NARRATIVE REPORT

Digital Inclusiveness Report of the Enabel Citizen Science Project:
Potential Risk & Mitigation Recommendations

Author

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1. GENERAL INFORMATION REGARDING THE INCLUSIVENESS REPORT

Leading implementing organization	IWMI
Implementing partners (if applicable)	GroundTruth, AWARD, UNICEF (Yoma), LIMCOM,
Point of contact (name and function)	
Title of the project	Enabel Citizen Science Project
Target country and region(s)	Botswana, South Africa, Zimbabwe, and Mozambique.
Direct users[1] (type and numbers of people concerned during the reporting period)	Citizen scientists, trainers, partners from marginalized and rural communities (numbers to be determined)
Final beneficiaries[2], if different from direct users (type and numbers of people concerned during the reporting period). If possible, disaggregated by gender and age	Rural and traditionally marginalized or isolated communities relying on surface water quality, youth, women (numbers to be determined)

2. APPROACH

The MDII Framework and the Enabel Project's Inclusivity Approach

The International Water Management Institute (IWMI) is the leading implementing organization for the Enabel Citizen Science (CS) project. IWMI's inclusivity approach for the Enabel project is based on its multi-dimensional digital inclusiveness index (MDII). The MDII is described as a comprehensive scientific framework designed to assess and enhance digital inclusiveness across various digital tools and platforms[3]. It provides a structured approach to identify areas of strength and improvement regarding the social inclusivity of digital innovation. The MDII evaluates the proposed innovation from a holistic point of view, providing insights for enhancing its accessibility, usability, and benefit,

[1] Direct users are the people in direct contact with the digital innovation. Example: doctors using a monitoring and referring system or small-scale farmers using a market app.

[2] Final beneficiaries are the people who benefit from the innovation/the project, but are not using directly the digital tools. Example: pregnant women using health facilities with a digitized system. Direct users can be similar to final beneficiaries, for example small-scale farmers using a market app. We do not consider people who indirectly benefit, for example families of these farmers.

[3] Opola, F.O., Langan, S., Arulingam, I. *et al.* A multi-dimensional framework for responsible and socially inclusive digital innovation in food, water, and land systems. *Agric Hum Values* (2025). https://doi.org/10.1007/s10460-025-10731-2

Martins, Carolina Iglesias; Opola, Felix; Jacobs-Mata, Inga; Garcia Andarcia, Mariangel; Nortje, Karen; Joshi, Deepa; Singaraju, N.; Muller, A.; Christen, R.; Malhotra, A. 2023. Development of the conceptual framework (version 2.0) of the Multidimensional Digital Inclusiveness Index. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Digital Innovation. 36p.

as well as mitigating any potential negative consequences of the innovation to the rural communities where its deployed.

This report serves as an initial assessment of the digital inclusiveness of the Enabel Project. The Enabel Project aims to enhance water resource management in the Limpopo River Basin (LRB) through a participatory citizen science approach that integrates community data into the LIMCOM Digital Twin for inclusive and transparent decision-making. During this initial reporting period, the progress of the Enabel Project has focused on defining the project's scope, inclusiveness goals, outreach to engage potential stakeholders in the LRB, potential digital tools to be developed/adopted and design of incentive proposal mechanisms for citizen scientist.

The MDII is structured into three hierarchical levels: dimensions, categories, and indicators. The three overarching dimensions of social inclusion are: Innovation Usage, Social Consequence, and Stakeholder Relationships[4]. The dimensions and categories in the MDII framework (in Figure 1 below) were integrated into interview questions, which were then used to collect information of the tool's inclusiveness from various stakeholders. The responses were then used for a digital inclusivity assessment based on the MDII, and to provide recommendations for enhancing inclusivity.

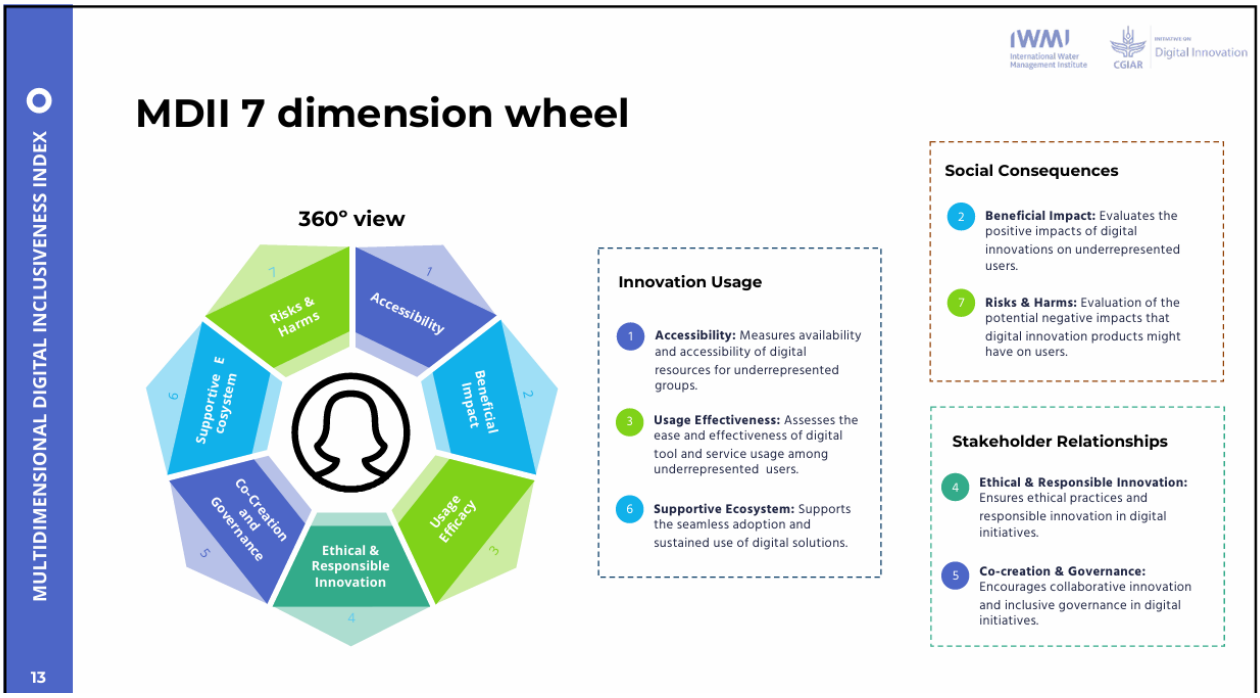

Figure 1. *The Multidimensional Index.*

[4] Martins, Carolina Iglésias; Opola, Felix; Garcia Andarcia, Mariangel; Joshi, Deepa; Muller, A.; Christen, R. 2024. Multidimensional Digital Inclusiveness Index: dimensionality reduction for improved applicability in Digital Agri-solutions. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Digital Innovation. 30p.

