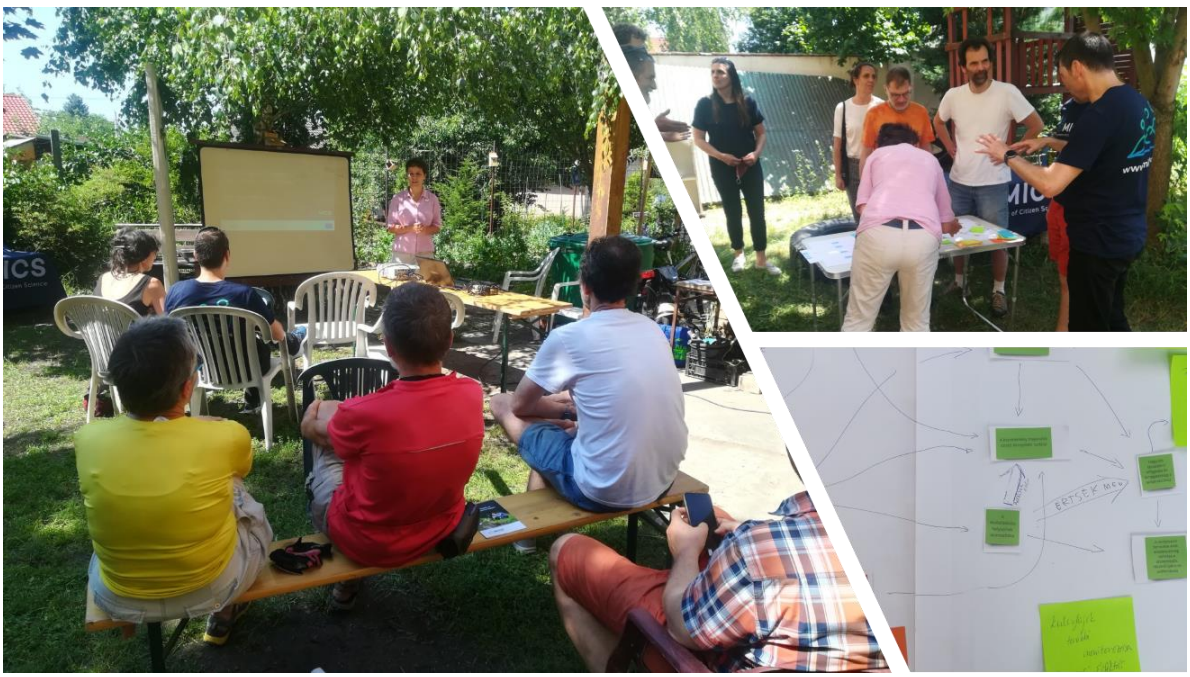


Figure 42. Photographs taken during the Hungarian case study impact workshop, 19th of June 2021.

The workshop content and activities focused on the validation of the draft IJM created for the Hungarian case study shown in Figure 41. A full description of the structure and schedule adopted for the workshop is provided in Annexe 13.

The attendees participated in several tasks. The first two tasks focused on validating specific aspects of the draft IJM (Figure 41):

Activity 1. Validating the impacts identified in the draft Impact journey.

Activity 2. Verifying how the impacts of the Creek Rákos citizen science project have/will be achieved.

Activity 3. Voting for impacts to prioritise and monitor (**activity not completed at the workshop**).

The IJM created by the MICS team was written on post-its and displayed on a whiteboard so participants could interact with it and make comments on it.

During the activities the discussion often reverted back to the issues surrounding the Creek and the revitalisation project, and participants expressed a preference in talking about these rather than the IA activities. While the event organisers attempted to manage the discussion to keep the workshop to schedule, it was felt that there was considerable value in allowing participants to air their thoughts and feelings. These discussions often migrated back to the impact of the project and in this way the activities of the workshop were addressed.

The final task of the workshop (Activity 3) was selecting short- and long-term impacts from the journey map to monitor. However, the open-style discussion of the workshop took longer than scheduled and there was not enough time to complete the task. Following the event, the project coordinator contacted the wider citizen science group to share the event outputs and request them to vote via email on the impact they believed to be most important. While this email was sent out to the group at large, including participants of the workshop, only four stakeholders responded.

Outputs of the Workshop

The primary output of the workshop was a validated IJM (Figure 43) for the Creek Rákos Citizen Science Project. Additionally, four project stakeholders responded by email to cast their votes for which impacts they believed to be most important and should be included with the projects IMS.

Validation of the Impact Journey Map

Two amendments/additions were suggested to the IJM by participants. These included:

- The addition of the output ‘species list’ (Item No. 9)
- The proposal of a new short-term impact ‘local municipality deals with the issue on all "fora" (Item No. 16)

The addition of ‘species list’ as an output was suggested by one of the citizen scientists who had a particular interest in entomology. Their concern was that the indicator species monitoring activities of the project (particularly those associated with insects but also flora – currently not monitored) was too generic and would not provide adequate information regarding habitat quality. They suggested the development of a list of indicator species specific to the region, something currently not available, that would inform on the type and condition of the habitat. This was a valuable point but was believed to be covered elsewhere in the IJM map in the related output ‘baseline datasets accessible/ visualised’ (Item No. 7). Therefore, these two items were combined to create the output ‘dataset (water quality

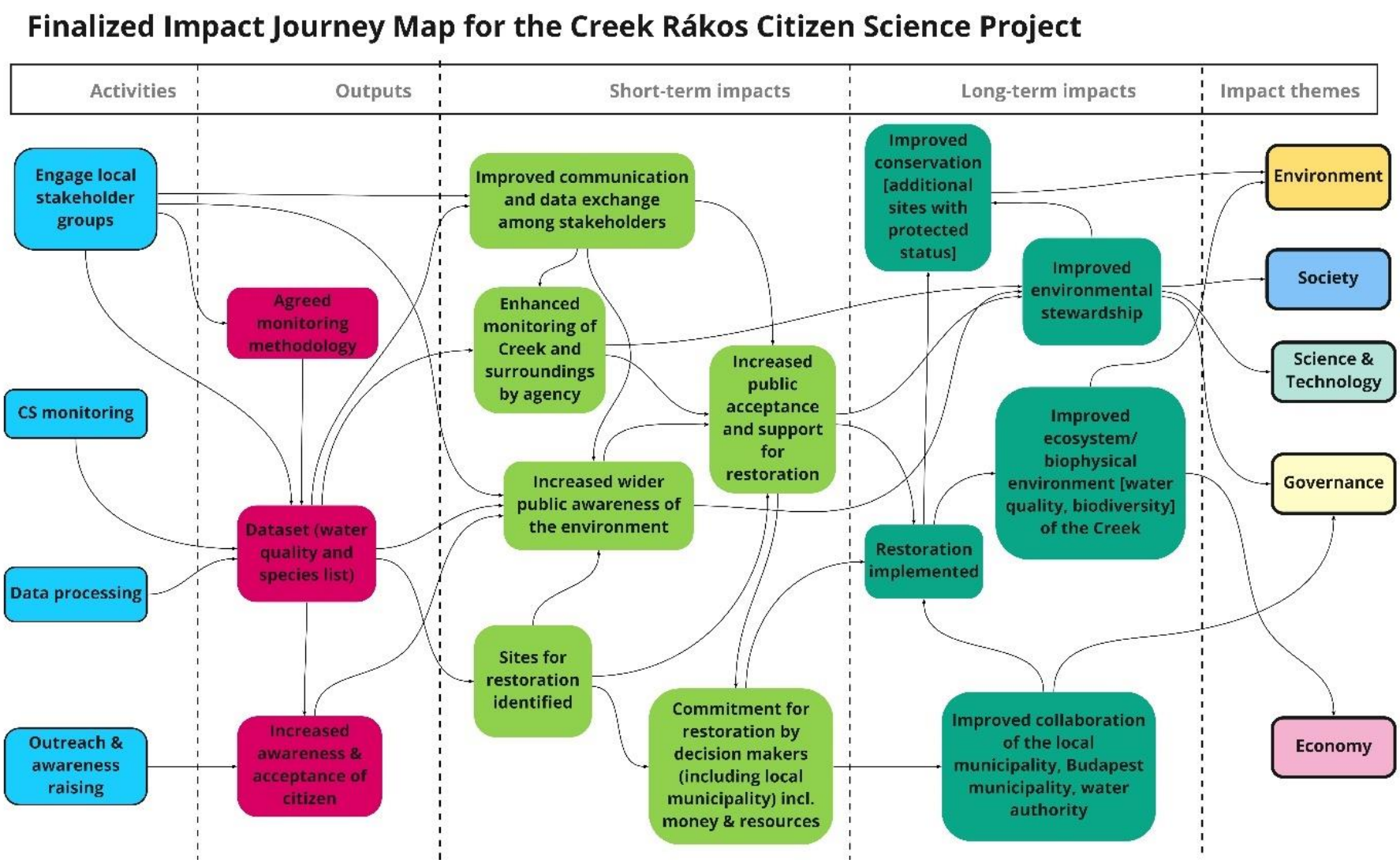


Figure 43. Validated IJM created for the Creek Rákos Citizen Science Project.

and species list)' (Item No. 8) in the final IJM.

The workshop participants felt that the local municipality should take the lead in restoration activities as they are seen to have the strongest lobbying power and ability to invoke change. This led to participants adding the short-term impact 'local municipality deals with the issue on all "fora"'. Upon reflection, however, it was considered that the project could not directly lead to this impact, and the item was removed from the final IJM.

Prioritising Impacts to Monitor

Voting for impacts to prioritise occurred via email, with 4 stakeholders responding. Based on these results, 10 impacts of the project were selected to include in the IMS. These included the five short-term impacts:

- Enhanced monitoring of Creek and surroundings by agency
- Improved communication and information exchange among stakeholders
- Increased wider public awareness of the environment
- Sites for restoration identified
- Commitment for restoration by decision makers (including local municipality) incl. money & resources

The long-term impacts selected were:

- Improved conservation [additional sites with protected status]
- Improved environmental stewardship
- Restoration implemented
- Improved ecosystem/ biophysical environment [water quality, biodiversity] of the Creek
- Improved collaboration of the local municipality, Budapest municipality, water authority

Feedback on the Workshop

During the event, participants provided feedback on IA approach.

Impact Assessment Activities

Stakeholders did not fully understand IA activities and found it difficult to complete the tasks. Instead, participants preferred to use the time as a means to express their thoughts and opinions regarding the current state of the Creek and issues surrounding it. This is likely to be because the discussion on monitoring actions and impact measurement have preceded any actual NBS restoration/revitalization project. At times it was difficult to manage the discussion but through informal questions put to attendees several of the IA activities for the workshop were completed successfully.

Impact Journey Maps

While the stakeholders found the concept of IA difficult to understand they found the IJM more easy to digest and helped to open a dialogue regarding projects impact.

10.4.3. Impact Monitoring Strategy for the Creek Rákos Citizen Science Project

The IMS for the Creek Rákos Citizen Science Project was created by MICS based on the impacts selected by stakeholders during the workshop. Table 27 details the monitoring scheme developed for the impacts selected.

Table 27. IMS developed for the Creek Rákos Citizen Science Project.

Impact selected to monitor		Monitoring scheme				
		Indicator	**Method type(s)**	**Frequency of measurement**	**Responsibility - Who is involved**	**Feasibility**
Short-Term Impacts	Enhanced monitoring of Creek and surroundings by agency	Number of citizen observations, notes to the agencies	Tracking of observations by citizens passed onto agency by NGO	Biannual	NGO	High feasibility
	Improved communication and information exchange among stakeholders	Changes in communication paradigm (3 items)	Track interactions/ survey	Biannual	Project managers, other key stakeholders	Feasible
	Increased wider public awareness of the environment	Number of citizens conscious of the environment	Survey	Biannual	Project coordinator, NGO, (targeted: citizen scientists, members of the public, incl. non-participating pupils)	Feasible (but resource intensive
	Increased acceptance and support for restoration	Ratio of citizens supporting ecological restoration	Survey	Biennial	NGO	Feasible
	Sites for restoration identified	Number of restoration sites	Desktop research on current public plan s	Annual	Project coordinator	Highly feasible
	Commitment for restoration by decision makers (including local municipality) incl. money & resources	Number of positive resolutions connected to restoration made by the local council	Monitoring local decisions	Biannual	Project coordinator	High feasible
Long-Term Impacts	Improved conservation [additional sites with protected status]	Number of hectares under conservation	Land use monitoring (report ed on governmental website)	Annual	NGO	High feasibility
		Number of protected species identified in the area	Area report – may identify number of protected species	Annual	NGO	Medium feasibility
	Improved environmental stewardship	Participation in political processes and civic engagement at the local level – progress towards fully realised	Survey	Annual	NGO	Feasible

		dialogue and shared responsibility for environment				
	Restoration implemented	# of sites / ha of land restored	Check reporting on water authority/ municipality website	Annual	Project coordinator	High feasibility
	Improved ecosystem/ biophysical environment [water quality, biodiversity] of the Creek	WFD status of the water	Monitoring annual environmental report of the City of Budapest	Annual	Project coordinator	High feasibility
	Improved collaboration of the local municipality, Budapest municipality, water authority	# of meetings, changes in types of channels & frequency of data and information flow between these stakeholders; resolutions in which ecological Creek Restoration is on the agenda	Monitoring meeting agenda, (minutes)	Annual	Project coordinator	Low feasibility

10.5. Evaluation of Measuring the Creek Rákos Citizen Science Project's Impact

The primary outputs for the Hungarian case study were:

- Increasing awareness of the environmental issues related to Creek Rákos through a variety of activities aimed at different stakeholder groups.
- Raising support for restoration options within community and local government
- Development of environmental monitoring methods that would have community appeal, e.g., indicator-species monitoring focused on readily identifiable animal behaviours such as woodpecker calls.
- The establishment of a baseline dataset for the Creeks ecological status.

The citizen science activities were well received and well attended. The monitoring activities have been designed to be repeatable and if the current level of citizen science engagement is retained the outputs should constituent a useful time series of measurements as action is taken to restore the naturalness of the Creek in future years.

The impact workshop itself was not as well received by stakeholders. This was likely due to the timing of the event which occurred after the end of the lockdown and in the beginning of summer, when long distance travel (for holidays) was finally possible. However, the small number of stakeholders present, who appeared mostly from civil society, participated fully in the IA activities, and helped in the creation of an IJM for the project.

Participants found it difficult to understand the concept of IA and did not easily undertake the tasks. This is likely to be because the discussion on monitoring actions and impact measurement have preceded any actual NBS restoration/revitalisation project. This is not a failure of the IA approach but a result of time constraints of the MICS project.

Despite the low turnout to the impact workshop there was an informative discussion regarding the project impact and the group identified additional points not recognised in the draft IJM. The IJM were useful in helping to open a dialogue regarding impact with the project stakeholders.

The impacts prioritised by stakeholders involved in the Creek Rákos Citizen Science Project can be grouped into two themes: delivering restoration of the Creek and improving cooperation/communication between stakeholder groups. The emphasis on the second reflects the necessity of engagement with the local populace as a key element for implementing the planned restoration of Creek Rákos. This is represented by a stronger emphasis on the Society domain in Hungary. In contrast to the UK and Southern Europe case studies, all stakeholder comments were related to impact at the local scale. This is characteristic of the case studies in Central and Eastern Europe where citizen science projects tend to be smaller in scope because the approach is still relatively untested in these regions, and thus lacks trust from the community and commitment from authorities.

11. Carasuhat Wetland, Danube Delta, Romania

11.1. Introduction

The Danube Delta is Europe's largest wetland habitat supporting a wide range of wildlife including several rare and globally threatened species and functioning as an important water purification system (UNESCO, 2019). However, the Delta is under intense pressure from human activity and large sections has been drained for agriculture. This has not only impacted wildlife, but as its ability to deliver ecosystem services, such as stormwater storage and the filtration of nutrients and pollutants among other things.

The Romanian case study focuses on Carasuhat Wetland (Figure 44), an area of drained pasture which was re-flooded in 2016. Citizen science activities have been embedded within the project with the primary aims:

i. Set-up a long-term monitoring scheme to generate an evidence base which will enable the evolution and efficiency of the NBS project to be assessed; and

ii. To raise awareness regarding NBS among local stakeholders.

11.1.1. Summary of the NBS Project

The Danube Delta is a labyrinth of waterways, islands and reed beds shared between Romania and

Figure 44. Carasuhat Wetland, view from above. (Source: A. Scrieciu).

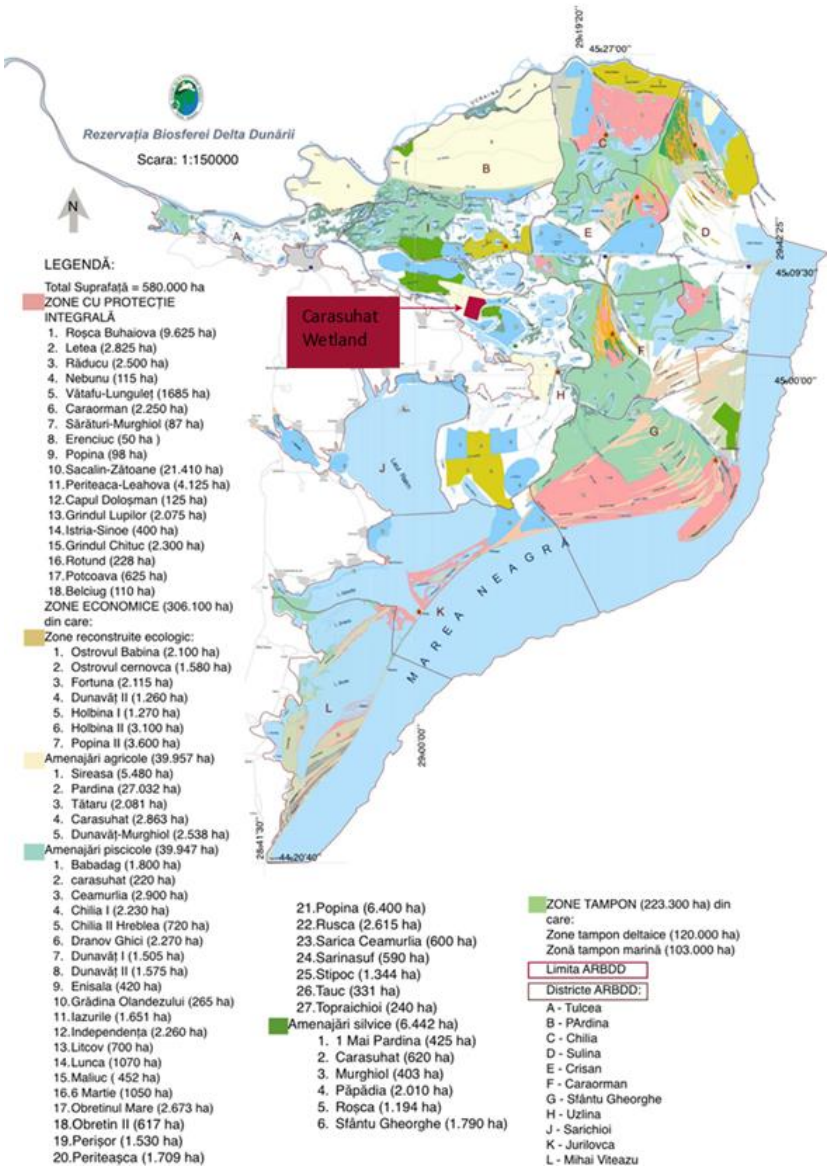


Figure 45. Carasuhat Wetland is located in the Danube Delta (45°06'25.3"N 29°06'33.9"E) being connected to the Saint George Arm of the Danube River, Romania (Figure 1 & 2).

