INTERNATIONAL ISOLATION INDEX (III): CONCEPT PAPER

A new approach to measuring and addressing rural isolation

Isolation shouldn't decide who is going to live or die

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Contents

1 Executive summary

This document outlines the challenge of measuring isolation and explores the development of the International Isolation Index (III), a tool aimed at providing a comprehensive, data-driven measure of isolation. The III will be a visualised heat map of the world which will highlight areas of involuntary and voluntary isolation (the latter being 'greyed' out). It will show relative isolation, with the ability to layer multiple types of isolation (as defined by the core dimensions of isolation) as is required. The insights and recommendations here will inform discussions at the Ingenuity Festival on 28 May 2025, led by PA Consulting in partnership with Mission Aviation Fellowship (MAF). Experts from the humanitarian, academic, and technology sectors will gather to explore innovative solutions for addressing rural isolation.

1.1 Why the International Isolation Index is needed

Understanding isolation is complex due to its varied definitions (explored in detail in section 2) and implications across different contexts, but it is underscored by issues around access – access to healthcare, infrastructure (such as roads, clean water, energy/electricity, digital connectivity), education, and economic opportunities. Despite efforts to reduce isolation, no standardised framework exists to comprehensively measure it at a global level. Existing indices (detailed in section 4) address isolated aspects such as transport accessibility and digital inclusion but fail to offer a holistic view of isolation. This gap hinders effective prioritisation and efficient targeting of interventions by humanitarian organisations, governments, and donors.

The III is a groundbreaking tool designed to pinpoint and quantify isolation globally. By leveraging cutting-edge geospatial technology, satellite imagery, and socioeconomic data, the III will deliver a detailed, real-time snapshot of the most isolated regions and how isolation can be reduced. Using this information, communities can push for necessary changes, humanitarian organisations can allocate resources more effectively, and policymakers can make well-informed decisions to improve access and provide opportunities for those who are often overlooked.

With 80 years' experience of connecting remote communities to essential services, MAF is uniquely positioned to address this challenge. MAF's aerial operations are crucial for delivering healthcare, humanitarian aid, and other services to isolated areas. However, to maximise its impact, and therefore the impact of key donor partners, MAF needs an evidence-based approach to assess isolation, guide flight operations, and demonstrate effectiveness and efficiency to funders and partners.

The III aims to provide a consistent, country-level measure of rural isolation by integrating geospatial data, satellite imagery, and human development indicators. The introduction of the III is poised to deliver several critical objectives:

- **Support humanitarian and development planning** by identifying the most isolated regions and enabling more targeted interventions
- **Enhance decision-making for flight planning and service delivery**, ensuring that MAF and its partners allocate resources effectively
- **Strengthen impact measurement and advocacy**, helping organisations communicate the significance of isolation and mobilise funding
- **Facilitate cross-sector collaboration,** allowing humanitarian actors, governments, and research institutions to work from a common evidence base.

The goal is to announce the launch of the III and present a fundable final solution at the Mansion House event in June 2025, marking MAF's 80th anniversary. This event will showcase the index's potential, and engage key stakeholders and potential investors.

This report contains six sections in addition to this Executive Summary:

- **Section 2: Case for change** – Discusses the need for the III, what the proposed III is intended to be, and highlights the limitations of current indices and the benefits of a multifaceted, data-driven approach.
- **Section 3: Critical success factors** – Identifies the key factors, risks, constraints, and dependencies essential for the successful development and implementation of the III.
- **Section 4: Existing indices measuring global isolation** – Reviews current approaches (i.e. existing indices) to measuring isolation, evaluating their methodologies, strengths, and limitations.

- **Section 5: Stakeholder ecosystem** – Describes the key stakeholder groups involved in the III and their roles in its development and implementation.
- **Section 6: Options for delivering the International Isolation Index** – Presents four potential approaches for delivering the III, each with varying scope and degrees of complexity.
- **Section 7: Recommendation** – Puts forward PA Consulting's recommended option (Option 4) for delivering the III, supported by a Proof of Concept (POC) to ensure effective testing and validation before implementation and scaling.