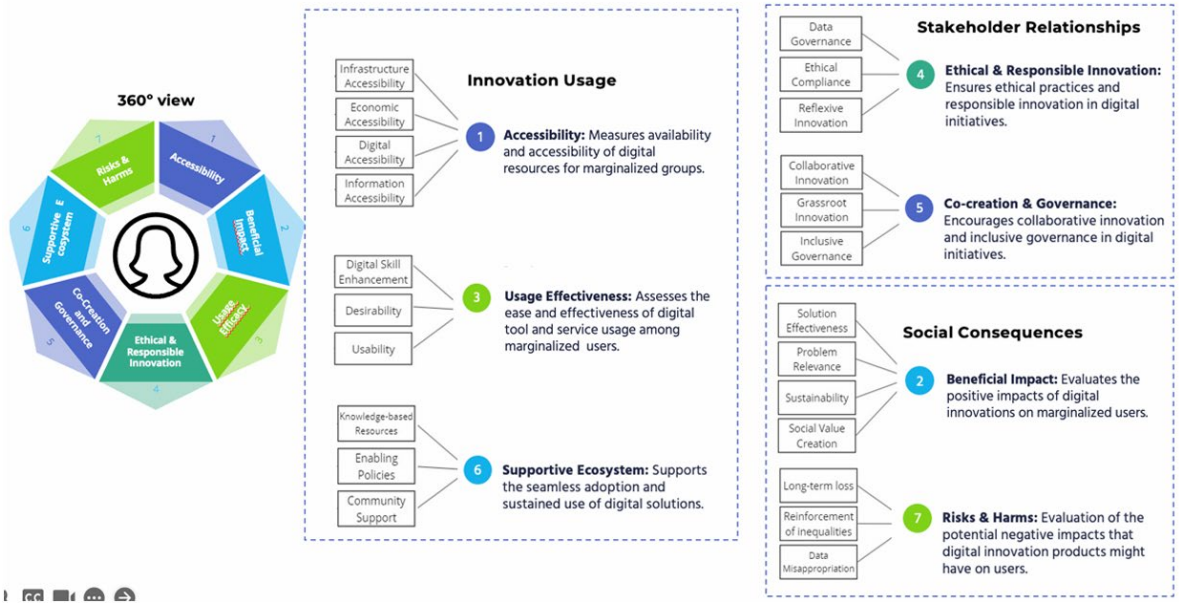

***Figure 2**. The Multidimensional Index. (Source[5])*

Approach and Evaluation Used in the Enabel Project

The inclusivity assessment for the Enabel citizen science project involved conducting several interviews with key stakeholders involved in the project. These stakeholders included implementing partners like GroundTruth, AWARD, UNICEF (Yoma), and LIMCOM. The interviews were conducted to understand their perspectives on inclusivity. Daniella Darlington, an IWMI-Consultant, conducted these interviews.

The interviews for the Enabel project's inclusivity assessment were guided by several specific subsections or topics (see Table 1). These topics included understanding the overall inclusivity goals, strategies for reaching marginalized communities, digital tools' accessibility and usability, addressing potential barriers and risks, learning from existing inclusive practices, incentives and motivation, and sustainability.

The approach used with the MDII interviews was iterative and tailored to the interviewee's role. All respondents interviewed can guide who else to interview. While there is a list of questions, they are tailored based on the person being interviewed and their role within the project[6]. The intention is to get a holistic understanding by utilizing specific questions for specific people. This was the

[5] Martins, Carolina Iglésias; Opola, Felix; Garcia Andarcia, Mariangel; Joshi, Deepa; Muller, A.; Christen, R. 2024. Multidimensional Digital Inclusiveness Index: dimensionality reduction for improved applicability in Digital Agri-solutions. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Digital Innovation. 30p.
[6] ibid

approach applied in conducting interviews with the implementing partners of the Enabel CS project.

The evaluation of the data collected through these interviews and project documentation was done using thematic analysis[7]. This qualitative analysis technique involved identifying key themes that emerged from the project documentation review and interview transcripts related to digital inclusiveness. Themes identified in the Enabel project report included inclusivity goals and strategies, technology and tools accessibility, and barriers and risks. The thematic analysis highlighted the multi-faceted nature of inclusivity, covering technological, social, and linguistic dimensions.

The MDII framework itself involves a scoring and evaluation method using quantitative evaluation alongside open-ended questions. The collected data is processed using the MDII evaluation framework, where responses are mapped to corresponding dimensions and indicators for scoring. This process leads to the calculation of an MDII score and the generation of an Inclusiveness Report with tailored recommendations. While this report does not involve any quantitative analysis as seen in the MDII framework, there was a great alignment between the questions asked and the sub-dimensions of the MDII framework, the qualitative data produced from the responses from the interview transcripts were mapped to the dimensions and indicators for recommendations.

Alignment of Interview Topics with MDII Areas of Inquiry

The topics covered in the interviews align with the areas of inquiry that the MDII framework is designed to assess. The interviews aimed to gather insights on inclusivity goals, strategies for reaching marginalized communities, digital tool accessibility and usability, potential barriers and risks, and lessons from existing inclusive practices. These topics are directly relevant to evaluating the different dimensions of digital inclusiveness as defined by the MDII.

For example, topics like 'digital tools' accessibility and usability' and 'potential barriers and risks' relate directly to assessing aspects like access, usage effectiveness, and risks within the MDII framework. 'Strategies for reaching marginalized communities align with the MDII's focus on underrepresented groups and social consequences. 'Incentives and motivation' and 'sustainability' are also listed as key topics discussed, reflecting considerations within a holistic inclusivity assessment.

The interviews were guided by the following subsections or topics:

Table 1. *Interview subsection and topics*

Interview Subsection/Topic	Related Areas within MDII Framework
Understanding overall inclusivity goals	Strategic Goals, Holistic view of inclusivity, defining project objectives related to inclusivity.
Strategies for reaching marginalized communities	Target Audience, Focus on underrepresented groups, Stakeholder Collaboration, Engagement with local actors.
Digital tools' accessibility	Accessibility, Usage effectiveness, Usability, Tool design and user

[7] Onwuegbuzie, A. J., Leech, N. L., & Collins, K. M. T. (2012). Qualitative analysis techniques for the review of the literature. The Qualitative Report, 17(Art. 56), 1 28. Retrieved from http://www.nova.edu/ssss/QR/QR17/onwuegbuzie.pdf

and usability	interface, Considering low-tech tools.
Addressing potential barriers and risks	Potential barriers and risks, forecasting risks, technical barriers, Risks related to incentivization, Competing priorities.
Learning from existing inclusive practices	Leveraging existing work and tools, Experience at community level, incorporating lessons learned.
Incentives and motivation	Incentivizing youth participation, Linking contributions to incentivization, Types of incentives, Motivation and engagement.
Sustainability (of the system science project/activities)	Sustainability, Blended financial model.
Stakeholder Collaboration	Importance of working closely with stakeholders, Roles of partners, Engaging local actors.

These topics informed the questions tailored for each interviewee. The analysis of the responses related to these topics using thematic analysis then fed into this report, which is based on the MDII framework. The MDII framework provides the structure (dimensions, subdimensions, indicators) that helps interpret the findings from these thematic areas, providing recommendations.

The main roles of the implementing partners in the Enabel citizen science project as provided in figure 3 are as follows:

International Water Management Institute (IWMI) is the leading implementing organization for the Enabel Citizen science project, and their inclusivity approach is based on the MDII which evaluates the project holistically, ensuring accessibility and benefits for all stakeholders. They are responsible for designing and delivering the project across five work packages, including understanding how to implement citizen science at the Transboundary River basin level, developing innovation tools, and ensuring inclusivity. IWMI is also developing a digital twin for river basin management to bring citizen data to decision-makers.