Ukraine that is an internationally important habitat (Gâștescu 2019). The wetlands support a wide range of wildlife including several species of rare and globally threatened species (e.g., the European mink, wild cat and monk seal).

However, much of the Delta has been subject to land-use pressure particularly from agriculture and urban development (Niculescu *et al.,* 2017). The local economy of the region is strongly dependent on natural resources, primarily fishing, agriculture, and reed extraction, which poses the risk of unsustainable and unwanted development and over-exploitation (Bell *et al.,* 2001). Historically, large areas of the wetland have been drained which has impacted on natural ecosystem function, resulting in habitat loss, eutrophication, and subsidence (Giosan *et al.,* 2013; Besset *et al.,* 2017).

To tackle these issues several restoration and rewilding projects incorporating NBS have been implemented across the Delta to restore and enrich former wetland areas. The Carasuhat Wetland is located in the Danube Delta being connected to the Saint George Arm of the Danube River, Romania (Figure 45). The area was historically drained for agriculture and disconnected from the Danube through the construction of dykes to form a 'polder', i.e. a low-lying tract of land enclosed within embankments. Drainage of the area ceased in 1989, and the area became local pasture. Restoration of the Carasuhat Wetland was widely supported by local citizens who were in favour of improving the local biodiversity and improving access to fishing areas. The involvement of the local volunteers started from the inception phase. These key stakeholders embraced the project proposal and continued within the public consultations for designing the best solutions. Some of these stakeholders have also been involved in the implementation phase as a part of their current jobs.

Restoration of the wetland was initiated in 2014, with the aim to recreate hydrologic conditions

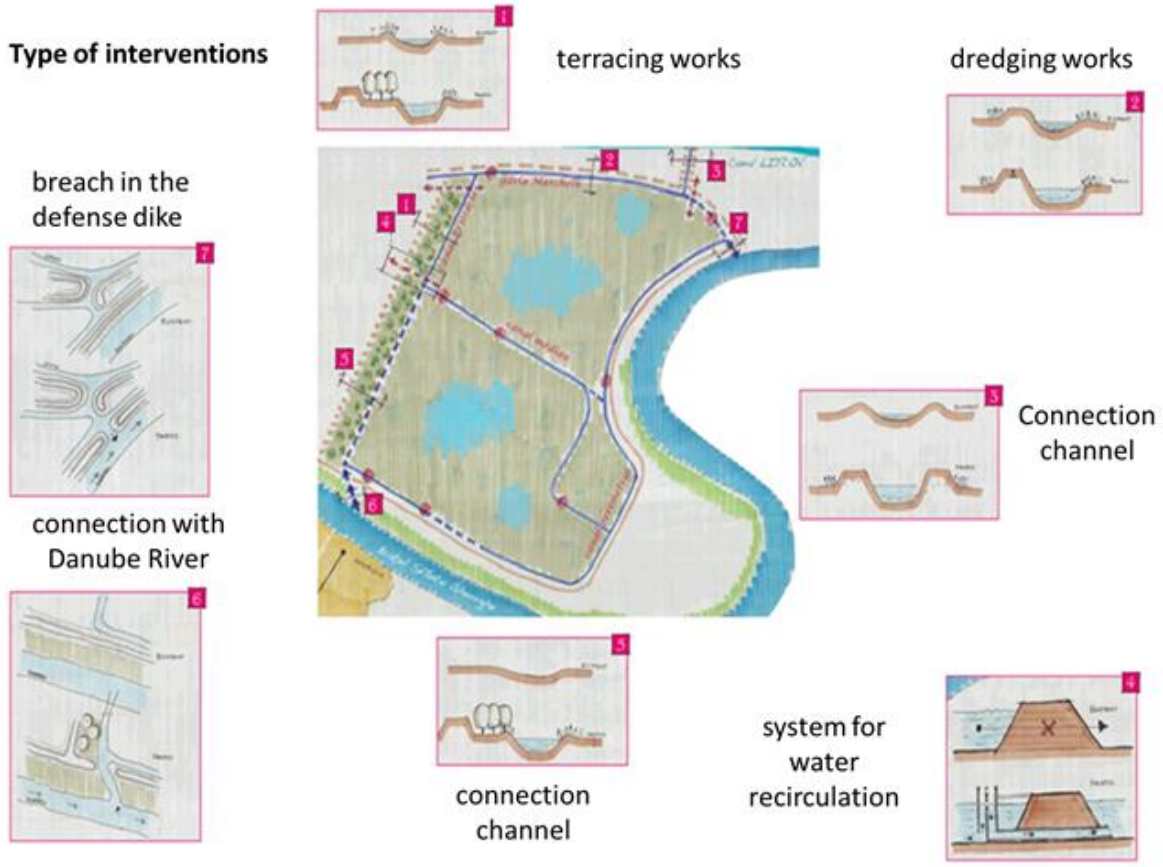


Figure 46. Types of measures implemented in the restoration of Carasuhat Wetland. Source: WWF Romania

suitable for the development of key natural habitats. This was achieved by re-connecting the area of local pasture with the Danube through dyke breaching (Figure 46). This work was carried out through collaboration between WWF Romania, the Local Council Mahmudia and the Danube Delta Biosphere Reservation Administration (DDBRA). In total, 924 ha of land was flooded by breaching to re-establish the hydrological conditions that existed in the Carasuhat area prior to impoundment. This contributed to an overall reduction in agricultural land in the Danube Delta of 2.3%.

Table 28 lists the water-related challenges wetland restoration helps to address.

Following the completion of the NBS, a monitoring program or dedicated Management Plan was not implemented by the newly created administrator of the Carasuhat Wetland. This resulted in a gap in understanding regarding the performance and effectiveness of the implemented NBS, making it difficult to compare achievements against the targets of restoration, and thereby inform upon the NBS project outcomes.

Table 28. The NBS implemented within the Carasuhat Wetland case study and the 'water challenges' it helps to address.

Nature-based solutions	Water Challenges									
	Surface water quality				Groundwater quality		Floods	Water availability		
	Nutrients	Sediments	Pesticides	Other chemical & emerging pollutants	Nitrates	Pesticides	Upstream watershed	Lower river flows	Lower groundwater levels	Droughts
Wetlands restoration/ conservation	●	●						●	●	●

11.1.2. Previous Citizen Science

In Romania citizen science is in its infancy, and environmental management focuses on ecosystem protection and infrastructure-related interventions. No citizen science activities existed in the case study site prior to the MICS project. The following sections provide a summary of the co-design process and subsequent citizen science activities related to the Carasuhat Wetland NBS Project.

11.2. Co-Design of the Citizen Science Activities

The following sections provide a summary of the co-design process and outcomes for Romanian Case Study. For full details regarding these workshops please refer to MICS deliverable D4.4 (Scrieciu *et al.*, 2020).

Bilateral discussions between GeoEcoMar, WWF and the stakeholders involved with the wetland restoration have been ongoing since project inception. This has allowed for the development of a strong understanding of the societal context, with knowledge of the different stakeholders involved in the monitoring of environmental quality. The stakeholders involved in the NBS and citizen science activities are documented in Table 22.

Table 22. Stakeholders involved in the citizen science activities associated with Carasuhat Wetland NBS Project.

Stakeholder type	Examples
Citizens	• Local stakeholders actively involved in the previous stages of the project (design and implement the NBS) • Local NGO's
Scientists	• NIRD, GeoEcoMar • Ovidius University of Constanța • Danube Delta National Institute for Research and Development
Public sector actors – legislative (policy makers)	• Danube Delta Biosphere Reserve Administration (DDBRA) • Tulcea County Council

Public sector actors - executive (local authorities; RBO; implementing agencies)	• Mahmudia Local Council
Industry/Private sector	• Fisherman • Landowners • Farmers • Tour operators

Prior to the co-design workshops series of informal meetings were held with small groups of local stakeholders were held to introduce the MICS project and explain the benefits of citizen science. These informal meetings were organised with the support of WWF Romania and Mahmudia Local Council. A co-design workshop (Figure 47) was then arranged with all stakeholders invited to discuss the challenges and objectives for citizen science monitoring in the Carasuhat Wetland. Details of the workshop are shown in Table 23.

Table 23. Summary of co-design workshop and citizen science activities held in the Creek Rákos case study. Note: rows highlighted in yellow are described previously in MICS deliverable D4.4 (Scrieciu et al., 2020)

No.	Date	Title of event	Number of attendees	Location
1	22/07/20	Co-design workshop	9	Mahmudia
2	06/11/20	Training for CS activities	8	Mahmugia
3	07/11/20	Kick Off CS activities	8	Carasuhat Wetland, Mahmudia
4	29/6/21	Impact workshop	10	Mahmudia
5	Periodic	Informal meetings	Not counted	Mahmudia
6	Monthly	Citizen science activities	Variable	Carasuhat Wetland, Mahmudia
7	20/10/20	Water discharge measurements	4	Carasuhat Wetland, Mahmudia
8	22/10/20	Perform drone flights to map the wetland	4	Carasuhat Wetland, Mahmudia

The primary challenge identified by stakeholders was the lack of a management or monitoring plan for the implemented NBS. This was recognised to be the result of resource limitations and institutional restrictions. Those stakeholders present at the workshop identified the benefits of the wetland restoration project and were supportive of using citizen science as a means to collect baseline data to assess the performance and effectiveness of restoration works.

Figure 47. Photographs from the co-design workshop with various stakeholders in Mahmudia in July 2020. (Source: A. Damian, WWF Romania).

Based on the discussion during the co-design workshop, the following parameters were agreed upon for citizen science monitoring:

- Water quality
- Water levels
- Dyke stability
- Wetland biodiversity

The stakeholders involved in the co-design process agreed on the methods to be used to monitor the environmental parameters (water quality, water levels, dyke stability and biodiversity), the tools, and frequency of monitoring. The agreed methodologies are outlined in Table 24. These were implemented by the citizen scientists over the following 16 months.

Table 24. List of the methods used to monitor the environmental parameters selected for the citizen science activities within the Romanian case study.

Parameter of Interest	Indicator to Measure	Frequency of measurements, e.g., monthly, yearly, or one of event (1 day event)
Water quality Water levels	Nutrients	Monthly
	Turbidity	Monthly
	Water level	Monthly
Dyke stability	Dyke stability	Monthly
Biodiversity	Birds Biodiversity	Three times per year

11.3. Undertaking Citizen Science Activities

Alongside these activities coordinated by the MICS project, WWF Romania initiated biodiversity monitoring with local citizens.

Figure 48 shows the locations of the sampling sites. To access these sites boats were required to transport volunteers as it was not possible to access sites on foot.

4 sites were selected for repeat water quality sampling, with additional observations sites referring water level and dykes stability (along the western dyke) during the Co-design workshop and additional informal meetings.

Field activities were performed with the support of several boats belonging to the stakeholders, due to the fact that the sites cannot be reached on foot. This aspect combined with the Covid 19 restrictions (lockdown, restricted no. of person allowed to be in the same boat, etc.) made the entire monitoring process more challenging than expected initially.

Figure 48. Sampling locations in the Carasuhat Wetland.

11.3.1. Water Quality Monitoring

Training sessions were held to introduce how to use the FWW platform and the FWW kits, including creating accounts for the participants. The citizen-science activities started with a 'train the trainer session' organised by Earthwatch in order

Figure 49. Citizen science activities conducted during 2021. (a d) water sampling activities, (e) wildlife in the wetland. Source A. Scrieciu.

to instruct the attendees (colleagues from GeoEcoMar, WWF Romania) on how to use the FWW platform and FWW kits.

Following this event, in November 2020 the GeoEcoMar team organised a training session dedicated to the local citizen scientists belonging to Carasuhat Wetland. This session was held at Mahmudia town and inside Carasuhat Wetland. After the training session, monthly field campaigns took place, some of them being organised at the initiative of GeoEcoMar team, other ones being organised by our 'CS champion' who is organising boat tours and it's passionate about bird watching.

The core team was represented by 12 active citizen scientists that collected 43 water samplings from

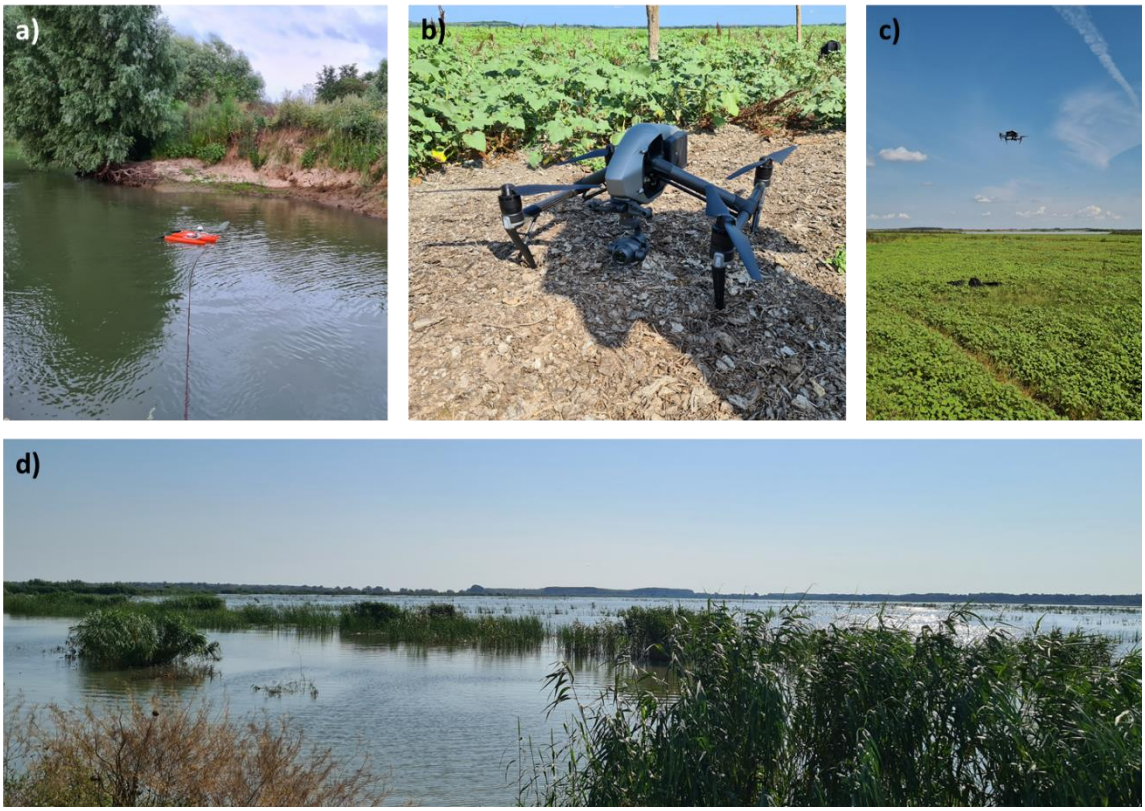


Figure 50. Citizen science activities conducted during 2021. (a) water level monitoring with a ADCP; (b - c) wetland biodiversity mapping with a drone; (d) view of the wetland. Source A. Scrieciu.

4 different locations. For monitoring the water quality (nutrients and turbidity), citizen scientists used the Fresh Water Kits (FWW) supplied by Freshwater Watch (Figure 49). Full details regarding the sampling method and kits can be found in the FWW methods manual. After conducting the tests, participants added their data to the FWW database, in addition to photographs and supplementary notes.

11.3.2. Water Level Monitoring

Alongside monitoring the water quality, citizen scientists also performed Water Level Monitoring using the FWW app and also took pictures using fixed markers already placed along the western dyke, starting with site 1 - canal entrance.

In addition, the GeoEcoMar team, with support from two citizen scientists, performed ADCP measurements (Acoustic Doppler Current Profiler) at the entrance (site 1 - canal entrance) and the exit (site 4 - canal exit) of the wetland in order to measure the water velocity and water discharge (Figure 50a).

11.3.3. Dyke Stability

Dyke Stability observations have been performed alongside monitoring the water quality and Water Levels using visual observations (i.e. looking for cracks in the dykes, looking for signs of subsidence) and via photo records. These observations took place along the western dyke, starting with site 1 - canal entrance.

11.3.4. Wetland Biodiversity

Biodiversity was monitored during one campaign in the summer, coordinated by WWF and the citizen scientists. This applied a methodology developed by WWF, focusing on bird diversity. Complementary to this activity, the GeoEcomar team, with support from two citizen scientists, performed two further campaigns of aerial observations using two drones in order to observe the evolution of the wetland (Figure 50b - d), at the landscape level of 'rewilding' (areas covered with vegetation and populated with wildlife). This is continuing, mapping the existing vegetation using a series of interpolation algorithms.

The information gathered so far shows very positive natural development of the newly created wetland.