A note on terminology:

Throughout this paper, the III is referred to at various developmental stages as follows:

- **Proof of Concept: (POC):** This refers to the initial III as an early concept that will require validation and feasibility with potential users before committing significant resources to development of final design.
- **Minimum Viable Product (MVP):** This refers to the simplest and earliest version of the III that can be taken publicly to potential funders. It will include only essential features/capabilities to satisfy Early Adopters, and will be tested with real-world users to gather feedback for future further development.
- **Solution:** When referring to the solution, this refers to the III that is ready for widespread release and use, i.e. the final III, which has incorporated all necessary features, improvements and refinements.

1.2 How the Proof of Concept was developed

The development of the III followed a structured, iterative process, ensuring that the final index will effectively meet stakeholder needs while being scalable and practical for global implementation. The first step was to build a strong case for change, recognising that existing indices failed to provide a comprehensive and holistic view of rural isolation due to their focus on a single dimension, such as gender or employment. Current indices are not comprehensive (multi-dimensional) enough in terms of geographic coverage, and breadth and depth of data, making it difficult for humanitarian organisations and governments to allocate resources and prioritise interventions effectively.

In parallel, critical success factors which reflect optimal outcomes of an index, such as comprehensive data coverage, real-time analytics, scalability, support for decision-making, and enhanced efficiency in aid delivery were identified. These factors helped guide the development process and were used to evaluate several design options. After careful review, Option 4 emerged as the most robust and adaptable approach, though the decision was made to start with a POC to enable thorough testing before full-scale deployment. Below is an overview of the key options considered:

- **Option 1: Basic geographic index** – A simple framework focusing on geographic isolation only, this option provided limited insights but lacked the depth needed to fully capture the multidimensional nature of isolation. While it was easier to implement, it did not support comprehensive decision-making.
- **Option 2: Expanded multidimensional framework** – This option integrated multiple dimensions of isolation, including geography, infrastructure, and social factors. It was a step forward in terms of data integration but lacked real-time analytics and predictive capabilities, limiting its effectiveness in dynamic situations.
- **Option 3: Comprehensive integration with machine learning** – Leveraging machine learning and real-time data analytics, this option allowed for more sophisticated insights, such as predictive modelling and anticipatory analysis. However, it was technically complex and resource-intensive, making it less suitable for early implementation.
- **Option 4: Fully adaptive global framework with crisis focus** – This option offered the most comprehensive and adaptable framework, combining multiple data sources (geospatial, economic, social, and infrastructure) with machine learning and real-time analytics. It was designed to scale globally, provide predictive insights, and support decision-making.

To address the technical complexities and resource requirements of Option 4, the team decided to begin with a POC. This POC will focus on a smaller geographic scale, such as South Sudan and Papua New Guinea, retaining the core features of Option 4, allowing for focused testing, validation, and feedback from stakeholders. It will ensure the III's effectiveness before scaling up to global implementation.

1.3 A targeted approach to delivering the International Isolation Index

The POC version of the III will focus on a targeted geographical area to provide early insights and test the system's core capabilities. While the full III aims for global coverage, the POC's smaller scope ensures it is immediately useful while remaining feasible in the short term. This approach will allow for rapid deployment, testing, and gathering of feedback from stakeholders before expanding further.

The key characteristics of the POC:

- **Targeted geographic scope:** The POC will focus on regions where isolation is most acute, allowing for targeted interventions that can make a measurable difference even with reduced geographic coverage
- **Core features:** The POC will retain the key features of the full III – predictive modelling and multi-dimensional analysis. Data pipelines will be created to update datasets incrementally, which will be extended to handle real-time data feeds in future.
- **Data-driven decisions:** By combining geospatial data, infrastructure insights, and social determinants, the POC will provide actionable insights to humanitarian agencies, policymakers, and development organisations
- **Flexibility for scaling:** Designed with future expansion in mind, the POC will serve as a testbed for scaling up the III by refining methodologies, improving data integration, and enhancing predictive capabilities.