LIMCOM (Limpopo Watercourse Commission) is a **transboundary institution** mandated by the Southern African Development Community (SADC) to work with countries on managing issues of transboundary relevance. A discussion was held with key LIMCOM staff to understand their approach to citizen science and inclusivity goals. LIMCOM is a custodian and co-implementer of the project, leveraging their stakeholder networks and technical capacities, were highlighted. Strategies for reaching marginalized communities and co-creation with these communities were also discussed. Challenges identified related to digital infrastructure and literacy, as well as the importance of educating users about AI limitations, were also addressed. Citizen science is important for LIMCOM as it aids in local custodianship[8] for scientific monitoring and its integration into an advanced information platform. LIMCOM also works to ensure the project aligns with national development plans and water policies of each Member State.

[8] Article 3.1 of the LIMCOM Agreement, (Agreement 2003) stipulates that the objective of the Commission is to "advise the Contracting Parties and provide recommendations on the uses of the Limpopo, its tributaries and its waters for purposes and measures of protection, preservation and management of the Limpopo"

AWARD is a non-governmental organization registered in South Africa. AWARD's role is primarily focused on technical innovation and support. Their main responsibility is to integrate citizen science data into the LRB's digital twin, ensuring the data is brought in via APIs and used effectively within the decision support system. An interview was conducted with Jai Clifford-Holmes from AWARD to understand their role in the technical innovation and support for the project, particularly concerning the integration of citizen science data into the LRB's digital twin using FAIR data principles. Discussions also covered inclusivity in data representation, considering language and literacy levels, and potential technical barriers. AWARD emphasizes the use of FAIR data principles in their work.

UNICEF Yoma (Youth Agency Market)[9] is a digital platform focused on youth engagement. Its main purpose is to support young people on a "learning to earning journey" by helping them build a digital track record of their achievements across areas like digital skills, social change, and environmental impact. Yoma is being explored as a platform for incentivizing youth participation and building a digital track record of their contributions. Yoma acts as a facilitator, relying on implementing partners for the actual impact on the ground. The Yoma platform can be used to list opportunities, and young people can apply to participate in programs or science initiatives. The project aims to bridge the gap between data contributions and incentivization through the Yoma platform. Discussions with key Yoma team

GroundTruth is a key partner responsible for engaging marginalized communities in data collection. A discussion was held with Pattison, 2025. They're focused on developing technical tools for data collection, such as the miniSASS app. They are also involved in training and onboarding citizen scientists. Ground Truth aims to partner with various organizations within the basin to assist with identifying and training field leaders. Their experience at the community level is considered valuable for ensuring inclusivity.

[9] https://yoma.africa/

Figure 3. *Implementing partners and their roles*

3. EVALUATION OF THE IMPLEMENTATION OF THE PROJECT'S ACTIVITIES

3.1. SUMMARY OF THE PROJECT

This report serves as an initial assessment of the digital inclusiveness of the Enabel Project. The Enabel Project aims to enhance water resource management in the LRB through a participatory citizen science approach that integrates community data into the LIMCOM Digital Twin for inclusive and transparent decision-making. During this initial reporting period, the progress of the Enabel Project has focused on defining the project's scope, inclusiveness goals, and potential digital tools to be developed/adopted. The project aims to make the citizen science approach as inclusive as possible, particularly when designing digital solutions and reaching out to communities, trainers, and partners. The primary contribution during this phase has been to lay the groundwork for an inclusive and sustainable citizen science model.

While direct engagement with users and tangible impacts in the target countries are yet to be realized, this initial phase of assessment is crucial for establishing a solid foundation for the Enabel Project. The focus has been on understanding the local context, identifying potential barriers to digital inclusiveness, and planning strategies to ensure the project's future effectiveness and sustainability in empowering communities to contribute to water resource management.
This model not only builds technical capacity within communities but also enhances transparency and accountability in water management, supporting sustainable development and climate resilience goals. A key aspect is through giving opportunity to anyone in rural and traditionally marginalized or underrepresented communities to be involved in monitoring and managing their water resources within the LRB basin. The project also aims to build in good representation of youth and women. The contribution of this action for direct users includes providing them with tools,

training, and recognition for their efforts in monitoring their water resources, potentially leading to improved local environments. For final beneficiaries, the project aims to provide better data for water management, potentially leading to interventions and improvements in their water resources.

Specific objective: To embed the principles of inclusivity and equity in all citizen science projects focused on enhancing water resource management in the LRB

Indicators: Representation in participation, accessibility of tools, and engagement of marginalized groups

Degree of achievement: To be determined later after the project is concluded as this report is being drafted at an early stage of the project.

3.2. PURPOSE OF THE INCLUSIVENESS ASSESSMENT

The purpose of the inclusiveness assessment of the Enabel project is primarily to evaluate and enhance the project's ability to be digitally and socially inclusive. This involves several key objectives:

- Understanding overall inclusivity goals for the project and its various partners. This includes clarifying what each stakeholder aims to achieve in terms of inclusivity.
- Developing strategies for reaching marginalized and vulnerable communities within the LRB. This involves identifying these communities and understanding the best ways to engage them.
- Assessing the accessibility and usability of the digital tools being leveraged for the project, such as the miniSASS app and the digital twin, for diverse user groups. This includes considering factors like digital literacy, language barriers, and device availability.
- Identifying and addressing potential barriers and risks that could hinder the project's inclusivity. This includes technical, infrastructural, social, and cultural barriers that might prevent certain communities from participating or benefiting.
- Learning from existing inclusive practices and initiatives, both within the partners' past experiences and in broader community-based water management initiatives. This allows the project to adopt successful approaches and avoid pitfalls.
- Informing the development of appropriate incentives and motivation strategies to encourage long-term participation from diverse communities.
- Ensuring the sustainability of the inclusive aspects of the citizen science project beyond the initial implementation phase.
- Providing recommendations on how best to approach the project to ensure the involvement of various communities in co-design of the required data/gaps, data collection activities, ownership and the overall success of the project in an inclusive and sustainable manner.

Ultimately, the assessment aims to provide a holistic understanding of the project's inclusiveness from various stakeholder perspectives, which will then inform strategies and actions to make the Enabel citizen science project as inclusive and beneficial as possible for all relevant communities within the LRB.

3.3. ACTIVITIES AND RESULTS

Key activities and outputs carried out during the project period in accordance with the logical framework and action plan.

- Key activities undertaken include:
  1. Initial discussions/ interviews with stakeholders/partners to understand the inclusiveness aspect of the project using the MDII as a guide.
  2. Engaging with GroundTruth developers to discuss potential digital tools for data collection, such as MiniSASS (a proxy for water quality and a training tool) and clarity tubes, and various data collection apps (e.g., ADK Collect, ArcGIS Field Survey, Freshwater Watch app, miniSASS app).
  3. Addressing the critical importance of ensuring digital inclusiveness of all tools developed by considering challenges related to accessibility, affordability (internet costs, device access), and participation (digital literacy) for diverse user groups including women and youths.
  4. Exploration of different incentive mechanisms for citizen scientists, including the UNICEF Yoma platform for digital tokens and potential financial support for participation costs.
  5. Identification of potential risks to inclusiveness, such as language barriers, literacy levels and financial constraints.
  6. Consideration, Identification/Mapping of strategies to mitigate these risks, such as leveraging AI for translation and exploring co-funding models for incentives.
  7. Identification of potential key partners who have worked with marginalized communities, such as Kruger to Canyons Biosphere Reserve (KTC) and AWARD.
  8. Discussion on how to reach marginalized communities through training and onboarding of partners.
  9. Review of existing citizen science projects and approaches, including the Enviro Champs initiative.
  10. Considering strategies to engage marginalized communities, youth, and women in co-creation, identification of gaps and data collection and monitoring methods, with the goal of providing agency to these groups.