11.3.5. Reflections on Citizen Science Activities

Engaging the local stakeholders has been challenging. The local community was sceptical of the NBS wetland project and its ability to make positive change, but with time, perseverance, and support from the colleagues in the WWF, the project team has managed to gain the local community's trust.

Most of the original issues encountered were around this issue of trust of local authorities. Following the co-design workshops the team saw an increase in the trust level of the community and an improved dialog has developed since. This has helped improve the understanding and awareness of the environmental issues, the NBS, and the importance of sustainable development.

The project team in GeoEcoMar are in contact with their stakeholders and discussions have begun about the possibility of replicating the NBS implemented at Carasuhat Wetland in the immediate vicinity. At the same time the local community is committed to continue with the monitoring activities in order to set an example for the authorities in charge of the monitoring and management of the wetland.

Despite the abovementioned challenges the project has managed to engage 12 active citizen scientists that collected 43 water samples from four different locations. Most of the citizen scientists, with very different backgrounds, are willing to get involved in a structure that allows further local efforts for looking after and sustaining the NBS and the local development agenda.

11.4. Measuring the Impact of the Carasuhat Wetland NBS Project

11.4.1. Application of the MICS IA Approach to the Carasuhat Wetland NBS Project

Similar to the Italian and Hungarian case studies the IJM for the Carasuhat Wetland NBS Project was developed by the MICS team and later validated by stakeholders engaged with the project. This involved:

1) Reviewing the IJMs created previously for other MICS projects (UK, Italy, and Hungary), and adopting / adapting any generic items pertinent to the Romanian case study;
2) Reviewing the contextual information about the Romanian case (during which the MICS IA Approach was also completed); and
3) Creating new items based on this contextual review that captured the activities, outputs and impacts specific to the Romanian case.

4)

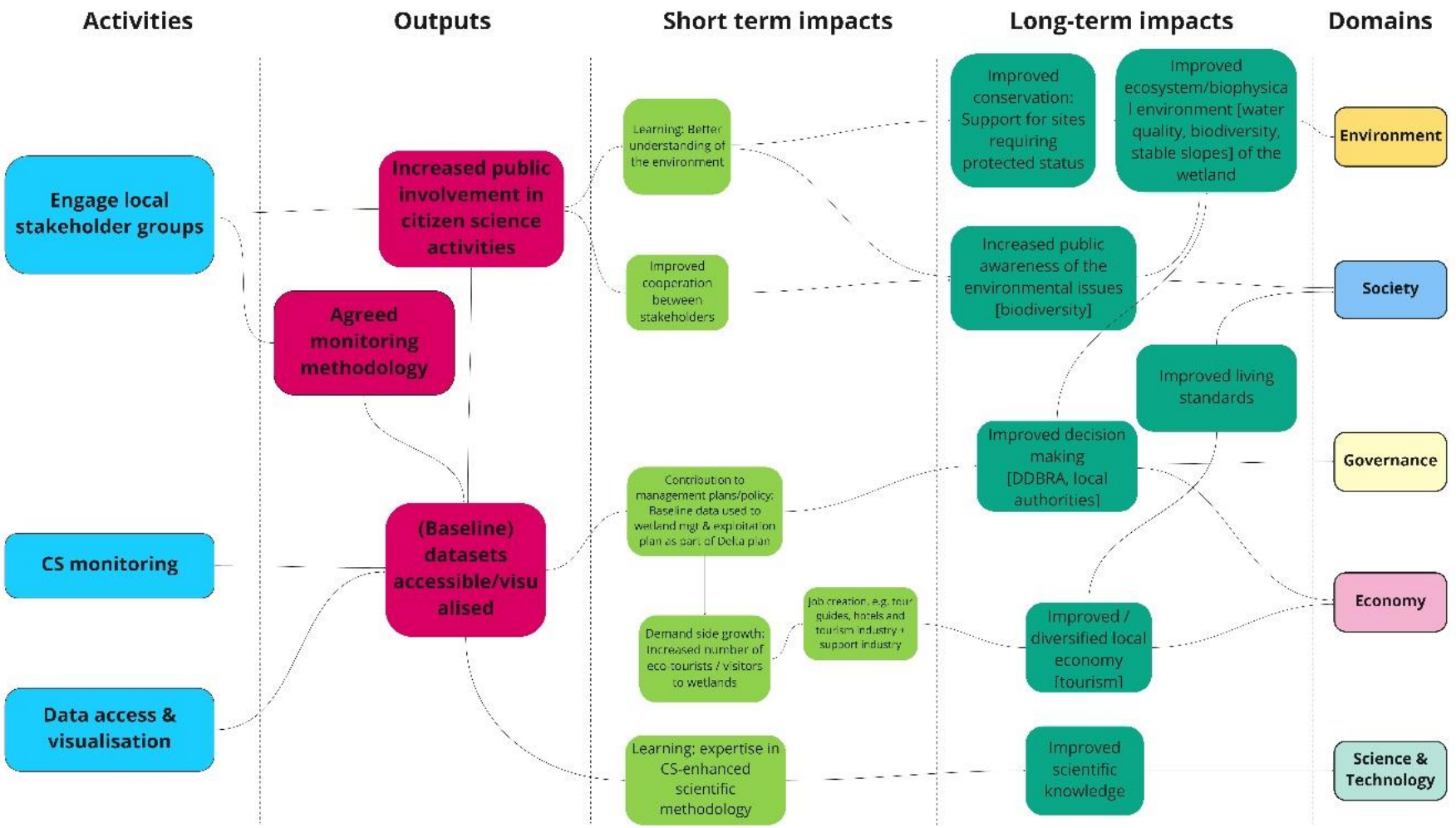


Figure 51. Draft IJM developed for the Carasuhat Wetland NBS Project.

Table 25 summarises impact domains in which the Romanian case study seeks to engender impact(s) and the rationale behind focusing on these domains. This was created during a review of contextual information about the Carasuhat Wetland NBS Project and the completion of the IA compendium for the case study.

Table 25. Impacts of the monitoring activities associated with the Carasuhat Wetland NBS Project grouped according to impact domain.

Domain	Carasuhat Wetland NBS Project
Science & technology	• Improved conservation for existing sites • Offering sites support
Society	• Increased public awareness regarding the environment • The creation of new organisations for management and protection of the sites selected for conservation
Environment	• Improve the environmental quality of the selected sites
Governance	• Informed and improved management strategies • The development of new organisations
Economy	• Better monetising the value of the selected sites in a green way by adhering to a new customised management plan and facilities

The draft IJM developed for the Carasuhat Wetland NBS Project is shown in Figure 51.

The development of the IJM was a collaborative process involving members from WP4 (WP4 lead – RRC and the Romanian project coordinator – GeoEcoMar) and WP2. As with the IJM created for the Italian and Hungarian case studies, care was taken to minimise the content of the Romanian IJM to capture the key elements of the project to ensure it was easy to read and by the project stakeholders.

Items within the IJM created for Carasuhat Wetland NBS Project were recorded in an excel spreadsheet so that their origin and any suggested changes made to them could be tracked. This included recording the origin of the item (i.e. created by the by the MICS team, modified, or adopted from IJM created for other MICS projects, or suggested by project stakeholders), whether it underwent any modifications or alterations during the validation process, and if it was retained in the final IJM. This information is summarised in Table 26 and shown in full in Annexe 14.

Table 26. Items identified in the IJM developed for the Carasuhat Wetland NBS Project.

Item Type	Item Number	IJM Title
Activities	1	Engage local stakeholder groups
	2	CS monitoring
	3	Data access & visualisation
Outcomes	4	Increased public involvement in citizen science activities
	5	Agreed monitoring methodology
	6	(Baseline) datasets accessible/visualised
	7	Learning: Better understanding of the environment

Short-term impacts	8	Improved cooperation between stakeholders
	9	Improved cooperation between stakeholders and high-level authorities (DDBRA)
	10	Job creation, e.g., tour guides, hotels and tourism industry + support industry
	11	Contribution to management plans/policy: Baseline data used to wetland management & exploitation plan as part of Delta plan
	12	Demand side growth: Increased number of eco-tourists / visitors to wetlands
	13	Learning: expertise in CS-enhanced scientific methodology
	14	Development of a centre for sustainable exploitation of local resources
	15	Increase the number of employees within DDBRA
	16	Simplifying the bureaucratic procedures
Long-term impacts	17	Improved ecosystem/biophysical environment [water quality, biodiversity, stable slopes] of the wetland
	18	Improved conservation: Support for sites requiring protected status
	19	Increased public awareness of the environmental issues [biodiversity]
	20	Increasing the awareness and responsibility level of unattended tourists
	21	Improved / diversified local economy [tourism]
	22	Improved decision making [DDBRA, local authorities]
	23	Improved scientific knowledge
	24	Improved living standards
	25	Development of a more comprehensive national strategy
	26	Impose local guides for large tourist group. / Creating a local guide (player) for good practices
	27	Dedicated Management Plan for Carasuhat wetland
	28	Creating an independent monitoring entity to supervise all the environmental monitoring activities for the DD
	29	New organization (NGO?) for promoting and protecting Carasuhat wetland

To validate the draft IJM a workshop was arranged with the stakeholder involved in Carasuhat Wetland NBS Project. During this workshop the IJM was presented to stakeholders for validation, giving them the opportunity to make additions, amendments and/or remove items from the IJM. During the preparation for the impact workshops the project coordinator (GeoEcoMar) expressed concern that the IA activities would be less well received by certain stakeholder groups (i.e. citizens). In communications between the project coordinator and citizen scientists prior to the event citizens expressed a keener interest in being involved in the physical monitoring activities as opposed to the more cerebral IA activities. To make the IA workshop more appealing to citizen scientists it was decided to run the workshop back-to-back with a citizen science training event. The workshop would be held in the morning while the training event would take place in the afternoon.

11.4.2. Impact Workshop: The Impacts of Citizen Science in the Carasuhat Wetland

Overview of Workshop

Stakeholders involved in the Carasuhat Wetland NBS Project attended a workshop to discuss and explore the impacts of the citizen science activities of the projects. This face-to-face workshop was held on 19/06/21 and was scheduled to be 4-hours in length (Figure 52). Table 23 provides details of the event.

A total of ten participants attended the event representing several stakeholder groups involved in the project. This included:

- Scientists;
- Education professionals;
- Representatives from the local governments;

Figure 52. Photographs taken during the Romanian impact workshop.

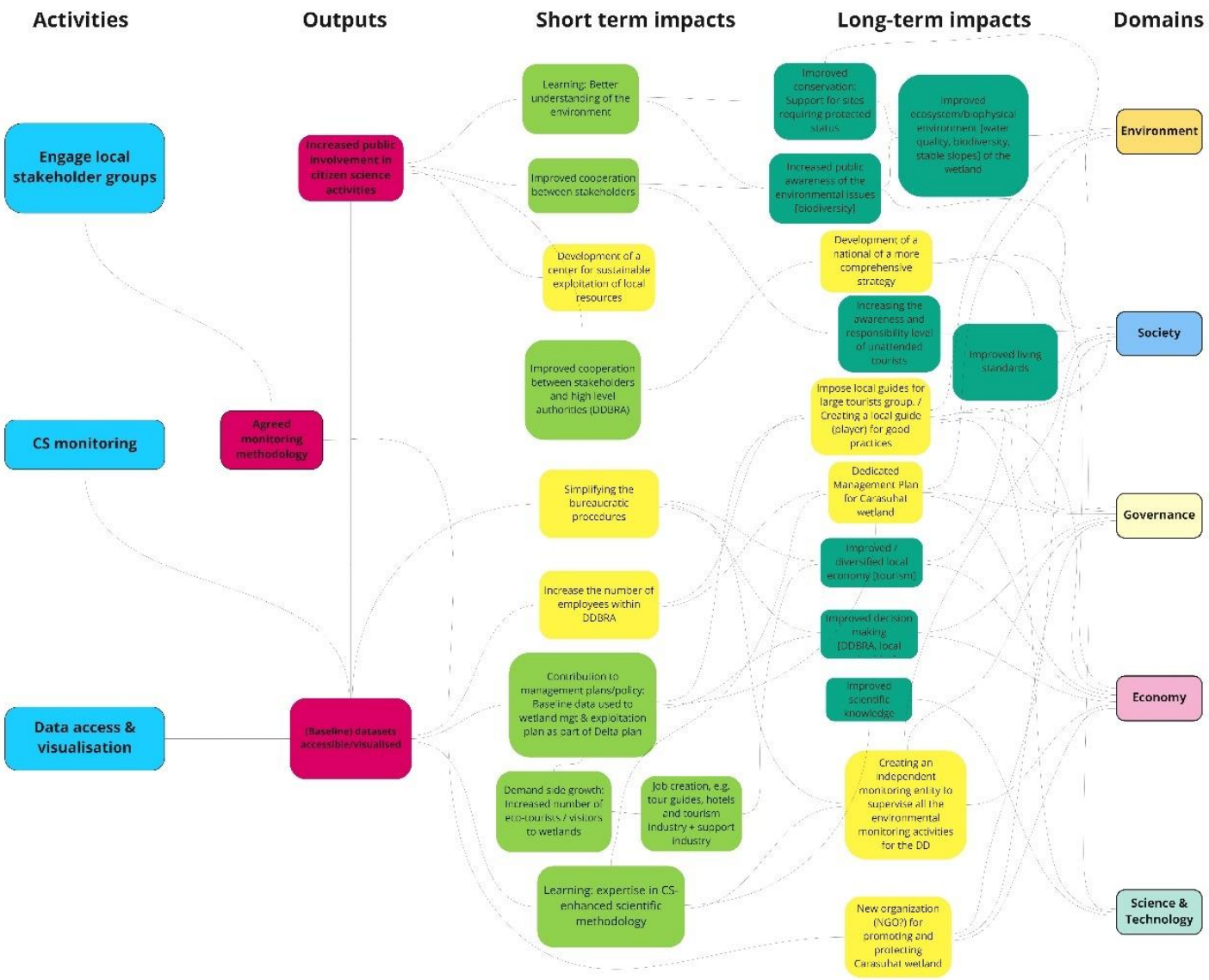


Figure 53. The draft IJM for the Carasuhat Wetland NBS Project edited by stakeholders during the impact workshop. Items in yellow boxes indicate additions / amendments made by the workshop participants.

- Citizen scientists, and;
- Affiliated NGO's (i.e. WWF).

The workshop content and activities focused on the validation of the draft IJM created for the Romanian case study shown in Figure 51.

Activity 1. The attendees participated in three IA activities. The first two of these focused on validating specific aspects of the draft IJM. Tasks included:

Activity 2. Validating the impacts identified in the draft Impact journey.

Activity 3. Verifying how the impacts of the citizen science activities associated with the Carasuhat Wetland NBS Project have/will be achieved.

Activity 4. Voting for impacts to prioritise and monitor.

During activities 1 and 2, the participants were split into smaller groups and provided with copies of the draft IJM printed out on large sheets of paper so that they could make review and make edits to it (Figure 52). The final task of the workshop (Activity 3) was selecting short- and long-term impacts from the journey map to monitor. During the workshop the hottest topic of discussion related to the Carasuhat Wetland, and how certain stakeholders with influence on the stewardship and development of the site (e.g., the local government, DDBRA) could be lobbied to take action to preserve and improve the wetland and support future citizen science activities.

Figure 53 shows edited version of the IJM with additions/amendments made by stakeholders highlighted in yellow boxes. At the end of the impact workshop the participants went into the field to undertake training / monitoring activities.

In addition to present the whole IJM to stakeholders the project coordinator demonstrated how the impacts of the project could be separated into strategy 'pathways'. Two strategy pathways were identified for the Carasuhat Wetland NBS project:

- Fostering Stakeholder Engagement (Figure 54)
- From Data to Action (Figure 55)

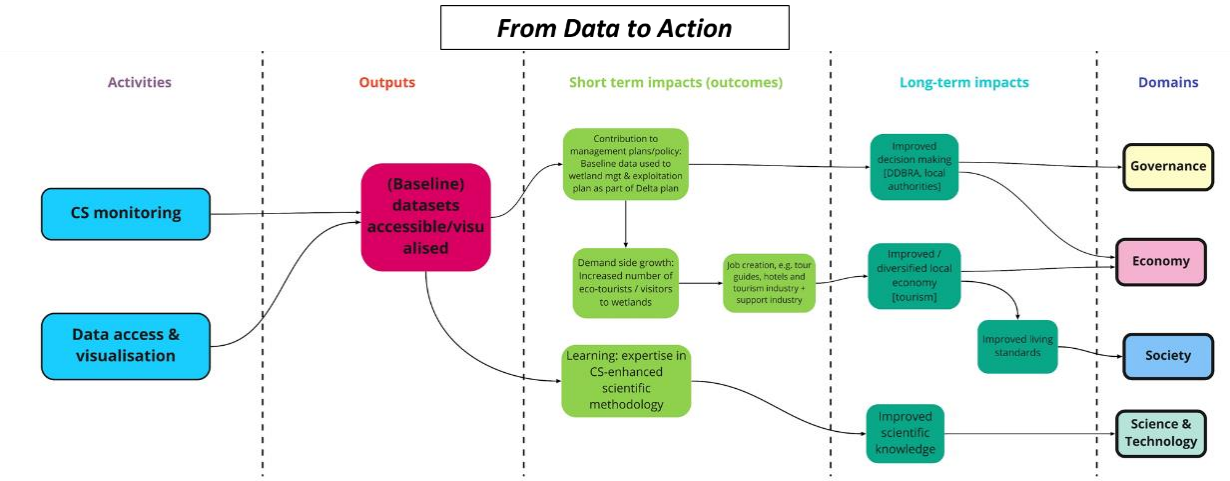


Figure 54. Impact pathways feeding into the From Data to Action strategy.