- Outputs achieved:
  - A clearer understanding of the project's inclusiveness goals, focusing on youth, women, and marginalized communities.
  - Identification of key partners with existing experience in citizen science and potential for engaging target groups.
  - A preliminary overview of digital tools currently used in citizen science initiatives within the region.
  - Initial insights into the accessibility considerations of existing digital tools, including offline capabilities and data usage.
  - Identification of potential challenges to accessibility, affordability, and participation, including internet costs, device accessibility, and digital literacy.

- The initial design of incentives with Yoma as the main digital platform for mobilization, engagement and compensation for citizen scientists.
- Early identification of risks to inclusiveness, notably language and financial barriers.

- Key learnings, insights, and evidence from the implemented and expected outputs and outcomes.

  Based on the interviews conducted as part of the assessment of the Enabel citizen science project's inclusivity and the insights gained from this process, several key lessons and insights have emerged.

Figure 4. *Insights and learnings from the interview*

Here are the key lessons and insights gained from this assessment process:

Inclusivity is a Central and Multi-faceted Goal: The project explicitly aims to be inclusive, embedding principles of inclusivity and equity with a special focus on women and youths. The assessment reinforces that inclusivity is not a single issue but requires a multi-dimensional approach, addressing aspects like accessibility, usability, language, digital literacy, cultural relevance, and motivation.

Collaboration with Partners is Crucial for Reaching Communities: A key insight is the reliance on partners like Ground Truth and LIMCOM who have existing experience and networks at the community level. IWMI is working with these partners, using data such as poverty levels and water quality issues, to identify and engage with vulnerable communities within the LRB. LIMCOM also leverages its relationships with IWMI and landscape custodians like biospheres to reach marginalized communities. The experience of these organizations in appropriate methods for engaging with rural communities, as well as in identifying and enhancing the inclusion of different social categories of people needs to be harnessed in the course of the project.

Digital Tools Require Careful Consideration for Accessibility and Usability: The assessment highlights the need for digital tools to be adaptable to varying levels of digital literacy and internet connectivity challenges prevalent in rural areas. Tools with offline functionality and low data requirements, such as miniSASS and Enviro champ, are being considered or developed to address these challenges. Language inclusivity is also a significant consideration, with plans for multi-language support in tools and materials, starting with Portuguese. AWARD's role involves focusing on the technical integration of data while ensuring its accessibility and usability through features like a chatbot, but its approach to incorporating Indigenous Knowledge Systems (IKS) remains unclear. The chatbot operates at two levels: one based on training documentation (e.g., miniSASS protocols) and another that dynamically connects with real-time data via an API.
For the benefit of users like water managers, integrating IKS alongside AI strengthens sustainability by leveraging local expertise in resource management. Addressing ethical challenges—such as bias and misinterpretation—requires transparency, community involvement in data collection, and safeguards against misuse, ensuring AI-driven water management is both equitable and responsible.

Appropriate and Context-Specific Incentives are Vital for Participation: A significant learning is that incentivization is important for motivating participation, especially for youth and in contexts where participants have limited time and resources. The UNICEF Yoma platform is being explored to provide sustainable incentives. However, the assessment reveals that technical integration between citizen science data collection tools (like miniSASS) and the Yoma platform for seamless incentivization is a key challenge currently being addressed. The project is considering a range of incentives, including digital tokens, recognition, and potentially practical support like data, transport, and food vouchers, recognizing that a digital CV might not be universally relevant. The incentive design process involves close collaboration with local individuals and young people to ensure alignment

with their needs. Organizations such as GroundTruth and LIMCOM, which have extensive experience working with local communities, along with local governments, church-based groups, and other stakeholders, play a vital role in fostering participation across different community demographics. Their involvement is also crucial for determining appropriate incentive levels that effectively support engagement.

Learning from Existing Practices Informs Strategy: The project is actively learning from past citizen science projects and existing inclusive practices, such as those undertaken by the as Kruger to Canyons Biosphere Reserve other community-based water management initiatives. This helps in identifying successful approaches for engaging marginalized groups.

Co-creation and Community Engagement are Essential: Engaging community leaders, using local languages, and incorporating the knowledge and perspectives of rural communities in project design and evaluation are recognized as fundamental for ensuring relevance and local ownership. LIMCOM's emphasis on a bottom-up engagement approach underscores this lesson.

Identifying and Addressing Potential Barriers Proactively: The assessment has helped to identify potential risks and barriers to inclusivity, including internet access/connectivity challenges, varying levels of digital literacy, language differences, financial constraints, and gendered differential access to technology. The project is developing or considering mitigation measures for specific groups, such as prioritizing tools with offline functionality and planning for language translation.

Sustainability of Inclusive Practices Requires Planning: Ensuring the long-term sustainability of inclusive engagement is a key consideration, linked to factors like aligning with national plans, building partnerships, and encouraging local ownership and exploring different funding models.

In summary, the inclusivity assessment, grounded in the MDII framework and conducted through interviews with various stakeholders, highlights that achieving inclusivity in the Enabel citizen science project requires a deliberate, multi-faceted approach. Key lessons involve leveraging partner expertise for community engagement, designing accessible and usable digital tools adapted to local contexts and languages, developing appropriate and context-specific incentive strategies, actively learning from existing inclusive practices, and proactively identifying and addressing potential barriers to participation. These insights will inform the project's ongoing implementation and strategies to ensure broad and equitable participation.

Inclusivity approach And Implementation

- The project aims to build agency within the communities especially those in rural and marginalized areas the skills to be involved in monitoring and managing their water resources through training, feedback and involvement in the various citizen science activities.

- There is a specific focus on driving engagement with youth and building in representation of youth and women.
- The selection of digital tools considers accessibility for individuals with limited internet access and aims for ease of use. There is consideration for offline options in areas where there's poor digital infrastructure or minimal digital literacy for tools like miniSaSS however this needs to be adopted for all digital tools being developed for the project.
- There is an intent to co-create the citizen science activities (by engaging to understand the varying local contexts and data/gaps) incentives and data collection methods with communities to ensure relevance.
- The project seeks to learn about community problems, jointly map out solutions and build their capacity to monitor relevant issues in relation to the LRB.
- The use of the Yoma platform aims to provide recognition and potential remuneration for contributions, addressing financial barriers.
- Translation of materials and apps into local languages (starting with Portuguese) is planned to address language barriers.
- The project aims to work with partners already operating in the basin and leverage their existing teams and tools.

3.4. RISK MANAGEMENT: MANAGING POTENTIAL RISKS OF SOCIAL EXCLUSION

Several risks focused on social exclusion and its potential impacts have been identified concerning the project. These risks can be broadly categorized as threats (potential negative impacts) or opportunities (potential positive impacts that can be leveraged). The way these are being, or will be, dealt with involves various strategies and mitigation measures aimed at enhancing digital and social inclusiveness. Table 2 summarizes the identified risks and their management, where applicable, the table also explains how the risk and mitigation relate to the MDII framework being used for the project's inclusiveness assessment.