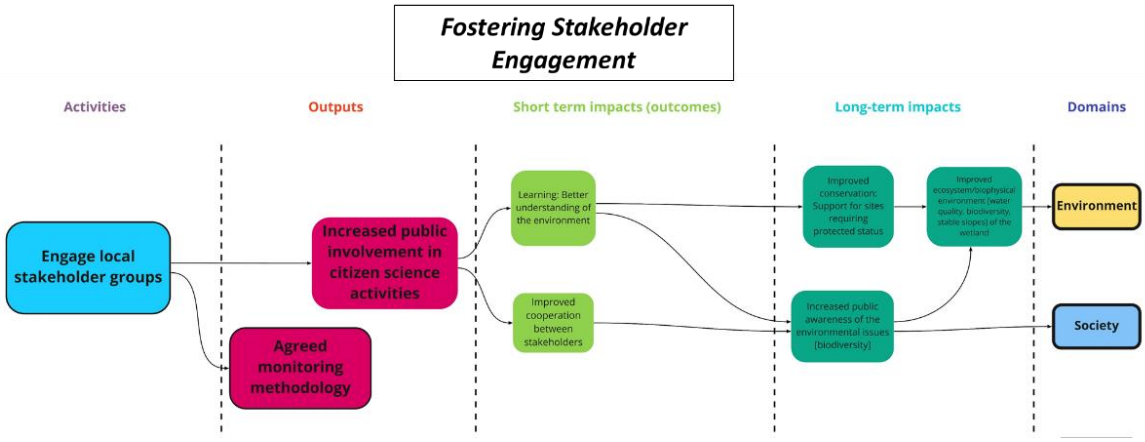


Figure 55. Impact pathways feeding into the Fostering Stakeholder Engagement strategy.

Outputs of Workshop

The primary outputs of the impact workshop were:

- A validated IJM (Figure 56) for Carasuhat Wetland NBS Project;
- A list of short- and long-term impacts selected by stakeholders for monitoring.

Validation of Impact Journey Map

The stakeholders who attended the workshop made several amendments and additions to the draft IJM. These included:

- The addition of four short term impacts:
- 'Development of a centre for sustainable exploitation of local resources' (Item No. 14)
- 'Increase the number of employees within DDBRA' (Item No. 15)
- 'Simplifying the bureaucratic procedures' (Item No. 16)
- 'Improved cooperation between stakeholders and high-level authorities (DDBRA)' (Item No. 9)
- The addition of six long-term impacts:
- 'Development of a national comprehensive strategy' (Item No. 25)
- 'Impose local guides for large tourists group. / Creating a local guide (player) for good practices' (Item No. 26)
- 'Dedicated Management Plan for Carasuhat wetland' (Item No. 27)
- 'Creating an independent monitoring entity to supervise all the environmental monitoring activities for the Danube Delta' (Item No. 28)
- 'New organisation (NGO?) for promoting and protecting Carasuhat wetland' (Item No. 29)
- 'Increasing the awareness and responsibility level of unattended tourists' to distinguish the change in awareness of tourists versus the local community.

Following the workshop, these additions, amendments, and the general comments made by stakeholders were reviewed. Some of the additions made to the draft IJM overlapped with pre-existing items. These included the short-term impact 'improved cooperation between stakeholders

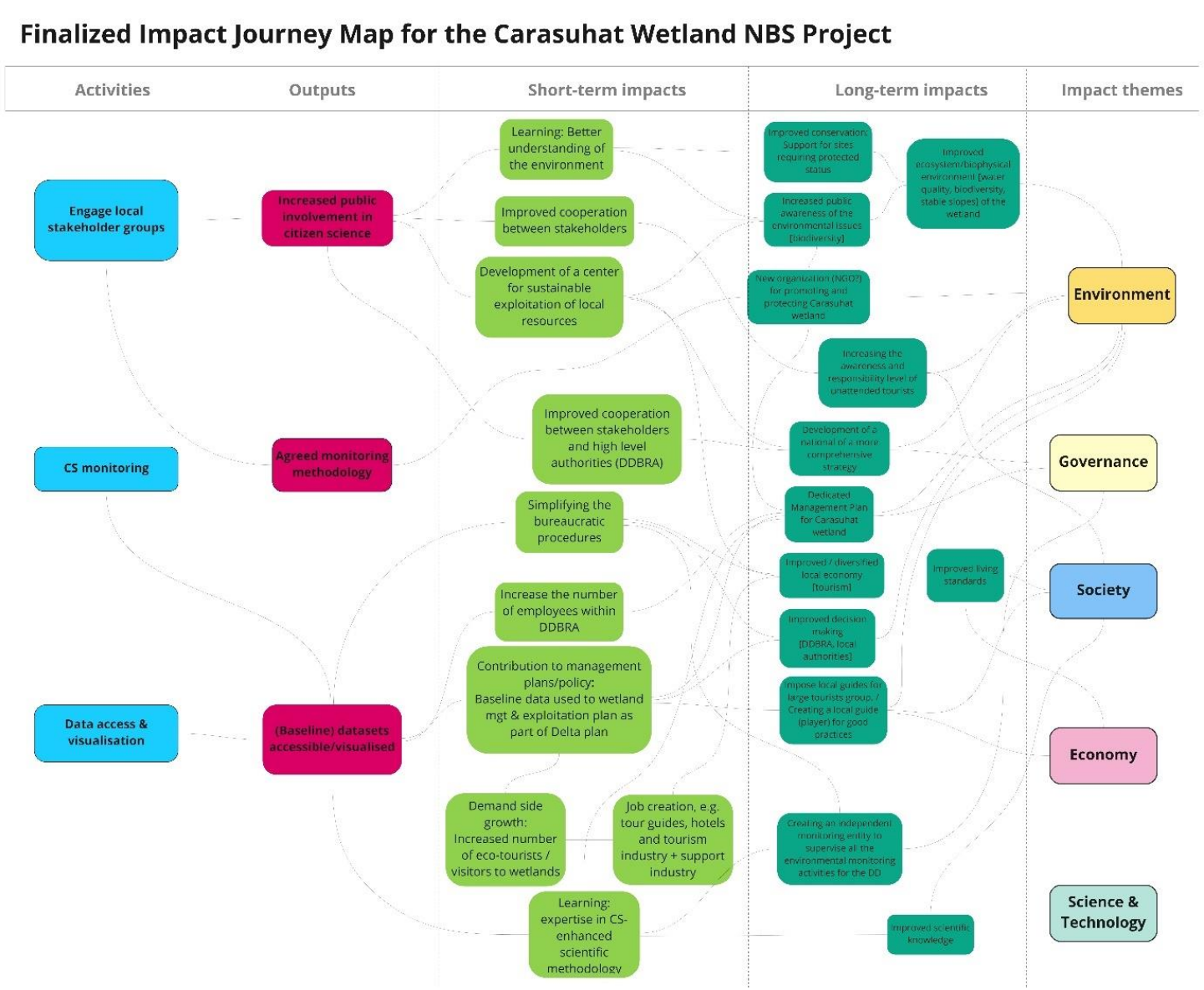


Figure 56. The validated IJM for the Carasuhat Wetland NBS Project.

and high-level authorities (DDBRA)', which is closely related to the item 'Improved cooperation between stakeholders' (No. 8). Similarly, the long-term impact 'increased public awareness of the environmental issues [biodiversity]' (No. 19) could be seen to overlap with 'Increasing the awareness and responsibility level of unattended tourists'. However, both of these were retained as the stakeholder group felt that the distinction was importance. 'Increased public awareness of the environmental issues [biodiversity]' can be seen to be subtly different to 'increasing the awareness and responsibility level of unattended tourists', one being focused on the local community, the other on tourists. This impact was believed by the project coordinator to be particularly important as issues related to inappropriate behaviour by tourists was a growing issue and of concern to the local community.

The stakeholders also identified an aspirational vision for the region with the impact 'development of a canter for sustainable exploitation of local resources'. The local economy of the area is heavily dependent on natural resources and there is the feeling among stakeholders that better regulation and guidance is needed to help them balance economic demand with restoration and regeneration of the wetlands.

Prioritising Impacts to Monitor

For the Romanian case the project coordinators and stakeholders present decided to structure their voting using the 'strategies' that had been defined in the draft IJM (Figures 54 and 55). Participants voted for the short-term and long-term impacts that they felt were the most important to monitor within each of the two strategies individually.

The results of voting for impacts related to the strategy pathway 'Fostering Stakeholder Engagement' is shown in Figure 57, while Figure 58 shows the impacts voted for by participants that fall within the strategy pathway 'From Data to Action'

Within the 'Fostering Stakeholder Engagement' strategy pathway, voting on the priority short-term impacts was largely split between 'increasing the number of employees at the DDBRA' and 'simplifying bureaucratic procedures'. While these both quite strongly point towards the desire for more effective governance support and procedures, there is also a clear view that the citizen science project should contribute towards better environmental management of the wetland and the wider Danube Delta,

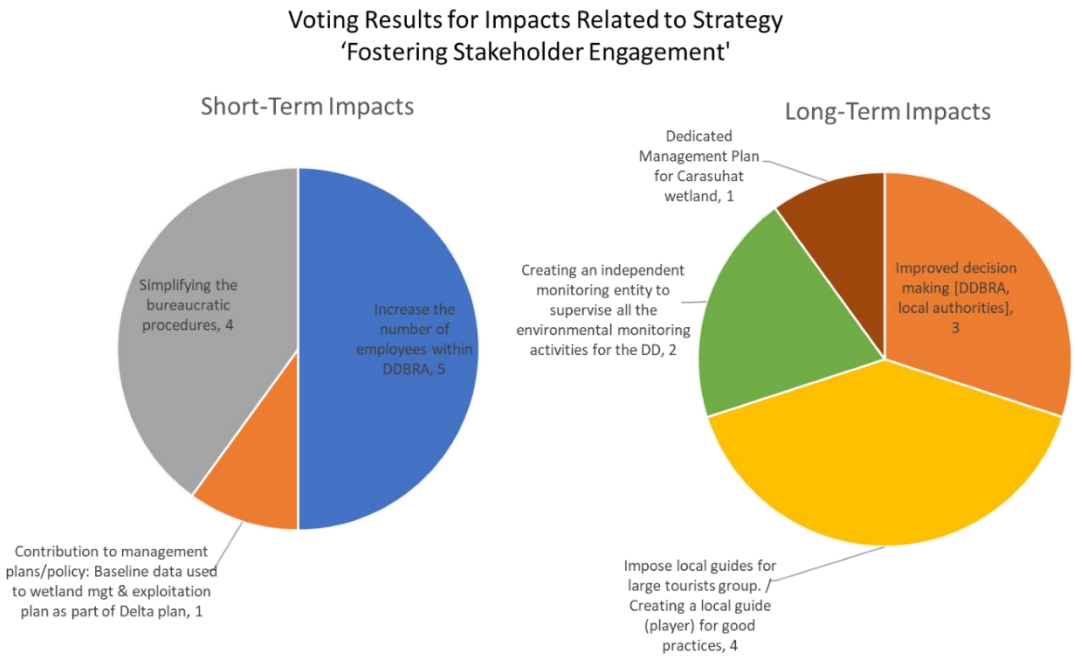


Figure 57. Voting results for the impacts related to the strategy 'Fostering Stakeholder Engagement'.

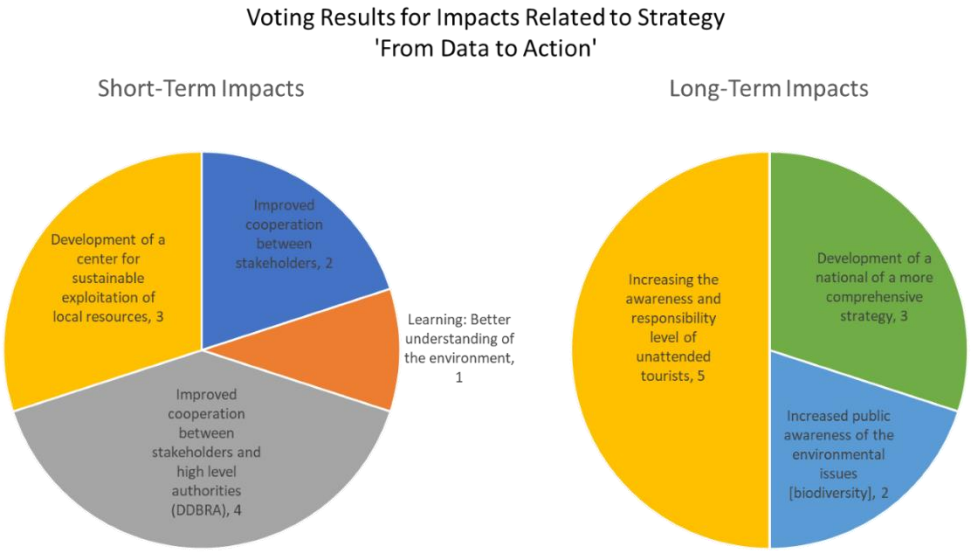


Figure 58. Voting results for the impacts related to the strategy 'From Data to Action'.

through the use of data and canvassing for adequate support for the environmental NGO. Voting for priority long-term impacts exhibited a wider split. six of the ten participants selected long-term impacts relating to better informed and better organised governance, either 'improved decision making [DDBRA and local authorities]' (three votes), 'the creation of an independent monitoring entity to supervise all of the environmental activities for the DD' (two votes), or 'the creation of a dedicated management plan for Carasuhat Wetland'. There was also a significant number of votes (4) cast for more sensitive management of tourists and other visitors to the wetland, reflecting significant concern within the stakeholder group over the detrimental effects caused by these activities.

Within the 'From Data to Action' strategy pathway, six out of ten participants voted for 'improved cooperation between stakeholders' or 'between stakeholders and high-level authorities' as a priority short term impact, indicating that over half of the participants currently consider that a lack of cooperation between stakeholder groups is a significant barrier to taking action to improve the Wetland environment. The remaining four votes were split between two impacts that both relate to increasing understanding of environmental functions and management ('development of a centre for sustainable exploitation of local resources [three votes] and 'learning: better understanding of the environment' [one vote]). Within the long-term impacts, six of ten participants identified increased public environmental awareness and responsibility as a priority, both within the general populace (two votes), and within the tourist population specifically (five votes). The remaining three participants voted for the 'development of a more comprehensive national strategy' relating to sustainable natural resource exploitation.

Feedback on Workshop

During the workshop participants expressed their thoughts regarding its content and format.

Content

Some of the participants expressed difficulties in framing their thoughts and opinions within the designed framework (this was mainly due to the fact that they were not used with this type of workshops) even though the team spent a lot of time translating the format of the workshop into a

common easy to understand language.

Format

The citizen scientists were not very familiar with virtual meetings and interaction software, so by respecting the Covid-19 limitations, the team prepared a face-to-face workshop with PowerPoint presentations, printed A0 paper sheets and post-its. It is felt that believe that this helped in gaining the attendance of the citizen scientists.

11.4.3. Impact Monitoring Strategy for the Carasuhat Wetland NBS Project

Based on the impacts selected by stakeholders involved in the impact workshops the MICS team are developing a draft IMS for the Carasuhat Wetland NBS project to implement.

11.5. Evaluation of Measuring the Carasuhat Wetland NBS Project's Impact

The primary developments of the Romanian case study were:

- Better cooperation between stakeholders and policy makers;
- Raised awareness regarding the importance of nature restoration.
- New ideas for furthering relations between the citizen scientist and the scientific community; and,
- A better understanding of the steps needed to be taken in order to maximise the impact of all the local green policies.

Despite the scepticism expressed by the local community in the effectiveness of the NBS project and the role citizen science could play in supporting it, the success of the citizen science activities has helped galvanise local support for the Carasuhat Wetland NBS Project and restoration within the wider region. This required developing communication channels, demonstrating results, and building trust. The co-design workshops helped to achieve this by opening a dialogue and bringing stakeholders together. This helped improve awareness regarding the environmental issues within the local area and promoted an understanding of how the NBS could help support the local community by addressing societal issues, e.g., improving the local economy through tourisms.

The IA workshops helped to build the understanding of how the different components of the project fit together and result in change in different areas. The delivery of the workshops was adapted to facilitate this growth and understanding, recognising the participant group would be working with unfamiliar concepts. Raising understanding is seen by the project lead as a key component in increasing involvement and positive engagement. The citizen science activities associated with the Carasuhat Wetland NBS Project are in an early phase. When undertaking IA towards the beginning or within an ongoing citizen science project the process can provide insight into how the stakeholders would like to see the project develop. In this case, the dominant theme is the need to balance the social and economic needs of the community alongside the environmental restoration of the wetland.

Part C: Evaluation of Test Site Development and Tool Validation

This deliverable describes and evaluates the application of the MICS IA approach (developed in WP2 (D2.3 and D2.7) for the five MICS case study sites. The impact IA approach has worked very well in practice, providing an extremely useful and very capable tool to explore, capture and evaluate the complexities of citizen science impact, and to demonstrate the range of impacts that citizen science activities can have. Below, the key findings from the test site development and tool validation are outlined.

12. Co-design of Citizen Science Activities

The MICS project has applied the best practice generated by the Ground Truth 2.0 project and D4.6 in the co-creation of hands-on citizen science in support of NBS for three citizen science communities and set up activities to monitor local environmental conditions in Romania, Hungary, and Italy. These citizen science activities were not in place prior to the MICS project. Through co-design, citizens have been engaged from the outset in the planning and design of these activities, and they continue to be involved:

- In the Italian case study, a minimum of 50 citizens and almost 350 students are engaged in five different citizen science activities. These activities include physical, chemical, and biological water quality testing, riverine habitat mapping and the new inclusion of field study activities in the curriculum for local school groups.
- In the Hungarian case study, citizens are engaged in eight different citizen science activities, including water quality measurements using physical, chemical and biological methods, and habitat and biodiversity monitoring using readily identifiable target indicator species, as well as outreach and awareness-raising activities.
- In the Romanian case study, 12 citizens are engaged in four different citizen science activities, including checks on dyke stability, water level monitoring, water quality monitoring and recording of bird species.

Implementation of the co-design process in the Romanian, Hungarian, and Italian case studies has increased the active involvement of citizens in the design and set up of activities. Workshops brought together interested parties and became focal points for lively stakeholder-led discussion, which has added value to the citizen science project development, identified potential obstacles early on, and fostered a commitment to the activities. For example:

- In the Italian case study, discussion revealed that citizen attitudes toward citizen science were influenced by their experiences with the earlier River Contract process (a collaborative citizen science endeavour that had suffered from lack of maintained commitment), and that this posed both a barrier and an opportunity. Citizens therefore wanted assurance that there would be sustained commitment from all parties in new citizen science initiatives. The co-design process was therefore important for engaging allof the citizens and ensuring commitment from organisations.
- In the Romanian case study, NBS application was hampered by lack of understanding of NBS aims and concepts by citizens and lack of trust between the different parties. The co-design workshops succeeded in opening a dialogue and building relationships between the stakeholders. Citizens gained increased knowledge of local NBS schemes and the environmental and economic opportunities that the schemes aimed to create, and local authorities achieved a higher level of trust from those citizens.