Risks, Potential Impacts and Mitigation

Table 2. *Risk of social exclusion and mitigation strategies*

Risk / Potential Impact Area	Type	Potential Consequences	How it is Being/Will Be Dealt With
Digital Access & Infrastructure			
Limited internet access, connectivity, and device availability	Threat	Can lead to the exclusion of communities who are disconnected digitally from accessing services or opportunities. Users may not find digital incentives or solutions relevant to their	Reduce/Contingency: Priorities low-data requirement tools with offline functionality. Explore partnerships to potentially provide access to devices or support local technological hubs. Consider alternative communication methods such as traditional communication centers if digital access is severely limited. Apps designed for low data and offline use are being developed. Assess

		immediate needs. This poses a significant barrier to participation in data collection and tool usage.	connectivity and smartphone availability in the LRB. Promote the digital twin via social media and other platforms.
Digital Literacy & Usability			
Varying levels of digital literacy and scientific understanding across communities	Threat	Pose a significant barrier to using digital tools and understanding project concepts or data. Makes it difficult to ensure the platform is usable for those without advanced scientific training.	Reduce: Develop user-friendly interfaces with clear visuals and intuitive navigation. Provide accessible training materials, including how-to videos, in relevant languages. Tailor approach to diverse groups' needs based on cultural sensitivity. Implement "train the trainer" programs to build local capacity. Design hybrid data collection systems that allow for offline data capture when connectivity is limited. Integrate Indigenous Knowledge Systems (IKS) into chatbot solutions and digital tools while educating users about AI limitations. Ethical risks—such as bias and misinterpretation—must be addressed through transparent AI decision-making, community involvement, and safeguards against misuse. A balanced approach leveraging both AI efficiency and traditional wisdom ensures responsible and equitable water management. Ensure design philosophy aims for lean apps to enhance usability in rural settings. Conduct adequate testing with beta versions of the software to gather feedback and ensure usability.
Developing unusable or too complex tools for citizen scientists,	Threat	Citizen scientists may perceive the tool as unusable or too complex, hindering adoption and participation.	Reduce/Avoid: Conduct adequate testing with beta versions of the software to gather feedback and ensure usability. Ensure design philosophy aims for lean apps in terms of data and processing requirements. Focus on balancing data rigor with tool usability. Assess the accessibility and usability of the digital tools, potentially via co-creating methods with communities.
Language Barriers			
Language barriers across the transboundary region of the LRB	Threat	Could hinder participation and effective training. Technical innovations primarily in English pose a barrier.	Reduce: Explore AI-powered translation tools for materials and potentially real-time communication. Priorities translation into key languages, such as Portuguese, initially. Work with local partners who can facilitate communication in different languages. Recognize the importance of providing adequate documentation to facilitate translation. The miniSASS tool already includes a multi-language approach with plans to add Portuguese. The MDII approach requires tailoring engagement methods to language preferences and cultural contexts of diverse communities
Financial & Incentive Issues			
Financial constraints for participants (costs for mobile data, transport to	Threat	May limit the ability to incentivize participation or cover costs. Can significantly hinder participation for individuals from vulnerable communities. Leads to a lack	Reduce: Leverage the Yoma platform to provide digital incentives and recognition. Explore co-funding opportunities with project partners to cover expenses like transport, opportunity costs, and other expenses for citizen scientists. Prioritize partnerships with organizations that already have existing community engagement and

sites, opportunity costs)		of resources to scale incentives effectively.	potentially existing funding streams. The UNICEF Yoma leverages the Yoma platform to provide digital incentives and recognition for youth involvement. Identifying and engaging the private sector for Corporate Social Responsibility (CSR) or other funding is being explored.
Participants motivated primarily by rewards / Potential for submission of false data to receive incentives	Threat	It might lead to participants submitting poor quality data just to get paid. False data could feed into the digital twin, impacting decision-making. Potential conflict or other unintended consequences related to incentivization.	Reduce: Engage broader community to find a way to guard against the risk of false data. Conduct a proper assessment of the understanding of data collection methodologies, through training. Field leaders can play a role in guiding data collection quality. Partners are expected to verify data. The design aims to balance data rigor with tool usability. Consider how to communicate project benefits without giving participants the idea they should participate *just* for rewards. Recognize this as an ethical point that needs consideration. Link incentives to high quality data contributions. An ethics data collection training could be provided during the workshops for local partners on how to use the data collection tools.
Safety & Risks of Harm			
Risk involved in data collection (health, safety, accessing contaminated water sources)	Threat	Poses physical risk to citizen scientists (e.g., injury from slipping, exposure during a cholera outbreak). Can involve the danger of accessing contaminated or otherwise hazardous water sources.	Reduce/Transfer: Ground Truth's model involves using field leaders who take participants through the process and enhance safety. There is a need for policy regarding the level of liability to secure their safety. Assess how risky it is for participants to get to the water source. Implement safeguards, including grievance mechanisms, to ensure community concerns are addressed, and the project is conducted ethically.
Data collected by citizen scientists may not be usable or valid. **by scientists**	Threat	Participants will not be incentivized for their effort and energy if their data cannot be used. This can lead to frustration and reduced participation.	Reduce/Avoid: Ensure verification of data. Implement data validation processes. Ensure participants understand the methodologies required for data collection through co-creation, capacity development, and assessment.
Misinforming decision makers with seasonal forecasts derived from citizen science data,	Threat	Could lead to incorrect decisions, such as releasing water from dams based on inaccurate forecasts. This can have significant consequences for water resource management.	Reduce: Add a level of confidence to forecasts. Provide detailed reports and notebooks explaining the models used. Acknowledge the need for a framework to disclose risks to stakeholders. Identify and mitigate critical risks within the project scope. Bring awareness to stakeholders about the identified risks. Educate people about the limitations of AI.
Exclusion of Specific Groups			
Gendered differential access to technology and project opportunities	Threat	Certain groups, such as women, youth, and the elderly, may have less access to or comfort with technology. This could lead to their exclusion from using and benefiting from platforms and projects. Socioeconomic and political factors, and cultural norms around digital device	Reduce/Avoid: Consider the inclusivity strategy. Develop and implement measures to mitigate identified risks for specific groups like women, youth, and the elderly. When interviewing, use language that empowers women and avoid stereotypes. Ensure privacy and comfort in interview settings, considering cultural norms about mixed-gender interactions. Highlight and respect the dual roles women play in agriculture and household management. Tailor approach based on underrepresented group needs, work with community-based organizations to ensure equity in