Co-design workshops are valuable in gaining the perspectives and initiating better engagement from the participants. They take time and resources to develop as they need to be specific to the contextual

needs of the case study. The co-design process has been trialled and developed in the MICS case studies and the resources and lessons learned can be taken forward to other projects to help make the setup of co-design activities more efficient. MICS has also produced a co-design compendium and template slide sets for co-design workshops (based on the Ground Truth 2.0 light method) which are available on the MICS website for application in other projects.

Early on in the co-design process, a common language must be set up with the participants, to avoid jargon or other similarly exclusive terminology, to promote common understanding and ensure a trusted place for everyone to speak.

Citizen science projects can be contributory, collaborative, or co-designed. Elements of the co-design process can be incorporated into any type of citizen science project. For example, the contextual analysis step is a fundamental process to understand the local governance, policies, stakeholders, and citizens who will be involved in the citizen science project to maintain engagement, in addition the review of citizen science activities step in the co-design process is important to maintain engagement and ensure the long-term success of the project. In the Outfall Safari case study, citizen consistently emphasised the necessity of feedback (on project progress, results, and impact) to the citizen scientists and the wider community as a requirement for maintaining motivation and enhancing engagement, following steps in the co-design process will enable this.

13. Understanding Citizen Science Impact

MICS has set up and implemented testing of the MICS IA approach, tools and metrics for citizen-science projects that captured the projects' impacts across five domains: society, science & technology, environment, economy, and governance. These NBS case studies have confirmed that citizen science has multiple impacts across all five MICS domains. Across the MICS case studies, the outputs, outcomes, and impacts were varied, from improved water quality to improved policies and legislation around environmental governance. For example, in the Romanian case study, long-term impacts were identified as being associated with the governance and the economy, whereas in the Hungarian and Italian case study impacts were focused on the society and environment domains.

Citizen science activities may have multiple impacts, and often a single stakeholder group cannot fully appreciate all of them. Additionally, perceptions of impacts vary between individuals depending on their level of involvement and the context in which they operate.

- The impact assessment workshops highlighted the number of different outputs, outcomes and impacts of citizen science activities. Before the impact assessment workshops, citizens and project managers were not aware of the extent of the impact of their activities.
- Perceptions of impact varied between stakeholder groups; for example, in Outfall Safari, citizen scientists identified society and the environment as the key impact domains of the project, whereas the project managers and environmental regulators highlighted the value in the data collected to improve efficiencies in management and resolution of polluting outfalls, focusing on the impact domains of governance and economy. Without the involvement of all stakeholder groups, the total extent of impact could easily be underestimated.

The relative importance of different impacts is context-dependent, and varies between citizen science projects, even if there is significant overlap in the types of activities carried out.

- The MICS case study citizen science activities were all associated with monitoring environmental variables and identifying pressures on the environment. Therefore, the environment impact domain was believed to be the dominant theme across all case studies.

However, the impact journey highlighted that citizen science activities had different types of impact based on local contexts and the stakeholders and individuals involved. For example, in the Romanian case study, citizens and project managers highlighted that citizen science activities such as water quality monitoring and habitat mapping are now contributing to the development of wetland management plans, the formation of a new NGO to protect the long-term future of the wetland and supporting improved and diversified local eco-tourism. In these contexts, the dominant impact domains were Governance and Economy.

Impact journey mapping is a valuable exercise and highlights the complexities and various types of impact a citizen science project can have and provides the context for focusing in on which impacts are the highest priority to monitor.

14. Measuring Citizen Science Impact

Impact assessment workshops were developed for each case study, reflecting and building on the experience gained within previous workshops, to validate the MICS methods and tools. Using the MICS IA approach, impacts, outcomes, and strategies have been identified for each case study, and a visual representation of the IJM has been created. The visualization of the IJM during the stakeholder meetings provided a very effective means of showing the cause-and-effect relationship between strategies, outcomes and impacts for each project.

The IA approach has room for flexibility in its implementation. For example, workshops may be run with all stakeholders present or with different stakeholder groups individually. An IJM may be drafted from scratch, including stakeholder input, or may be prepared by project coordinators and later validated through stakeholder involvement. The approach can be used at the beginning of a project to help plan the activities in order to ensure that they engender the desired impacts, or it may be used as an evaluative tool for an ongoing project or a project nearing completion. Different aspects of it can be emphasised based on the interest and motivations of the stakeholders and other interest groups or the aims of the project coordinators. For example, it may be that the main focus for carrying out the IA approach is to generate a robust IMS. However, in other cases, the primary motivation may be its use as a collaboration tool to bring stakeholders together and provide feedback on the scope of the project impacts and the overall effect that the citizen scientists work is having. Based on all these factors, applying the IA approach may vary and can be adapted to suit each project.

The MICS case studies have identified which actions best contribute to the successful implementation of the IA approach:

1) undertaking a contextual analysis that will provide the background of the stakeholders and their previous engagement;
2) encouraging the participation of all stakeholders to offer a full range of views in the IA workshops;
3) packaging the IA approach within simple, interactive activities and apply a common language to promote understanding; and,
4) tailoring the IA format to the specific context and objective of the project.

The contextual analysis provides the information required to create a draft IJM and identify the main impacts of the project's objectives. It identifies all relevant stakeholders that should be invited to participate and allows the format of the activities to be tailored to the specific context of the project in terms of the interests, prior knowledge, and motivations of the participants. For example, in running the Outfall Safari workshops, the contextual analysis identified that there had not been many previous

opportunities for the citizen scientists to engage with the development of the project or interaction with the project coordinators who use the data citizens collect (e.g., the regulatory agency, utility companies and NGOs). Running two separate workshops allowed a comparison of the differing viewpoints of both citizen scientists and the project coordinators.

Evaluation of the case studies showed that the success of the IA approach depends on capturing all the impacts that may be generated by a project, and to do this requires good representation at the IA workshops from all stakeholder groups. Two methods can be used to promote participation:

- *Promoting the workshop by focussing on the interest of the stakeholder groups*. E.g., in the Italian case study, the IA workshops were presented to participants as a means of providing feedback to the stakeholders about the project. The contextual analysis had identified that the citizen science community within the Italian case study was particularly concerned with the lack of progress from previous schemes (i.e. the River Contract initiative).
- *Combining impact assessment workshops with citizen science activities where appropriate*. For example, in Hungary and Romania, the workshops were held back-to-back with citizen science training activities to appeal to a broader audience.

The IA approach contains concepts that will be unfamiliar to many of the stakeholders, particularly the citizen scientists. Testing through the case studies show there are two alternative approaches:

1) adopt the format of the IA approach applied to Outfall Safari, whereby stakeholders are involved in the drafting of the IJM and therefore develop a familiarity with the concepts and content; and,
2) avoid circulating the draft IJM for independent study and instead dedicate time during the IA workshop to thoroughly and methodically break down the IJM into its constituent parts and explore its linkages.

15. Applicability to Nature-based Solutions

The MICS IA approach was applied and validated in five NBS case-study sites, in regions with differing needs, contexts, and approaches to NBS, and with various levels of citizen-science application. Citizen science helps to better understand the environment and support the monitoring, implementation, and development of NBS. Through the MICS case studies, citizen scientists have collected new evidence on the condition of their nature-based solutions. For example:

- Outfall Safari citizen scientists have helped to identify polluting outfalls and raise awareness of misconnections
- In Hungary, citizen scientists working on Creek Rákos have mapped the distribution of Black Woodpecker territories and taken measurements of amphibian and selected insect abundance. This forms a baseline measurement against which future surveys can be compared as work is done to increase the naturalness of the river. They have designed activities that are attractive to different age groups and that are visible to the local community as a way of raising awareness of the ecology of the river.
- In Romania, citizen science underpins the environmental monitoring strategy for the newly-reconnected Carasuhat Wetland. 12 volunteers undertake regular hydrological observations to develop the evidence base for how the wetland is responding to the embankment breaches made as part of the restoration.
- In Italy, water quality monitoring and habitat mapping at four river and wetland restoration

and creation sites in the Marzenego River basin has become a fixture of the local school curriculum as well as the activities of local interest groups. Over 150 water samples and 20 vegetation surveys have been taken to date, and the monitoring methodology that has been established will provide data on the evolution of the ponds, wetlands, and river channel in the coming years.

16. Ongoing and Future Development of the MICS Platform

Whilst the work described in this report focuses on testing and evaluating the methodologies developed as part of the IA Approach of MICS, the lessons learnt through the case-study activities will permeate throughout the MICS project. Specifically, the ongoing and future development of the MICS platform, designed to allow any citizen-science project to measure impact at any point during the project lifecycle, is and will continue to be guided by the case-study findings.

Through the co-design activities and workshops that have taken place as part of WP4, the impact indicators developed in WP2 and subsequently adopted by the platform in WP3 have been tested and validated in a real-world scenario. This validation will ensure that the platform addresses the needs and considerations of all stakeholders and that the MICS IA approach and platform are relevant and applicable in different citizen-science contexts.

Additionally, the increased awareness and consideration of impact raised through the WP4 case studies and their co-design practices guide the platform design. The measurement of impact (the platform's output) will be validated against the case-study expectations regarding their impact across the domains of Economy, Science and Technology, Society, Governance, and Environment to ensure that impact is measured understandably and realistically. The impact measurement tools and guidance accessible through the platform will also be guided by the case studies to ensure they are relevant and usable across different citizen-science contexts.

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Annexe 1: UK Case Study – Impact Workshop Structure Adopted for Outfall Safari

Outfall Safari – Workshop 2 and 3: Measuring the Impacts of Outfall Safari: Developing an Impact Journey

Workshop 2 – 1½ hour workshop held on 03/02/21 with citizen scientists.

Workshop 3 – 1½ hour workshop held on 10/02/21 with project managers and representatives from organisations associated with the project (e.g., NGOs, Environment Agency, Rivers and Wildlife Trusts, Water Company etc.).

Session item	*Purpose*	Desired output/ understanding	*Who*	*Materials, support*	*Timing*
Welcome and introduction	*Outfall Safari & why MICS project can be relevant to Outfall Safari – include some slides from Jan workshop (to remind people)* *Objective of the workshop: to develop an impact journey of Outfall Safari*	Awareness of project context	*Facilitator*	*Slides*	*10 min.*
Participants' expectations and opportunity t o introduce themselves	*Warm up – all participants introduce themselves and write down any expectations they have from the session.*	All know who's in the room, and what the respective expectation s are of collaboration on outfall safari – MICS collaboration	*Participants*	*Slides, Zoom, MIRO*	*10 min.*
Structure, envisaged results & approach	*Provide clarity on structure of this workshop and overall purpose/envisaged results – show an example of an impact journey. This is the first in a series of workshops. These workshops are stepping stones to measure overall impact of Outfall Safari.*	Awareness of the way of working in this workshop/project and timelines Manage expectations	*John*	*Slides*	*5 min.*
What are the impacts of outfall safari?	*Get participants to work in small groups and think about the long-term impacts of Outfall Safari.* *Participants use post it notes to write down long term impacts and group them within the MICS domains – environment, science & technology,*	Awareness of the long-term impacts of Outfall Safari and which are most important to the volunteers.	*Facilitator, group leader and participants* *Participants – split into 2 groups*	*Slides, MIRO and Zoom*	*30 min.*

	governance, economy, society. *Participants rank which are the most important impacts to them.*				
What are the outcomes of outfall Safari?	*Get participants to work in small groups to think about the outcomes of Outfall Safari.* *Participants use post it notes to write down short term outcome s and group them within the MICS domains – environment, science & technology, governance, economy, society.* *Participants rank which are the most important outcomes to them.*	Awareness of the outcomes of Outfall Safari and which are most important to the volunteers.	*Facilitator, group leader and participants* *Participants – split into 2 groups*	*Slides, MIRO and Zoom*	*30 min.*
How do we achieve the outcomes and impacts of Outfall Safari through the CS activities? (e.g., what are the strategies) Drawing the linkages between strategies – outcomes and impacts	*Get participants to write down how they contribute to the outcomes and impacts of Outfall Safari: 'the strategies' and assumptions* *Get participants to draw linking lines between the groups of post its and how everything links together.*	Know about the strategies and assumptions that the citizen scientists are involved with to achieve the outcomes and impacts of the project Identify the links between the strategies outcomes and impacts to create theory of change logic diagram	*Facilitator, group leader and participants* *Participants – split into 2 groups*	*Slides, MIRO and Zoom*	*30 min.*
Plenary	*Each group present – so they see each other work*		*Facilitator (JW), group leader (HJ and SP) and participants*	*Slides, MIRO and Zoom*	*10 min*
Summary & workshop close	*Summarise the workshop (MICS team) and the theory of change diagram produced* *Highlight the aims of the next workshop / bigger picture* *Next workshop with EA/water company / have dates fixed in agenda.* *Solicit personal pledges & commitment*	Clarity on outcomes and impacts of outfall Safari Commit for next meeting which looks at how we measure the outcomes and impacts.	*John*	*Slides*	*5 min.*

Outfall Safari – Workshop 2: How do we monitor the impacts of Outfall Safari?

Workshop 2 held 17/02/21 jointly with citizen scientists, project managers and representatives from organisations associated with the project (e.g., NGOs, Environment Agency, Rivers and Wildlife Trusts, Water Company etc.).

Session item	*Purpose*	Desired output/ understanding	*Who*	*Materials, support*	*Timing*
Welcome and introduction	*Introduce the MICS project; & why it is relevant for Outfall Safari, timings of workshop* *Summarise theory of change diagram produced by citizen scientists & water companies workshop.* *Objective of the workshop:* ***To decide what indicators can be used to measure the impacts of Outfall Safari and how they can be implemented***	Awareness of project context	*Facilitator*	*Slides* *MIRO boards* *Zoom* *Zoom poll – motivations for participating in citizen science*	*10 min.*
Structure, envisaged results & approach	*Provide clarity on structure of this workshop and overall purpose/envisaged results*	Awareness of the way of working in this workshop/project and timelines	*Facilitator*	*Slides*	*5 min.*
Activity 1 - check 'distilled' theory of change	*Validation - Have a look at the miro boards, is anything missing, additional info, additional links is there anything else you would like to capture?*	Participants sent to breakout rooms - **2 - 3 groups working at 1 MIRO board**	*Participants*	*Zoom* *MIRO boards*	*20 mins* *(15 mins activity 5 min feedback)*
Activity 2 - Prioritise impacts to monitor	*Priortise the key Strategies/activities (1-2) short term impacts (1-2) long term impacts (1-2) on the miro board then get people to vote via zoom polls which impacts are a priority to them. Share results on screen.* *Google sheet or poll to vote which they are most interested in*	Participants asked to vote on *Strategies / activities, short term impacts, long term impacts* 5 - 10 break? To collate results of polls **Breakout rooms 2 – 3 voting on MIRO board**	*Facilitator* *Participants*	*Slides* *Zoom poll*	*10 mins*
Activity 3 – Monitoring / scheme/Indicators to measure citizen science	*Clarify -* *Table prepared as miro board – transfer outputs from 2nd activity, onto miro board* *4- 5 priorities split between different groups -* *What do you want to measure?* *How?* *Who?* *Discuss indicators to measure impact - State who is involved/responsible for measuring each indicator & timescales for monitoring & evaluation*	Participants sent to breakout rooms - 3 groups Individual MIRO boards (x3 for each group)			
Plenary - what is the most meaningful way	*MICS presents options for measuring impacts of Outfall Safari*		*Facilitator, group leader and*	*Slides, MIRO and Zoom*	*15 mins.*

to implement measuring impacts			*participants*	*Group feedback. Breakout group leader (HJ and SP) share screens and 1 citizen scientist from group presents results*	
Summary & workshop close	*Summarise* *Solicit personal pledges & commitment*	Clarity on outcomes Commit for next meeting: co-design of tools for identified monitoring scheme	*Facilitator & participants*	*Slides*	*10 min.*

Annexe 2: UK Case Study – Development of Impact Journey Map for Outfall Safari

			Stage 1: Synthesis of draft IJM created by stakeholders						Stage 2: Validation of draft IJM by stakeholders				Stage 3: Finalisation of IJM			
	No.	Title	Item generated from stakeholder comments - title created by MICS team (Y/N)	# of Citizen scientist comments	# of project manager comments	TOTAL # of comments	TOTAL # of Votes	Item added to draft IJM by MICS team to fill gap (Y/N)	Item amended / expanded upon by stakeholders (Y/N)	New item added by stakeholder (Y/N)	Item validated by stakeholders at workshop 2 (Y/N)	Number of votes	Item added during validation process retained (Y/N/NA)	Amendment / expansion added during validation process retained / adapted (Y/N/NA)	Item in original draft removed / combined with another item (Y/N)	Item added to draft IJM by MICS team to fill gap (Y/N)
Activities	1	Project planning	Y	0	1	1	NA	N	N	N	Y	NA	NA	NA	N	N
	2	Secure resources	Y	0	0	0	NA	N	N	N	Y	NA	NA	NA	N	N
	3	Engage local stakeholder groups	Y	0	2	2	NA	N	N	N	Y	NA	NA	NA	N	N
	4	Establish monitoring methodology	Y	0	5	5	NA	N	N	N	Y	NA	NA	NA	N	N
	5	Conduct surveys	Y	0	3	3	NA	N	N	N	Y	NA	NA	NA	N	N
	6	Reporting to EA / Thames Water / homeowners	Y	1	1	2	NA	N	N	N	Y	NA	NA	NA	N	N
	7	Feedback / follow up to citizen scientists	Y	0	2	2	NA	N	N	N	Y	NA	NA	NA	N	N
	8	Future development	Y	0	0	0	NA	N	N	N	Y	NA	NA	NA	N	N
Outputs	9	Funding sources identified	Y	0	1	1	NA	N	N	N	Y	NA	NA	NA	N	N
	10	Volunteers engaged via environ. NGOs	Y	3	0	3	NA	N	N	N	Y	NA	NA	NA	N	N

	11	Volunteers trained	Y	1	3	4	NA	N	N	N	Y	NA	NA	NA	N	N
	12	Other groups from general public engaged	Y	0	0	0	NA	N	Y	N	Y	NA	NA	N	N	N
	13	Statutory agencies engaged	Y	0	0	0	NA	N	N	N	Y	NA	NA	NA	N	N
	14	Local authorities engaged	N	0	0	0	NA	Y	N	N	Y	NA	NA	NA	N	N
	15	Water companies engaged	Y	1	1	2	NA	N	N	N	Y	NA	NA	NA	N	N
	16	Identification of the locations of polluting outfalls	N	0	0	0	NA	Y	N	N	Y	NA	NA	NA	N	N
	17	Analysis of survey results	Y	1	0	1	NA	N	N	N	Y	NA	NA	NA	N	N
	18	Improved baseline data	Y	1	4	5	NA	N	N	N	Y	NA	NA	NA	Y - Removed	N
	19	Feedback to volunteers	Y	5	0	5	NA	N	N	N	Y	NA	NA	NA	N	N
	20	Disseminate approach	Y	1	2	3	NA	N	N	N	Y	NA	NA	NA	N	N
	21	Expansion of project scope	Y	1	2	3	NA	N	N	N	Y	NA	NA	NA	N	N
	22	Coordinating with other citizen science initiatives	Y	2	3	5	NA	N	N	N	Y	NA	NA	NA	N	N
	23	Outfalls that not important yet polluting	N	0	0	0	NA	N	N	Y	Y*	NA	N	NA	N	N
	24	Contacting householders	N	0	0	0	NA	N	N	Y	Y*	NA	N	NA	N	N
Shor	25	Stronger community	Y	0	5	5	2	N	N	N	Y	3	NA	NA	N	N

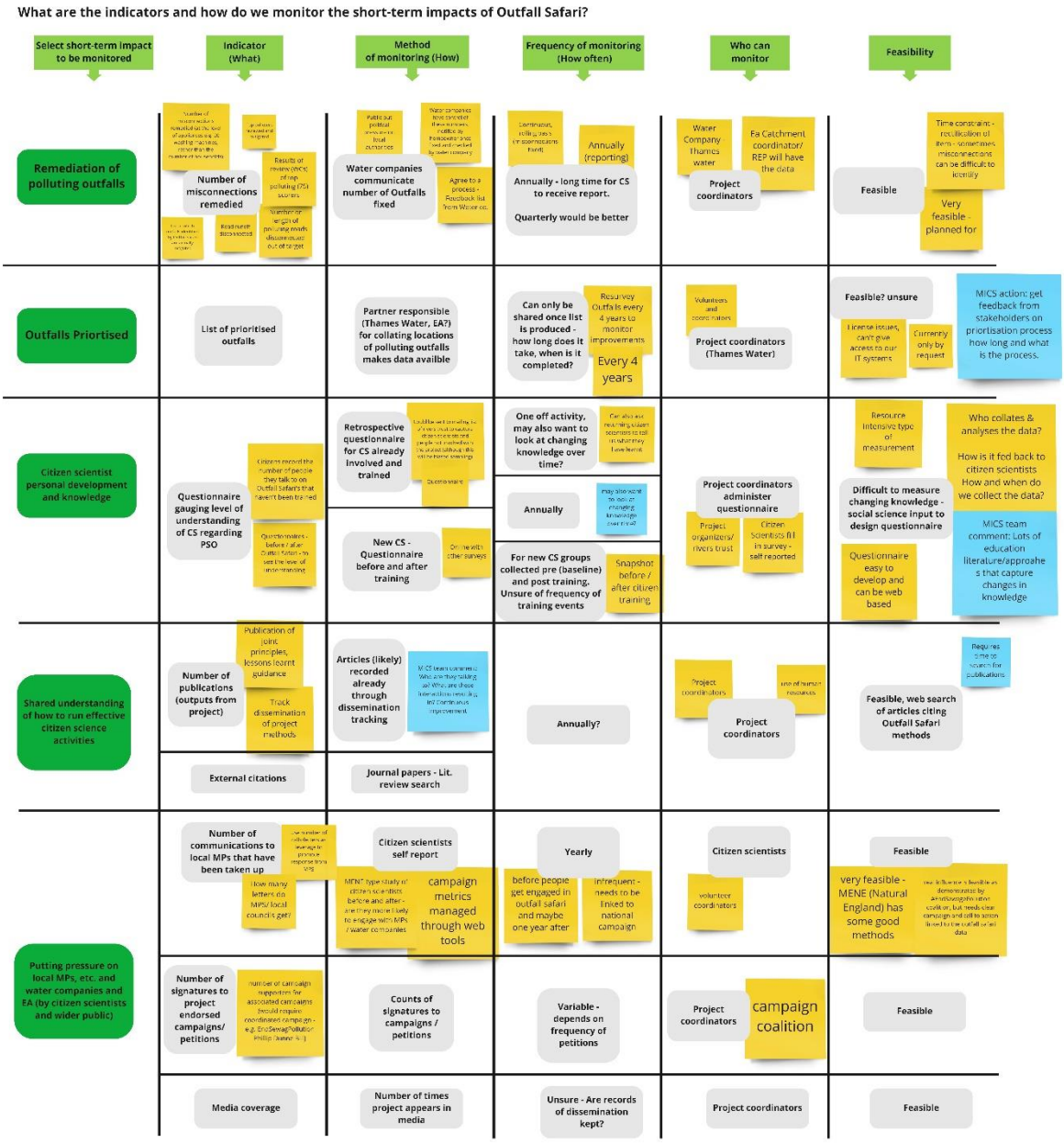
		feeling / sense of place														
	26	Increased active involvement - cascade effect	Y	0	4	4	4	N	N	N	Y	7	NA	NA	N	N
	27	Improved mental and physical health of volunteers	Y	0	1	1	1	N	N	N	Y	2	NA	NA	N	N
	28	Enhanced citizen scientist knowledge	Y	7	6	14	11	N	N	N	Y	3	NA	NA	N	N
	29	Upskilling	Y	0	1	1	1	N	N	N	Y	0	NA	NA	N	N
	30	Improved relationships among stakeholders	Y	3	5	8	5	N	N	N	Y	2	NA	NA	N	N
	31	Locations of misconnections investigated	Y	0	1	1	0	N	N	NA	Y	0	NA	NA	N	N
	32	Outfalls prioritised	Y	6	5	12	8	N	N	N	Y	7	NA	NA	N	N
	33	Remediation of polluting outfalls	Y	0	1	1	0	N	N	N	Y	2	NA	NA	N	N
	34	Targets for mitigating polluting outfalls met	N	0	0	0	0	Y	N	N	Y	4	NA	NA	N	N
	35	Political pressure on local MPs, etc. and water companies and EA (by citizen scientists and wider public)	N	0	0	0	0	N	N	Y	Y*	4	Y	NA	N	N
	36	Application of Outfall Safari	N	0	0	0	0	Y	N	N	Y	5	NA	NA	N	N

		method in other urban areas														
	37	Shared understanding of how to run effective citizen science activities	Y	0	1	1	0	N	N	N	Y	5	NA	NA	N	N
	38	Outfalls not surveyed/ accessible identified	N	0	0	0	0	N	N	Y	Y*	1	N	NA	N	N
	39	Other pollution sources identified (not just misconnections)	N	0	0	0	0	N	N	Y	Y*	0	N	NA	N	N
Long-Term Impacts	40	Community building	N	0	0	0	0	N	N	N	N	0	N	N	N	Y
	41	Improved volunteer health	N	0	0	0	0	N	N	N	N	0	N	N	N	Y
	42	Wider public awareness / changing attitudes of polluting outfalls	Y	2	14	17	5	N	N	N	Y	8	NA	NA	N	N
	43	Improved river water quality and habitat	Y	7	4	13	14	N	N	N	Y	9	NA	NA	N	N
	44	Improved Policies / Legislation	Y	2	5	7	8	N	N	N	Y	6	NA	NA	N	N
	45	Changed policy priorities	N	0	0	0	0	N	N	Y	Y*	1	Y	NA	N	N
	46	Improved decision making regarding	Y	0	5	5	8	N	N	N	Y	5	NA	NA	N	N

		polluting outfalls														
	47	Business Creation	Y	1	0	1	1	N	N	N	Y	0	NA	NA	N	N
	48	Increased institutional knowledge in how to run effective citizen science project	N	0	0	0	0	Y	N	N	Y	1	NA	NA	N	N

Annexe 3: UK Case Study – IMS for Outfall Safari

Stakeholders who attended impact workshop 4 were asked to create draft IMS for the impacts they had selected. Following the workshop the MICS team edited these draft IMS (using whiteboard software MIRO) to create a final IMS for the project. Below are the results of processing the stakeholder comments. For short-term impacts:



And long-term impacts:

What are the indicators and how do we monitor the long-term impacts of Outfall Safari?

Annexe 4: UK Case Study – Development of IJM for Riverfly

Item			Step 1 - Development of IJM		Stage 2: Validation of draft impact journey by stakeholders						Stage 3: Finalisation of Impact Journey
	No.	Title	Item taken / modfieid from Outfall Safari IJM	Item created by MICS team	Item amended / exanded or comment upon by stakeholders (Y/N)	Number comments received for item	New item added by stakeholder (Y/N)	Item validated by stakeholders (Y/N)	# of votes proj. coord.	# of votes cs	Item added during validation process retained (Y/N/NA)
Activities	1	Acquire funding for training	N	N	Y	1	Y	Y	NA	NA	Y
	2	Engage local stakeholder groups	Y	N	N	0	N	Y	NA	NA	NA
	3	Conduct ARMI monitoring	N	Y	N	0	N	Y	NA	NA	NA
	4	Reporting to EA by Riverfly coordinators	N	Y	N	0	N	Y	NA	NA	NA
	5	Feedback / follow up with volunteers	Y	N	N	1	N	Y	NA	NA	NA
	6	Outreach (public engagement / educational events)	N	N	Y	1	Y	Y	NA	NA	Y
Outputs	7	Volunteers trained and equipped	Y	Y	N	0	N	Y	NA	NA	NA
	8	Pollution events identified & reported to EA)	N	Y	N	0	N	Y	NA	NA	NA
	9	Data checked by Riverfly group coordinator (LCSP)	N	Y	N	0	N	Y	NA	NA	NA
	10	Extended Riverfly Methodology	N	Y	N	0	N	Y	NA	NA	NA
	11	Publicity and PR for project	N	N	N	0	N	N	NA	NA	NA
S	12	Improved mental and physical health of volunteers	Y	N	N	0	N	Y	0	0	NA

	13	Increased active involvement - cascade effect	Y	N	N	0	N	Y	0	0	NA
	14	Enhanced citizen scientist knowledge	Y	N	N	0	N	Y	0	0	NA
	15	Improved relationships among stakeholders	Y	N	Y	3	N	Y	1	1	NA
	16	Opportunistic pollution events reduced	N	Y	N	0	N	Y	0	0	NA
	17	Pollution source identified and remedied	N	Y	Y	1	N	Y	1	2	NA
	18	Improved data coverage (Lincolnshire)	N	Y	Y	1	N	Y	0	2	NA
	19	Application of Extended Riverfly methodology by other Riverfly groups	N	Y	N	0	N	Y	1	0	NA
	20	Improved knowledge regarding additional river stressors	N	Y	Y	1	N	Y	0	1	NA
	21	Wider public knowledge regarding riverflies, and understanding of how monitoring can lead to action	N	N	N	0	N	N	NA	NA	NA
Long-term impacts	22	Community building	Y	Y	N	0		Y	1	2	NA
	23	Improved river water quality and habitat (including recreational fisheries)	Y	Y	N	0		Y	1	2	NA
	24	Improved decision making regarding river management	Y	Y	N	0		Y	1	2	NA
	25	Improved economic potential of waterways (Green economy - green tourism)	N	N	Y	1	Y	Y	0	0	N* SEE Item No. 23

	26	Wider public awareness / changing attitudes toward river health	N	N	N	0	N	N	NA	NA	NA

Annexe 5: UK Case Study – Impact Workshop Structure Adopted for Riverfly

Riverfly – Workshop 1: Measuring the Impacts of Riverfly

Workshop 2½ hour workshop with citizen scientists and project coordinators.

Session item	***Purpose***	**Desired output/ understanding**	***Who***	***Materials, support***	***Timing***
Welcome and introduction	*LCSP Riverfly & why MICS project can be relevant to Riverfly* *Objectives of the workshop:* *To develop an impact journey for the LCSP Riverfly* *To decide how the impacts of the the LCSP Riverfly activities can be monitored*	Awareness of project context Background to MICS	*Facilitator (JW)*	*Slides*	*10 min.*
Participants' expectations and opportunity to introduce themselves	*Warm up – all participants introduce themselves using and write down any expectations they have from the session.*	All know who's in the room Introduce MIRO and use post-its to write what their expectations are for the *Riverfly* – MICS collaboration	*Participants*	*Slides, Zoom, MIRO*	*5-10 min.*
Structure, envisaged results & approach	*Provide clarity on structure of this workshop and overall purpose/envisaged results – show an example of an impact journey. This workshop has two sections:* *Section 1: Creating an impact journey* *Section 2: Identifying indicators* *The workshop will allow the impact of Riverfly to be measured*	Awareness of the way of working in this workshop/project and timelines Manage expectations	*Facilitator (JW)*	*Slides*	*5 min.*
What are the impacts of Riverfly? **Activity 1 - A) Long term impacts** **B) prioritise long term impacts** **Activity 2 – A) Short term impacts** **B) prioritise long term impacts**	*Get participants to think about firstly the long-term impacts of Riverfly then secondly the short-term impacts* *Participants use post it notes to write down long- and short-term impacts and group them within the MICS domains – environment, science & technology, governance, economy, society.* *Participants rank which are the most important impacts to them.*	Awareness of the long- and short-term impacts of Riverfly and which are most important to the volunteers.	*Facilitator (JW), support from rest of group directing discussion (HJ, UW, SP)*	*Slides, MIRO and Zoom*	*25-30 min.*
How do we achieve the long- and short-	*Get participants to write down how they contribute to the*	Know about the strategies and	*Facilitator (JW), support*	*Slides, MIRO and Zoom*	*20 min.*

term impacts of Riverfly through the CS activities? & what are the assumptions **Activity 3**	*impacts of Riverfly: 'the strategies' and assumptions* *Get participants to draw linking lines between the groups of post its and how everything links together.*	assumptions that the citizen scientists are involved with to achieve the outcomes and impacts of the project Identify the links between the strategies outcomes and impacts to create theory of change logic diagram	*from rest of group directing discussion (HJ, UW, SP)*		
Feedback – recap on impact journey created	*Group discussion regarding process of creating impact journey*	Feedback from workshop participants regarding draft impact journey	*Facilitator (JW), group leader (HJ and SP) and participants*	*Slides, MIRO and Zoom*	*10 min*
How do we monitor the short-term impacts of Riverfly? **Activity 4**	*To decide describe the what, how, who and when of monitoring selected short-term impacts*	Top 3-4 short-term impacts identified in activity 1 added to MIRO board by Parky ahead of discussion (during break or Breakdown of Impact Journey) Participants discuss and brainstorm the strategies for monitoring long-term impacts, filling in table on MIRO board	*Facilitator (JW), support from rest of group directing discussion (HJ, UW, SP)*	*Slides, MIRO and Zoom*	*20 min.*
How do we monitor the long-term impacts of Riverfly? **Activity 5**	*To describe the what, how, who and when of monitoring selected long-term impacts*	Top 3-4 long-term impacts identified in activity 1 added to MIRO board by Parky ahead of discussion (during break or Breakdown of Impact Journey) Participants discuss and brainstorm the strategies for monitoring long-term impacts, filling in table on MIRO board	*Facilitator (JW), support from rest of group directing discussion (HJ, UW, SP)*	*Slides, MIRO and Zoom*	*20 min.*
Group Discussion regarding impact monitoring and next steps	*Discuss the draft impact monitoring strategy proposed*	Recap/feedback of Activities 3 and 4 Discussion of proposed monitoring strategy, what do CS think? Agreement on monitoring strategy *Discuss next steps - MICS presents options for measuring impacts of Riverfly*	*Facilitator (JW), support from rest of group directing discussion (HJ, UW, SP), participants*	*Slides, MIRO and Zoom*	*10-15 min.*
Summary & workshop close	*Session close*	Thank everyone for attending, confirm timeline for receiving outputs from workshops and reiterate next	*Facilitator (JW)* *Tech support (Alex) to take group screenshot*	*Slides*	*<5 min.*

		steps/anything decided during discussion. Close session			

Annexe 6: UK Case Study – Citizen Science in river restoration: co-designing and managing for impact workshop held at RRC Annual Conference 2021

Notes from RRC MICS Conference Workshop – 22nd October 2021

In October 2021, the MICS team hosted a workshop at the Annual River Restoration Centre Conference titled 'Citizen Science in river restoration: co-designing and managing for impact'. The workshop aimed to discuss how to co-design and measure the impacts of citizen science in river restoration projects. The workshop was held in person (in Harrogate) and streamed online. 30 people joined into the workshop (including MICS team members), the participants joined from River Trusts, Consultancies, Environment Agencies, and were involved with volunteer engagement, catchment coordinators, data & monitoring. The workshop was structured into three parts:

1. Co-design for Impact: presentations and discussions around, what is co-design and reflections of the experience of co-design in the MICS case studies
2. Impacts of citizen science activities in river restoration projects – presentations and discussions around how impact is measured
3. The Big Picture discussion: co-designing & managing citizen science for impact in river restoration

The following section records the notes taken during the discussions in the workshop.