		ownership, contribute to this risk. Exclusion from services and tools is likely due to gender, age, and geography.	the selection of citizen scientists
Leveraging Partnerships & Existing Work			
Use of existing partnerships and successful models (like KTC, AWARD, Ground Truth, Enviro Champs)	Opportunity	Can provide valuable lessons and established approaches for broader implementation. Leverage their experience and stakeholder mapping to identify and engage with vulnerable communities. Partners are already operating in the basin with existing teams and tools. Provides existing networks and resources to scale initiatives. Enable's reaching marginalized communities effectively.	Explore/Enhance: Building on existing work and tools developed under initiatives like Enviro Champs. Leverage their networks to identify resources and opportunities. Partner with them for community engagement and training. Learn from their existing inclusive practices. AWARD identified as an important partner operating in the basin. IWMI's approach is guided by the MDII, leveraging partner experience. Ground Truth is a key partner for engaging the marginalized communities.
Co-creation & Community Engagement			
Identification of challenges, Co-creation of solutions and data collection methods with communities	Opportunity	Ensures relevance and buy-in from participants. Helps learn about community problems and build capacity to monitor relevant issues. Includes local knowledge and perspectives in project design and implementation. Builds agency within the community to monitor and advocate for change.	Enhance: Engaging local actors, including rural communities, in design, development, and implementation of the project needs clarification and proper structure. e.g. LIMCOM incorporates community knowledge and perspectives via engaging leaders, using local languages, and continuous reflection throughout the project. Concept notes are then validated with community input and adapted to local contexts. Safeguards, including grievance mechanisms, are implemented. Ensure continuous reflection and address any shortfalls.
Incentivization & Sustainability			
Leveraging the Yoma platform for incentives	Opportunity	Can provide digital incentives and recognition. Serves as a potential mechanism for incentivizing citizen scientists, especially focusing on youth engagement. Offers a way to build a digital track record of contributions. Includes a sustainable financing and micro-credential model.	Explore/Enhance: Explore co-funding opportunities for costs. Use the platform for opportunities listing. Bridge the gap between data contributions and incentivization. Focus on youth. UNICEF (Yoma) is being explored as a platform for youth participation and incentivization. It is intended to be used post post-project to sustain engagement. IWMI is working alongside Yoma to strategize on incentives to address any risks such as exploitation and ensure adequate compensation for the contribution made by citizen scientists. Community assessment will be conducted to validate these incentives with the citizen scientists (questions to address with them: is the incentive appropriate, is it enough for the contribution made by citizen scientists)
Potential for addressing bigger	Opportunity	Provides a strong, tangible benefit for the community as a whole. Can serve as a	Enhance: Work with local partners or implement amenities or priorities identified by the participating communities. is noted that this approach could also come with risks its

community issues (e.g., installing a borehole) through collective effort/points earned		powerful motivation beyond individual gain, fostering community cohesion and collective action.	own risks
Policy Alignment & Data Use			
Alignment with National Development Plans and Water Policies of Member States	Opportunity	Ensures project is contextually relevant and supported by government frameworks across the region. Can lead to an investment platform for the basin. Allows data to serve both national and transboundary interests.	Enhance: Ensure the project aligns with national plans and policies. LIMCOM is developing a transboundary diagnostic analysis and strategic action plan which the project feeds into. Harmonizing approaches across the four countries. A discussion was held to ensure the project aligns and is further entrenched within the national development plans and water policies.
Ensuring Transparency in Models Used and Risk Disclosure	Opportunity	Improves trust and understanding of the digital tools and data used. Ensures stakeholders are aware of potential errors and limitations.	Enhance: Increase exchange of information and the sharing of detailed reports explaining the models used. Develop a framework for disclosing risks to stakeholders. Educate people about the limitations of AI and digital tools. Identify and mitigate critical risks and bring awareness to stakeholders about these risks.

This information aligns implicitly with the MDII by addressing factors such as accessibility, usability, beneficial impact, risks & harms, and the supportive ecosystem, which are key dimensions evaluated by the framework.

While the report identifies risks and some mitigation approaches, the level of detail on *how* each mitigation strategy will be implemented (e.g., specific protocols for avoiding harm, detailed contingency plans) is not exhaustively provided in these excerpts.

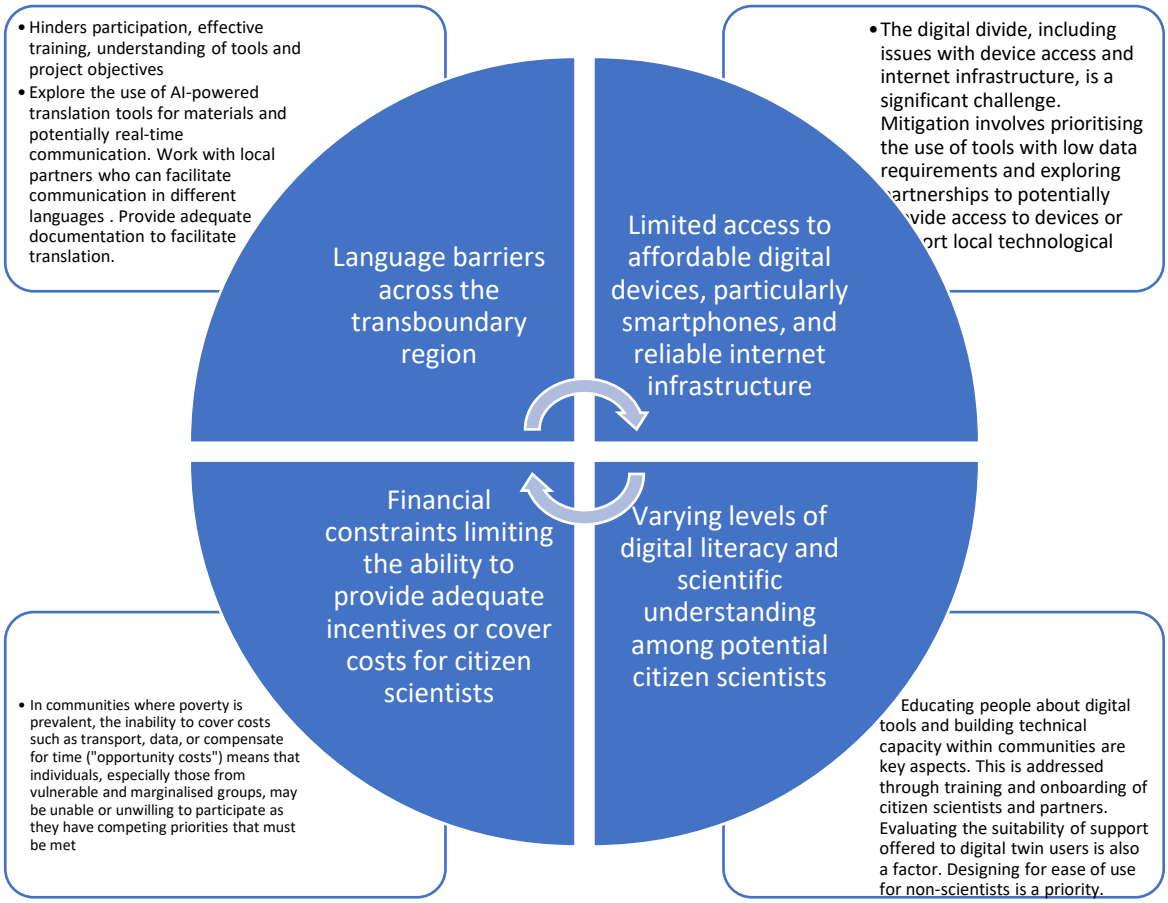

***Figure 5**. Snapshot of some risks, impacts and mitigation*

3.5 Thematic Analysis of Digital Inclusiveness

Thematic analysis was the qualitative analysis used in the digital inclusiveness report. This involved identifying key themes that emerged from the project documentation and interview transcripts related to digital inclusiveness. The report then elaborated on these themes, such as inclusivity goals and strategies, technology and tools accessibility, and barriers and risks the following themes emerged from the analysis of the project documentation and interview transcripts, highlighting key aspects of digital inclusiveness within the Enabel citizen science project:

- **Inclusivity Goals and Strategies:** The project has explicit inclusivity goals, focusing on understanding overall inclusivity, reaching marginalized communities, ensuring digital tools' accessibility and usability, addressing potential barriers and risks, learning from existing inclusive practices, and considering incentives and sustainability. IWMI's approach is guided by the multidimensional digital inclusiveness index, which evaluates the project holistically to ensure accessibility and benefits for all stakeholders. Strategies for reaching marginalized

communities involve collaboration with partners like Ground Truth, leveraging their experience working with these communities. Data such as poverty levels and water quality issues are used to identify vulnerable communities within the LRB. Engagement channels like UNICEF and Yoma are also being considered. Working closely with stakeholders in the Member States is crucial to ensure contextual relevance and prevent leaving any communities behind.