1. Co-design for impact

The participants stated that co-design had potential and it can help to change behaviour by engaging citizen scientists in the problem early on working alongside project managers. Notes / comments for the participants during the session:

- Co-design is the "gold standard" but sounds hard to put into practice
- Potential limitations with co-design in an area with private landowner's - don't want people turning up on privately owned land
- How can we demonstrate 'value for money' with co-design, and what more does co-design offer compared to traditional methods?
- In the Riverfly Citizen Science Monitoring initiative, they are trying to adopt a co-design approach - staff time set aside for citizen development - hoping to improve sustainability of project
- Potential of co-design is big - people more likely to continue with project after project has ended - in Norway citizen scientists are often ask to 'help out' and want to be more proactive in helping to run project

- Co-design matches better the needs from all stakeholders (Environment agencies, citizen communities) and it will ensure the communities and authorities' activities complement each other
- Co-design is a good education tool and helps to engage community and spread messages on protecting river quality, biodiversity and invasive species
- Co-designed CS does not need to be started by project managers / scientists, it can start with citizens/communities wanting to initiate projects
- Engage with people is important – co-design allows this early on in a citizen science project. It is important to understand why people should get involved (positive and negative visions) let's aspire to a common purpose / social capital.
- There are potential barriers to co-design and measuring the impact: Barriers to co design
    - Lack of common language (jargon) "user terminology"
    - The existence of experts; how to prevent power dynamics from making citizens defer to the 'expert'
    - Co-design explicitly stipulates there's a facilitator, but this should be more neutral e.g., WWF (by in and recognition of that role)
    - Face to face meetings help to align language
    - Resources are a limiting factor in whether a co-design approach can be applied (e.g., staff time)

2. *Impacts of citizen science activities in river restoration projects*

Measuring the impact of citizen science is important & having a platform and tools to do this will be very helpful. Participants stated:

- When measuring impact, it is important to establish a 'Common Language' to ensure everyone - no matter their background - understands what is being said/discussed. Ensures ease of communication among stakeholders
- We should channel current interests into new contexts / avenues [can be limited by funding or evidence filing]
- Measuring impact is important for funding
- How do we attract new people?
    - Important to tap into current networks, use resources where people are already interested
    - Challenge to reach out to more diverse communities and not just parachuting in and out – making these connections long term

- How do we get the not interested more interested?

3. *The bigger picture discussion: The Big Picture' discussion: co-designing & managing citizen science for impact in river restoration*

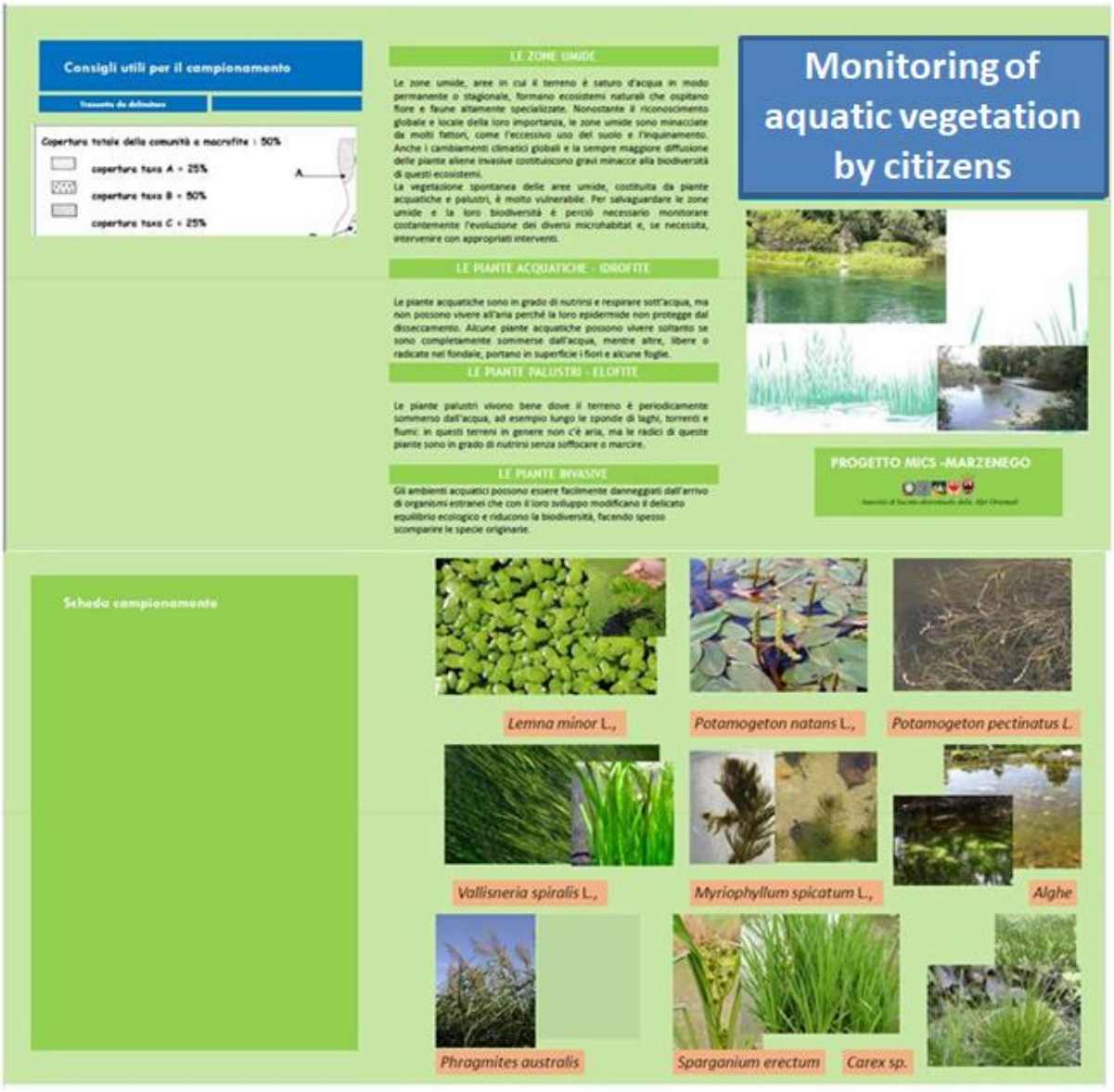
We began the big picture discussion by asking: how important is it that we measure impacts of citizen science in River Restoration?

- It is important to document a framework from an Environment Agency point of view. Giving experience and results helps to integrate citizen science into public authorities
- We need to know citizen science is worth doing; set up to gather more data and secondly to remove barriers/ bureaucracy – also improves wellbeing (this is important to open funding streams)
- Securing funding to improve sustainability is key [behaviour change = improved environment] builds better evidence based to spend money on NBS
- This is not a quick fix, it takes time to implement "adaptive management"
- Measuring impact helps projects to achieve impact
- Impact not to fixate on the 'number' scored with impact assessment – context is more informative. This can be linked to other things (funding)

Are we heading in the right direction?

- It's hard to balance taking advantage of what we know vs. engaging all stakeholders, we need to find a way of bringing stakeholders up to speed. But who's knowledge counts? We need to create a communal understanding and ensure humility.
- We need to be aware we can't just take from citizens we need to give back
- Including social science in environmental science is important
- Going beyond behavioural change to long term sustainable changes

Annexe 7: Italian Case Study – Aquatic Vegetation Mapping



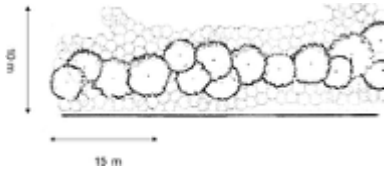
Annexe 8: Italian Case Study – Riparian Vegetation Mapping: RiVe mobile application

For mapping of riparian vegetation within the Italian Case Study the mobile appication RiVe was used. This is application was developed by Bruna Gumiero (Itlaian case study lead) in collaboration with the the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA - Italian National Institute for Environmental Protection and Research).

Description of monitoring Guide

Transept to be delimited

Delimit a perndicular transept to the 10 m wide river for your observation of riparian vegetation (e.g., 15x10).

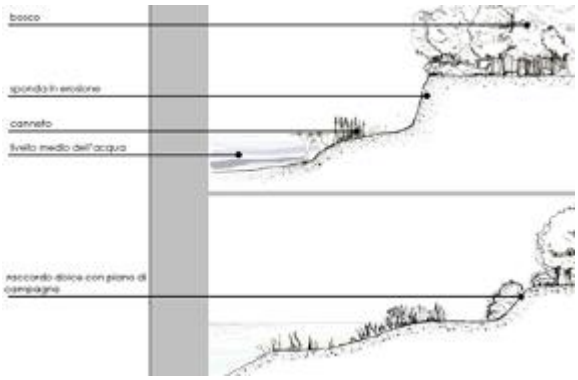


Maximum approximate vegetation height

To estimate the height of the trees it is advisable to take as a reference your own height or that of a helper and project it many times in height until you reach the top of the tree. In this way you will get an approximate measurement in meters of the real height.

Bank erosion

The erosion of the banks is a natural process of evolution of the river system. In a heavily anthropized territory it can become an effective problem of hydraulic risk. In some cases it is highly evident due to the presence of net cuts along the banks that drastically reduce the normal gentle trend.



Vegetation structure

The general appearance of vegetation is used to describe the main characteristics of vegetation, such as the biological form (and/or growth forms) of the dominant species(s) within a plant community. You must indicate if the vegetation is mainly made up of: -Trees -Shrubs -Only herbaceous -Mixed (a set of all components).

Vegetation layers

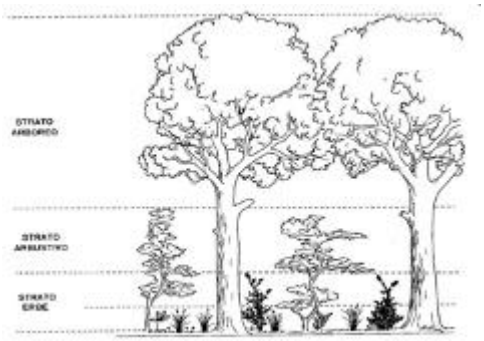
The layers of vegetation are classified according to the different heights at which the plants develop.

Arboreal Layer: > 3 m

Shrub layer: between 1 m and 3 m

Herbaceous layer: < 1 m

Inside each layer you need to make an estimate of the abundance (coverage) of the species you observed Not present, Rare (<5%), Common (5-40%), Abundant (40-70%), Dominant (>70%).



Annexe 9: Italian Case Study – Development of Impact Journey Map for the Marzenego River NBS Project

Item			Step 1 - Development of IJM		Stage 2: Validation of draft impact journey by stakeholders		Stage 3: Finalisation of Impact Journey
Item Type	**Item Number**	**IJM Title**	**Item adopted / modified from other case study IJM (e.g. Outfall Safari)**	**Item created by MICS team**	**New item added by stakeholder (Y/N)**	**# of votes**	**Item added during validation process retained (Y/N/NA)**
Activities	1	Engage local stakeholders (citizens and local authorities)	Y	N	N	NA	NA
	2	Involvement of schools	N	N	Y	NA	Y
	3	Monitoring activities	Y	N	N	NA	Na
	4	Common projects between the different schools	N	N	Y	NA	N
	5	Data processing	Y	N	N	NA	Na
	6	Methods adaptation and validation	N	N	Y	NA	Y
	7	Environment training/education	Y	N	N	NA	Na
Outcomes	8	More suitable and reliable methods	N	N	Y	NA	Y
	9	Enhanced environmental databases	Y	N	N	NA	Previously short-term impact redefined by MICS team as an activity
	10	Scientific evidence on the effectiveness of NBS	N	Y	N	NA	Merged with No. 12
	11	Restart River Contract	N	Y	N	NA	NA
	12	Monitoring activities defined	Y	N	N	NA	NA
	13	Improved citizen scientist understanding of data	N	N	Y	NA	Y

	14	Early warning system	Y	N	N	NA	Y
Short-term impacts	15	Increased collaboration of local stakeholders with local Authorities	Y	N	N	5	NA
	16	Enhanced environmental databases	Y	N	N	5	Previously an activity redefined by the MICS team as a short-term impact
	17	Increased citizen awareness for environment (es. riparian vegetation, water and NBS)	Y	n	N	14	NA
	18	Improved data interpretation	N	N	Y	0	Y
	19	Early identification of problems	Y	N	Y	0	NA
	20	Increased connection between groups of active/sensitive citizens	Y	N	Y	6	NA
	21	Increased connection between different schools via joint project	N	N	Y	8	NA
	22	Develop a network between different schools	N	N	Y	3	Merged with No. 21
	23	Increased (theoretical) knowledge	N	N	Y	1	Y
	24	Reduced cost monitoring for regional environmental authority	N	Y	N	0	N
Long-term impacts	25	Increase in bargaining power based on evidence gathered	N	N	Y	4	Y
	26	Increased environmental databases (as official monitoring extension)	Y	N	N	2	NA
	27	Official monitoring extension	N	N	Y	3	N
	28	Improved knowledge of freshwater ecosystems and NBS	N	Y	N	8	NA

	29	Evidence on the importance of NBS	N	N	Y	9	Merged with No. 28
	30	Improved flood risk management	N	N	Y - Merged with No. 31	0	NA
	31	Authorities increase decision-making skills	Y	N	N	4	NA
	32	Increased recognition of the scientific role of secondary schools in environmental management	N	N	Y	2	Y
	33	Community building	N	N	Y	4	Y
	34	Greater confidence in the authorities	N	N	Y	1	Merged with No. 35
	35	Increased confidence in science	N	N	Y	0	Y
	36	Modify individual behaviours	N	N	Y	5	Y
	37	Increased uptake of NBS to tackle environmental issues	N	Y	N	2	NA
	38	Identification of sites to be protected	N	N	Y	1	Merged with No. 37
	39	Improved wetlands (NBS), river quality and riparian vegetation	Y	N	N	0	N

Annexe 10: Italian Case Study – Results of Prioritisation Voting

The results of the voting done via email for the prioritisation of long-term impacts

Key to column number for long-term impacts

1 = Increase environmental databases

2 = Authorities increase decision-making skills

3 = Identification of sites to be protected

4 = Increased bargaining power of citizens, based on the evidence gathered

5 = Improved knowledge of freshwater ecosystems and NBSs

6 = Evidence on the importance of NBSs

7 = Community building

8 = Official monitoring extension

9 = Modify individual behaviors

10 = Greater confidence in the authorities

11 = Increased recognition of the scientific role of secondary schools in environmental management

12 = Increased uptake of NBS to tackle environ. Issues

LONG TERM IMPACTS	1	2	3	4	5	6	7	8	9	10	11	12
Municipality representative		3					1	2				
Environmental Acengy representative		1		2					3			
Drainage authority representative	3					2		1				
WWF representative	3				2		1					
Education professional					2	1			3			
Education professional						3		2	1			
Education professional			1			2					3	
Education professional						1			2		3	
Citizen scientist		2			1	3						
Citizen scientist				3	2	1						
Citizen scientist		3			2	1						
Citizen scientist					3	2			1			
Citizen scientist					3		2					1

Citizen scientist				3	2							1
Citizen scientist				3			2			1		
Total score	6	9	1	11	17	16	6	5	10	1	6	2
tot number	2	4	1	4	8	9	4	3	5	1	2	2
Prioritisation		5		3	1	2	6		4			

Key to column number for short-term impacts

1 = Quick collection of many environmental data and measurements

2 = Increased citizen awareness of riparian vegetation, water and NBS

3 = Outdoor school activity with practical and theoretical purposes

4 = Develop a network between different schools

5 = Increased collaboration of local stakeholders with local Authorities

6 = Increased connection between groups of active/sensitive citizens

7 = Environmental awareness

8 = Early identification of problems

9 = Increased (theoretical) knowledge

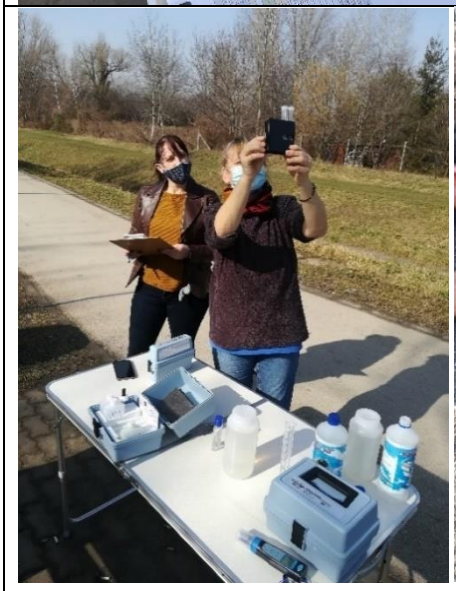
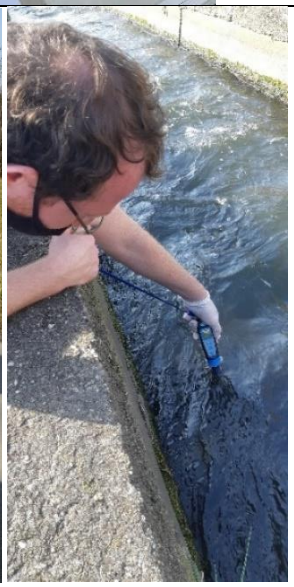
SHORT TERM IMPACTS	1	2	3	4	5	6	7	8	9
Municipality representative	2	3		1					
Environmental Acengy representative		3	1						2
Drainage authority representative		3	1		2				
WWF representative	2		3			1			
Education professional		3	1	2					
Education professional		3				2	1		
Education professional		2	3				1		
Education professional		3	1	2					
Citizen scientist		2			1	3			
Citizen scientist		3			1	2			
Citizen scientist		3			2	1			
Citizen scientist		2				1	3		

Citizen scientist	2	3				1			
Citizen scientist	2	3				1			
Citizen scientist	2	3			1				
Total score	10	39	10	5	7	12	5	0	2
tot number	5	14	6	3	5	8	3	0	1
Prioritisation	4	1	3	6	5	2			

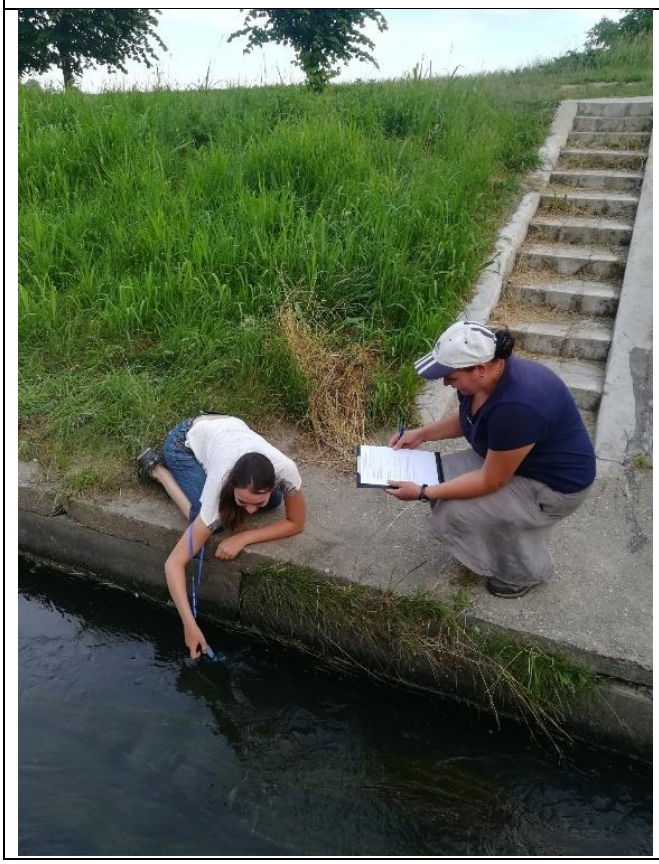
Annexe 11: Hungarian Case Study – Summary of Citizen Science Activities in 2021

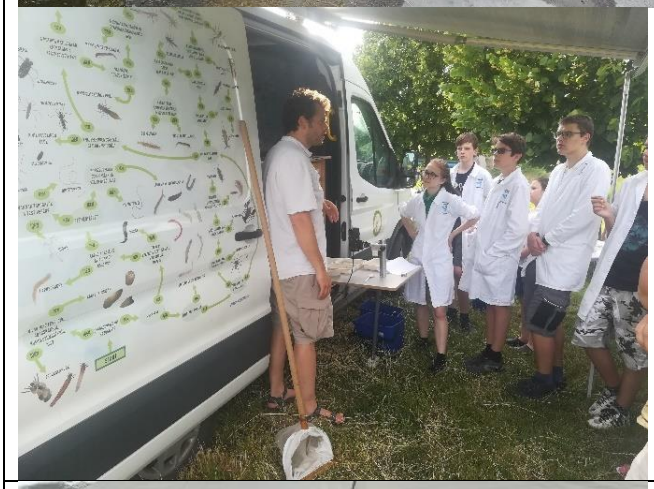
Below is provided a description of the citizen science activities organised in the Hungarian case study during 2021 (Events No. 12 – 32). For details regarding events organised for 2020 (Events No. 1 – 11) please refer MICS deliverable D4.3 (Kozák *et al*., 2020).