- **Citizen Science Implementation and Inclusivity:** Making the project as inclusive as possible in terms of data collection, training, and onboarding is a central aim. This involves understanding the best approaches for reaching various groups. LIMCOM emphasizes a bottom-up engagement approach and creating awareness for citizen science initiatives. Learning from existing inclusive practices in citizen science is also a key consideration.
- **Technology and Tools Accessibility and Usability:** The project is leveraging digital tools, including mobile apps (like miniSASS) and the digital twin itself. Ensuring the accessibility and usability of these tools for individuals with varying digital literacy levels and access to technology is paramount. The digital twin infrastructure is open source and can be deployed on any cloud. However, the challenge of internet access for some communities is acknowledged. To address this, offline tools like miniSASS and Enviro champ are being developed to allow data collection without constant internet connectivity. The miniSASS tool also includes a multi-language approach, with plans to add Portuguese. The design philosophy aims for lean apps in terms of data and processing requirements to enhance usability in rural settings with limited internet access or data availability. There is a focus on balancing data rigor with tool usability to encourage participation.
- **Addressing Barriers and Risks to Digital Inclusiveness:** Several potential barriers and risks to digital inclusiveness have been identified. These include the challenge of internet access and connectivity in certain regions. Varying levels of digital literacy and scientific understanding across communities pose another barrier. Language differences within the LRB are a significant consideration. While technical innovations will primarily be in English, the importance of providing adequate documentation to facilitate translation is recognized. Financial constraints, such as the cost of mobile data and transport to monitoring sites, can also hinder participation. There's an awareness of gendered differential access to technology that needs to be considered in the inclusivity strategy.
- **Incentives and Motivation for Participation:** Incentives and motivation strategies are being explored to encourage diverse communities to participate and ensure long-term engagement. The Yoma platform is being considered as a potential tool for incentivization and communication with citizen scientists. Discussions involve understanding the most appropriate incentives for different contexts and communities, recognizing that digital CVs might not be relevant for all. Practical incentives like data for phones, transport, and food vouchers have been considered in the incentive proposal. The need for a strategy to incentivize marginalized groups specifically is highlighted. There is a risk of fraud and exploitation if the incentive given is not sufficient compared to the contribution made by citizen scientists.

- **Project Sustainability and Inclusiveness:** Ensuring the sustainability of the citizen science project is linked to its inclusiveness. Strategies for sustainability include aligning the project with national development plans and water policies. Partnering with NGOs, and existing landscape custodians is seen as a way to scale up citizen science initiatives.
- **Data Management and Language Considerations:** Ensuring that collected data is brought into the system in a way that is understandable to the greatest number of people is emphasized, with language being a key sensitivity. The miniSASS tool aims to support a multi-language approach. Protocols for data verification and validation, incorporating metadata and time-stamping features, are being designed. The need to verify data scientifically is recognized, potentially through lab analysis of a subset of citizen-collected samples

Figure 6. *Insights and learnings from the interview*

4. Conclusion and Potential Recommendations

The Enabel citizen science project demonstrates a strong commitment to digital inclusiveness through its stated goals, planned strategies, and consideration of various barriers. The thematic analysis highlights the multi-faceted nature of inclusivity, encompassing technological, social, and linguistic dimensions. Amina's story illustrates how addressing these dimensions through accessible tools, language support, community engagement, and relevant incentives can facilitate participation from diverse communities.

Based on the analysis, the following potential recommendations could further enhance digital inclusiveness within the project:

Prioritize and expand multi-language support:

a) Translation of miniSASS, Green Learn 2 Earn course and all training materials by Q3 2025;
b) Conduct focus group discussions for language selection and assessment in each basin country by Q3 2025. Develop translation for priority interfaces selected by Q4 2025;

c) Establish community translator networks in each country for verification and feedback.
d) Transparently address use of AI and ethical concerns especially for translation of low resourced and culturally sensitive languages.

Invest in offline data collection and upload solutions:

a) Deploy offline-capable miniSASS version to by Q1 2026;
b) Establish community data upload hubs with WIFI access in priority areas;
c) Train community facilitators on offline data collection protocols;
d) Implement automatic data sync when connectivity is restored.

Digital Literacy Training Programme:

a) Develop simplified visual training materials (pictorial guides) for low-literacy users;
b) Train 5 community digital champions per country who can provide peer support;
c) Create video tutorials, training materials and privacy policy documents in local languages using storytelling and visualizations in digital tools.
d) Establish WhatsApp support groups for troubleshooting.

Comprehensive inclusiveness assessment of all tools:

a) Conduct planned surveys with downstream users, tool developers and experts to gather feedback on the inclusiveness of digital tools including the miniSASS app, YOMA platform, and the digital twin by Q3 2025;
b) Administer usability testing sessions with representative user groups from each basin country, ensuring participation from women, youth, and marginalized communities;
c) Evaluate all tools against the MDII framework dimensions including accessibility, usability, and beneficial impact;
d) Produce a comprehensive MDII evaluation report documenting findings and actionable improvements for each digital tool by Q1 2026.

Co-design incentives to community needs and contexts: A nuanced understanding of the diverse needs and priorities of different communities is essential for designing effective incentive programmes. Offering a range of relevant incentives beyond digital rewards should be considered.

Explore partnerships for enhancing digital access: Collaborating with mobile network providers and other organizations to explore options for improving digital infrastructure and affordability in underserved areas could indirectly enhance digital inclusiveness in the long term.

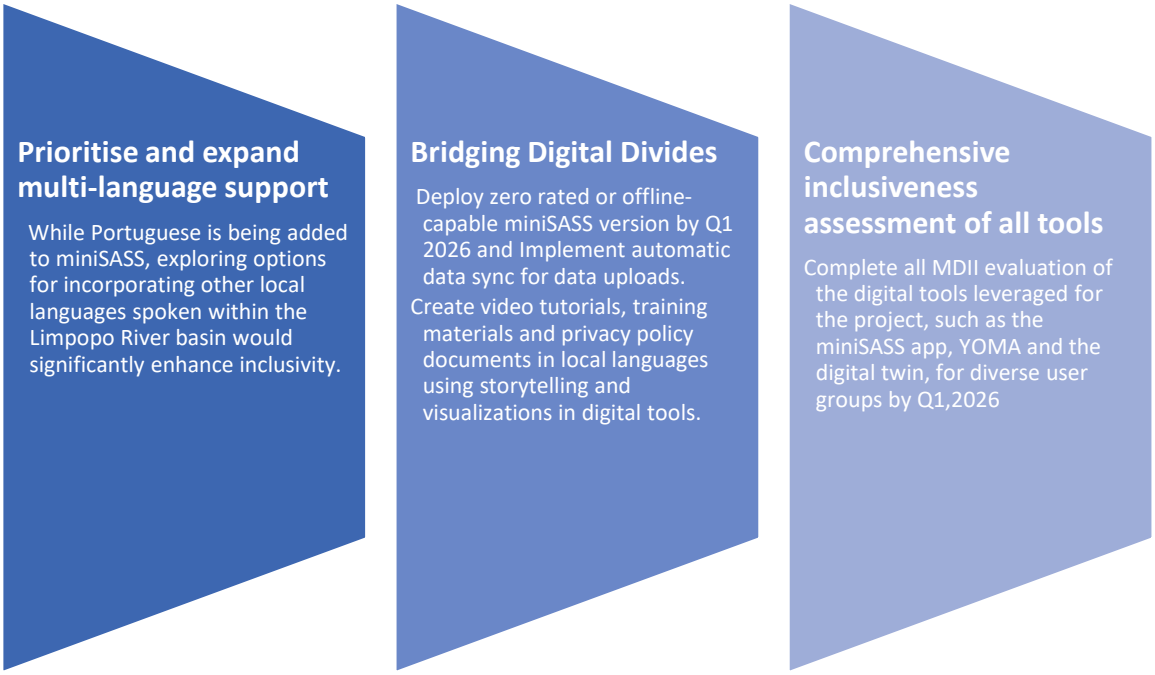

Figure 7. *Key Recommendations*

By continuing to prioritize these considerations and adapt strategies based on ongoing learning and feedback, the Enabel citizen science project can further strengthen its commitment to digital inclusiveness and ensure that the voices and data of all communities within the LRB contribute to sustainable water resource management.