	**Water quality monitoring – Physical and chemical** **Date: 11/12/2020** **Location: Creek Rákos, BP 17** Regular physical and chemical water quality monitoring continued with the core team. Due to the pandemic, only in a small, core group, teachers of a local high school even in cold winter time. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.

	**Water quality monitoring – Physical and chemical** **Date: 22/01/2021** **Location: Creek Rákos, BP 17** Regular physical and chemical water quality monitoring continued with the core team. Due to the pandemic, only in a small, core group, teachers of a local high school even in cold winter time. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.
 	***Water quality monitoring – Physical and chemical*** ***Date: 26/02/2021*** ***Location:*** **Creek Rákos, BP 17** Regular physical and chemical water quality monitoring continued with the core team. Due to the pandemic, only in a small, core group, teachers of two local high schools. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.

	**Water quality monitoring – Physical and chemical** **Date: 30/03/2021** **Location: Creek Rákos, BP 17** Regular physical and chemical water quality monitoring continued with the core team extended with engaged high school students. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.
	**Water quality monitoring – Physical and chemical** **Date: 29/04/2021** **Location: Creek Rákos, BP 17** Regular physical and chemical water quality monitoring continued with the core team extended with engaged high school students. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P. Starting measurements by the pedestrian and cyclist path, but the rain let the citizen scientists find shelter under the bridge, providing the opportunity to take sample from the stormwater too.

	**Water quality monitoring – Physical and chemical** **Date: 04/06/2021** **Location: Creek Rákos, BP 17** Regular physical and chemical water quality monitoring continued with engaged high school students. The member of the Parliament of the district and local representatives joined the citizen science activities for a while. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.
	**Water quality monitoring – Physical and chemical** **Date: 19/06/2021** **Location: Creek Rákos, BP 17** First public event for water quality monitoring with new citizen scientists, who took place in other monitoring activities too that afternoon. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.

 	**Water quality monitoring – Biological** **Date: 19/06/2021** **Location: Creek Rákos, BP 17** First public biological water quality monitoring since October 2020 with lots of young and adult volunteers. After taking samples, citizen scientists analyzed the caught macroinvertebrates.
	**Habitat mapping, naturalness assessment** **Date: 19/06/2021** **Location: Nyilas-meadow + one riparian area near Creek Rákos, BP 17** Following a training, citizen scientists learnt how to recognize and differentiate habitats types. In the next part of the training, volunteers learnt how to use a simplified and recognized methodology to assess the naturalness of a habitat type. Following that, they assessed designated riparian areas of the Creek.

	
	**Water quality monitoring – Physical and chemical** **Date: 27/08/2021** **Location: Creek Rákos, BP 17** The next regular public water quality monitoring event was led by the most enthusiastic student of a local high school. Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.

 	**Mantis monitoring** **Date: 27/08/2021** **Location: Nyilas-meadow, BP 17** One enthusiastic citizen scientist took the lead and led a mantis monitoring event. They found several praying mantis, but more of the cone-headed grasshopper, valuable endemic species of the Carpathian basin and of the Budapest District 17.
	**Water quality monitoring – Biological** **Date: 27/08/2021** **Location: Creek Rákos, BP 17** The next public biological water quality monitoring, macro invertebrate monitoring was well received by the locals. Many families with children appear, but mostly school pupil and adults participated the activities.
	**Water quality monitoring – Physical and chemical** **Date: 18/09/2021** **Location: Creek Rákos, BP 17** The last regular public water quality monitoring event was mostly welcomed by elementary school pupils while sharing a lot of information about the Creek and freshwater.# Basic physical and chemical factors were measured with colorimetry toolkits of the HACH company. Citizen scientist measured the

	following parameters: pH, water temperature, salinity, conductivity, dissolved oxygen, oxygen saturation, NH4-N, NO2-N, NO3-N, PO4-P.
Black woodpecker observation **Date: 09/10/2021** **Location: Creek Rákos, BP 17** The last woodpecker observation was led by an ornithologist. Following an introduction and training, the group want on a longer long along the riparian areas of the Creek in Rákoscsaba. Unfortunately, we have not found any, but that might have been due to the very windy weather.	
Habitat mapping, naturalness assessment **Date: 09/10/2021** **Location: Creek Rákos, BP 17** Small number of participants appeared at this event, that was the last of this kind. A new area was mapped by the citizen scientists.	
Water quality monitoring – Biological **Date: 09/10/2021** **Location: Creek Rákos, BP 17** The last biological water quality monitoring took place in a relatively cold, windy weather. The citizen scientists took samples from the Creek Rákos, separated the macro invertebrates, then identified together.	

Annexe 12: Hungarian Case Study – Development of IJM for the Creek Rákos Citizen Science Project

Item			Step 1 - Development of IJM		Stage 2: Validation of draft impact journey by stakeholders	Stage 3: Finalisation of Impact Journey
Item Type	**Item Number**	**IJM Title**	**Item adopted / modified from other case study IJM (e.g. Outfall Safari)**	**Item created by MICS team**	**New item added by stakeholder (Y/N)**	**Item added during validation process retained (Y/N/NA)**
Activities	1	Engage local stakeholder groups	Y	N	N	NA
	2	Citizen science monitoring	Y	N	N	NA
	3	Data processing	Y	N	N	NA
	4	Outreach & awareness raising	Y	N	N	NA
Outcomes	5	Increased public involvement in CS activities	Y	N	Removed by participants of workshop	NA
	6	Agreed monitoring methodology	Y	N	N	NA
	7	(Baseline) datasets accessible/ visualised	N	Y	N	Merged with No. 8
	8	Dataset (water quality and species list)	Y	N	N	NA
	9	Increased awareness & acceptance of citizen scientists	N	Y	N	NA
	10	Species list	N	N	Y	Merged with No. 8
Short-term impacts	11	Improved communication and data exchange among stakeholders	N	Y	N	NA
	12	Increased public acceptance and support for restoration	N	Y	N	NA
	13	Commitment for restoration by decision makers (including local municipality) incl. money & resources	N	Y	Alteration / rewording suggested	NA
	14	Sites for restoration identified	N	Y	N	NA

	15	Enhanced monitoring of Creek and surroundings by agency	N	Y	N	NA
	16	Increased wider public awareness of the environment	Y	N	N	NA
	17	The local municipality deals with the issue on all "fora"	N	N	Y	Item deleted by MICS team
Long-term impacts	18	Improved conservation [additional sites with protected status]	N	Y	N	NA
	19	Improved environmental stewardship	Y	N	N	NA
	20	Restoration implemented	N	Y	N	NA
	21	Improved ecosystem/ biophysical environment [water quality, biodiversity] of the Creek	Y	N	N	NA
	22	Improved collaboration of the local municipality, Budapest municipality, water authority	N	Y	N	Impact reworded based on advice from project coordinator

Annexe 13: Hungarian Case Study – Structure of Impact Workshop

Impact workshop title: The Impacts of Citizen Science in the Carasuhat Wetland

4-hour workshop (10:00 – 14:00) held on 29/06/21 with key stakeholders engaged with NBS project.

Session item	Purpose	Desired output/ understanding	Who	Materials, support	Timing
Welcome and introduction	*Context to Carashuat Wetland project, citizen science activities & why MICS project can be relevant to these* *Objective of the workshop: to develop an impact journey of citizen science activities in the Carashuat wetland*	Awareness of project context	*Facilitator*	*PowerPoint Slides*	*10 min.*
Participants' expectations and opportunity to introduce themselves	*Warm up – all participants introduce themselves and write down any expectations they have from the session.*	All know who's in the room, and what the respective expectations are of citizen science – MICS collaboration	*Participants*	*Slides, post-its, pens/pencils, paper* *COVID – need to minimise movement and contact*	*10 min.*
Structure, envisaged results & approach	*Provide clarity on structure of this workshop and overall purpose/envisaged results – show an example of an impact journey. This is the first in a series of workshops. These workshops are stepping stones to measure overall impact of the citizen science activities in the Carashuat wetland*	Awareness of the way of working in this workshop/project and timelines Manage expectations	*Facilitator, Participants*	*Slides*	*5 min.*
What are the impacts of Carashuat wetland?	*Get participants to work in small groups and think about the long-term impacts of the citizen science activities in the Carashuat wetland* *Participants use post it notes to write down long term impacts and group them within the MICS domains – environment, science & technology, governance, economy, society.* *Participants rank which are the most important impacts to them.*	Awareness of the long-term impacts of *the citizen science activities in the Carashuat wetland* and which are most important to the volunteers.	*Facilitator, participants*	*Slides, post-its, pens/pencils, paper* *A2 print / draw out theory of change created by MICS team in advance of meeting. 2-3 printed copies* *Participants add post-its/write on to and validate, round stickers for voting*	*30 min.*
What are the outcomes of the citizen science activities in the Carashuat wetland	*Get participants to work in small groups to think about the outcomes of the citizen science activities in the Carashuat wetland*	Awareness of the outcomes of the citizen science activities in the Carashuat wetland and which are most important to the volunteers.	*Facilitator, participants*	*Slides, post-its, pens/pencils, paper* *A2 print / draw out theory of change*	*30 min.*

	Participants use post it notes to write down short term impacts (outcomes) a nd group them within the MICS domains – environment, science & technology, governance, economy, society. *Participants rank which are the most important outcomes to them.*			*created by MICS team in advance of meeting. 2-3 printed copies* *Participants add post-its/write on to and validate, round stickers for voting*	
How do we achieve the outcomes and impacts of the citizen science activities in the Carashuat wetland throu gh the CS activities? (e.g., what are the strategies) Drawing the linkages between strategies – outcomes and impacts	*Get participants to write down how they contribute to the outcomes and impacts of the citizen science activities in the Carashuat wetland: 'the strategies ' and assumptions* *Get participants to draw linking lines between the groups of post its and how everything links together.* *Or get participants to cross out links they think are non- existent.*	Know about the strategies and assumptions that the citizen scientists are involved with to achieve the outcomes and impacts of the project Identify the links between the strategies outcomes and impacts to create theory of change logic diagram	*Facilitator, participants*	*Slides, post-its, pens/pencils, paper* *A2 print / draw out theory of change created by MICS team in advance of meeting. 2-3 printed copies* *Participants add post-its/write on to and validate, round stickers for voting*	*30 min.*
Feedback – recap on impact journey created Voting on short- and long-term impacts	*Group discussion regarding process of creating impact journey*	Feedback from workshop participants regarding draft impact journey	*Facilitator, participants*	*Slides, post-its, pens/pencils, paper* *Voting ideas -* *Raise of hands – COVID safe, minimal movement* *Voting dots, people add dots (x3) to their top impacts*	*10 min*
How do we monitor the short-term impacts of the citizen science activities in the Carashuat wetland?	*To decide describe the what, how, who and when of monitoring selected short-term impacts*	Top 3-4 short-term impacts identified in feedback sessions Participants discuss and brainstorm the strategies for monitoring short-term impacts	*Facilitator, participants*	*Print empty table with impacts, indicator headings etc, (inclu de empty space on short-term impacts column) below – so there is room to add any additional impacts people identified in the morning session.*	*20 min*

				Albert / facilitators use markers to highlight prioritised impacts identified during voting *People add post-its under the column headings & draw links (starting with prioritised impacts)*	
How do we monitor the long-term impacts of the citizen science activities in the Carashuat wetland?	*To describe the what, how, who and when of monitoring selected long-term impacts*	Top 3-4 long-term impacts identified in feedback sessions Participants discuss and brainstorm the strategies for monitoring long-term impacts	*Facilitator, participants*	*Print empty table with impacts, indicator headings etc, (include empty space on long-term impacts column) below – so there is room to add any additional impacts people identified in the morning session.* *Albert / facilitators use markers to highlight prioritised impacts identified during voting.* *People add post-its under the column headings & draw links (starting with prioritised impacts)*	*20 min*
Group Discussion regarding impact monitoring and next steps	*Discuss the draft impact monitoring strategy proposed*	Recap/feedback of activities Discussion of proposed monitoring strategy, what do CS think? Agreement on monitoring strategy	*Facilitator, participants*	*Slides, representative from group to capture points raised during discussion*	*10-15 min*

		Discuss next steps - MICS presents options for measuring impacts of the citizen science activities in the Carashuat wetland			
Summary & workshop close	*Session close*	Thank everyone for attending, confirm timeline for receiving outputs from workshops and reiterate next steps/anything decided during discussion. Close session	*Facilitator*	*Slides*	*<5 min*

Annexe 14: Romanian Case Study – Development of Impact Journey Map for the Carashuat Wetland NBS Project

Item			Step 1 - Development of IJM		Stage 2: Validation of draft impact journey by stakeholders		Stage 3: Finalisation of Impact Journey
Item Type	**Item Number**	**IJM Title**	**Item adopted / modified from other case study IJM (e.g. Outfall Safari)**	**Item created by MICS team**	**New item added by stakeholder (Y/N)**	**# of votes**	**Item added during validation process retained (Y/N/NA)**
Activities	1	Engage local stakeholder groups	Y	N	N	NA	NA
	2	Citizen science monitoring	Y	N	N	NA	NA
	3	Data access & visualisation	N	Y	N	NA	NA
Outcomes	4	Increased public involvement in citizen science activities	N	Y	N	NA	NA
	5	Agreed monitoring methodology	Y	N	N	NA	NA
	6	(Baseline) datasets accessible/visualised	Y	N	N	NA	NA
Outcomes	7	Learning: Better understanding of the environment	Y	N	N	1	NA
	8	Improved cooperation between stakeholders	Y	N	Stakeholder suggested expanding item to distinguish the improved relationship with local authorities (DDBRA) – see Item No. 9	2	NA
	9	Improved cooperation between stakeholders	0N	N	Y	4	Y

		and high-level authorities (DDBRA)					
	10	Job creation, e.g., tour guides, hotels and tourism industry + support industry	N	Y	N	0	NA
	11	Contribution to management plans/policy: Baseline data used to wetland management & exploitation plan as part of Delta plan	N	Y	N	1	NA
	12	Demand side growth: Increased number of eco-tourists / visitors to wetlands	N	Y	N	0	NA
	13	Learning: expertise in CS-enhanced scientific methodology	Y	N	N	0	NA
	14	Development of a centre for sustainable exploitation of local resources	N	N	Y	3	Y
	15	Increase the number of employees within DDBRA	N	N	Y	5	Y
	16	Simplifying the bureaucratic procedures	N	N	Y	4	Y
Long-term impacts	17	Improved ecosystem/biophysical environment [water quality, biodiversity, stable slopes] of the wetland	Y	N	N	0	NA
	18	Improved conservation: Support for sites requiring protected status	Y	N	N	0	NA
	19	Increased public awareness of the environmental issues [biodiversity]	Y	N	Expansion of item suggested to capture increased awareness of tourists – see Item No. 20	2	NA
	20	Increasing the awareness and responsibility level of unattended tourists	N	N	Y	3	Y

	21	Improved / diversified local economy [tourism]	N	Y	N	0	NA
	22	Improved decision making [DDBRA, local authorities]	Y	N	N	3	NA
	23	Improved scientific knowledge	Y	N	N	0	NA
	24	Improved living standards	N	Y	N	0	NA
	25	Development of a more comprehensive national strategy	N	N	Y	3	Y
	26	Impose local guides for large tourist group. / Creating a local guide (player) for good practices	N	N	Y	4	Y
	27	Dedicated Management Plan for Carasuhat wetland	N	N	Y	1	Y
	28	Creating an independent monitoring entity to supervise all the environmental monitoring activities for the DD	N	N	Y	2	Y
	29	New organization (NGO?) for promoting and protecting Carasuhat wetland	N	N	Y	0	Y