4. PARTNERSHIPS AND CONTRACTORS

- How do you evaluate the relations between your organization and the various partners to this grant agreement (co-applicants, associates, contractors)? Please provide specific information for each partner.

  Evaluation of relations between your organization and the various partners:

  - **LIMCOM**: is a transboundary institution mandated by the Southern African Development Community to work with countries on managing issues of transboundary relevance. Their role as a custodian and co-implementer of the project, leveraging their stakeholder networks and technical capacities, is important for the projects long term sustainability. Citizen science is important for LIMCOM as it aids in local custodianship for scientific monitoring and its integration into an advanced information platform. LIMCOM also works to ensure the project aligns with national development plans and water policies of each Member State.
  - **Ground Truth and Conservation Trust:** There is an existing working relationship, particularly around the Enviro Champs initiative and the development of citizen

science tools. They are key partners in developing and refining data collection methodologies.

- **Kruger to Canyons Biosphere Reserve (KTC):** A strong existing partnership with prior training and ongoing data collection activities. They serve as a positive case study for engaging communities in citizen science. Their data goes into a UNESCO repository, which the project aims to build upon.
- **AWARD:** Identified as an important partner operating in the basin with existing teams collecting data. Further engagement is needed to understand their inclusivity goals and data collection practices.
- **UNICEF:** Focus on youth engagement aligns with the project's inclusiveness goals. with UNICEF YOMA platform's sustainable financing and micro-credential model being a potential mechanism for incentivizing citizen scientists in the project.

In addition, the relationship between our organization (IWMI) and the public authorities in the countries where the Enabel Project is being carried out (Botswana, Mozambique, South Africa, and Zimbabwe) is evaluated as positive and strategically important, primarily facilitated through the Limpopo Watercourse Commission (LIMCOM). This is evidenced by a "landmark agreement" and the signing of a Memorandum of Understanding (MoU) between LIMCOM and IWMI. This strategic partnership focuses on mutual knowledge exchange and scientific collaboration to enhance water resource management[10].

The relationship, formalized through LIMCOM which represents the four member states, has had a significantly positive impact on the project by:

- Providing a framework for transboundary cooperation, essential for the LRB.
- Facilitating data sharing and scientific collaboration, crucial for the development and use of the Digital Twin.
- Aiming to align national water initiatives with LIMCOM goals.
- Supporting the integration of real-time data, including citizen contributions, into the Digital Twin, enhancing accuracy and stakeholder empowerment.
- Contributing to improved decision-making in water management across the basin.
- The strong, formalized, and mutually beneficial relationship through LIMCOM is considered crucial for the Enabel Project's ability to achieve its goals of enhancing water resource management through collaborative and data-driven approaches.

5. SUSTAINABILITY OF THE PROJECT

The sustainability of the Enabel citizen science project is being approached through several

[10] https://www.iwmi.org/news/transboundary-collaboration-on-the-limpopo/
https://limpopocommission.org/article/limcom-and-iwmi-sign-landmark-agreement/

interconnected strategies. Above all, fostering a sense of ownership among CS and the communities through co-identification of challenges and solutions is one of the drivers for sustainability.

Firstly, engaging with the private sector and leveraging corporate social responsibility (CSR) is considered crucial for long-term financial support. LIMCOM is actively exploring partnerships with organizations like Conservation International and The Nature Conservancy, who already engage in citizen science as part of their projects. There's an intention to more strategically engage larger corporate entities with strong CSR models linked to freshwater monitoring and replenishment. This engagement could potentially provide funding for maintaining and updating the Digital twin and citizen science initiatives.

Secondly, the project aims to build on existing networks and resources. LIMCOM highlighted the potential of partnering with NGOs, and existing landscape custodians like biosphere reserves to scale citizen science initiatives. These established entities can provide infrastructure and community links that contribute to long-term viability.

Thirdly, capacity building programs are being implemented to ensure that water managers understand how to use the digital twin and that citizens are trained to use tools like miniSASS. This focus on building local expertise and ownership is vital for the continued use and development of the project's outputs after the initial funding period.

Furthermore, the project has a clear handover plan in place. The citizen science program will be handed over to LIMCOM and the participating countries, accompanied by an implementation plan designed to ensure its sustainability. LIMCOM, as a transboundary institution with a mandate for long-term water resource management, is well-positioned to take on this custodianship.

The potential of the Yoma platform to provide sustainable incentives for citizen scientists, including tapping into employment funds, is also a key consideration for long-term engagement. While the exact mechanisms are still being developed, the idea is to move beyond short-term rewards and create pathways for upskilling and potential employment for participants. Contextualizing incentives based on location is also recognized as important.

Exploring alternative financial mechanisms such as carbon credits and maintenance fees for the digital twin are also being considered for the sustainability of the digital infrastructure.

Finally, discussions also touched upon the possibility of creating a value chain at the community level, where activities related to citizen science (e.g., environmental restoration) could generate income, thereby providing a self-sustaining incentive for continued participation.

In essence, the sustainability strategy for the Enabel citizen science project is multi-faceted, focusing on financial diversification through private sector engagement, leveraging existing institutional and community networks, building local capacity, establishing clear ownership through handover to LIMCOM and national authorities, and developing long-term motivation and incentivization mechanisms for citizen scientists.

6. ANNEXES

Interviews

Andarcia, 2025 *Interview with* Mariangel Garcia Andarcia. Citizen Science Inclusiveness Assessment Interview LIMCOM 4th April 2025.

Bashe, 2025 *Interview with* Khanya Bashe. Citizen Science Inclusiveness Assessment Interview UNICEF 17th April 2025.

Clifford-Holmes, 2025 *Interview with* Jai Clifford-Holmes. Citizen Science Inclusiveness Assessment Interview LIMCOM 14th April 2025.

Danga, 2025 *Interview with* Laura Danga. Citizen Science Inclusiveness Assessment Interview LIMCOM 4th April 2025.

Haux, 2025, *Interview with* Camila Haux. Yoma App Tour 4th April 2025.

Jacobs, 2025, *Interview with* Desme Jacobs. Yoma App Tour 4th April 2025.

Riddell, 2025, *Interview with* Dr. Eddie Riddell. Citizen Science Inclusiveness Assessment Interview LIMCOM 4th April 2025.

Storie, 2025 *Interview with* Dr. Maryna Storie. Citizen Science Inclusiveness Assessment Interview LIMCOM 10th April 2025.

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