Through a user-friendly interface, the POC will allow stakeholders to visualise isolation levels and make more informed decisions about where and how to intervene. Its flexible architecture will also support further refinement and expansion over time, incorporating new data sources and expanding its geographic reach as more resources become available.

1.4 Next steps and path to implementation

The POC version of Option 4 represents an effective, scalable approach to delivering the III. It retains all core features of the full version, such as real-time data updates, predictive modelling, and integration across multiple domains, but operates on a smaller, more manageable scale. This approach ensures the tool is immediately useful while providing a solid foundation for future expansion.

Starting with the POC allows for the testing and validation of all system components, gathering valuable feedback, and making necessary adjustments before a global rollout. The phased expansion ensures that the system remains sustainable and ethical frameworks are adhered to as the system grows. As the POC evolves, it will enable the III to become a transformative tool for addressing isolation globally, improving aid delivery and influencing policy decisions for years to come.

Once the POC is in place, the next steps will focus on refining the tool, scaling it beyond a single country focus and incorporating broader stakeholder feedback. After the Ingenuity Festival, the POC will be further tested, iterated, and adjusted based on gathered insight, and a scalable plan for future implementation will be developed. The Mansion House event in June will provide a platform for presenting a fundable solution that can expand the III to more regions, paving the way for a global rollout.

Key next steps are:

1. **Refine the scope and concept for the POC:** Validate and refine the III concept with enablers and adopters, incorporating feedback from the Ingenuity Festival's participants to further iterate the concept for the POC
2. **Create a Community of Interest committed to developing the III:** Form partnerships with governments, non-governmental organisations (NGOs), and tech companies, and expand data sharing agreements
3. **Secure funds to develop the POC:** Identify potential funding sources via government grants, international organisation partnerships, private foundations, and/or corporate

sponsorships. Develop a compelling proposal, leverage networks and partnerships, demonstrate sustainability, and engage in fundraising activities.

4. **Develop and test the POC:** Develop the POC based on the updated scope and concept, and conduct thorough testing of the POC with target audience segment to gather feedback and refine requirements/solution architecture
5. **Refine and develop the MVP:**
    a. **Prioritisation:** Determine the key features that need to be included and prioritise builds for functionality and maximum value to users
    b. **Scalability:** Design the system for future expansion, allowing for the integration of more advanced features like real-time tracking and predictive modelling at a global scale
    c. **Sustainability planning:** Ensure that the system is sustainable in the long term by considering ethical, technical, and financial factors.

The successful implementation of the POC will enable MAF and its partners to start measuring and addressing rural isolation with precision, creating the foundation for global efforts to reduce isolation and improve access to critical services worldwide.

2 Case for change

This section outlines the need for the III and highlights the challenges in measuring rural isolation and the limitations of current tools. It begins with a problem statement on the difficulties humanitarian organisations face in assessing isolation. The rationale for change explores key gaps and how the III can address them. The benefits of a data-driven approach are then examined, followed by critical success factors (CSFs), risks, and dependencies to ensure effective implementation.

2.1 Problem statement

Despite ongoing efforts by MAF and other humanitarian organisations, measuring and understanding rural isolation remains a major challenge. Current methods rely on anecdotal evidence, limited surveys, and subjective local knowledge; approaches that, whilst valuable in providing a lens into isolation and the lived experiences of those inhabiting such spaces, lack precision, scalability, and the ability to capture isolation's complex, multi-dimensional nature.

Without accurate, updated data that evidences multiple forms of isolation at a detailed level in a user-friendly format, MAF and partners will continue to struggle to identify where isolation is most severe, leading to inefficiencies in resource allocation and decision-making. These gaps hinder collaboration with partners by limiting the ability to assess long-term impact and make it harder to demonstrate accountability to donors who expect evidence-based reporting. By increasing efficiency and maximising the impact of interventions, the III could fill existing data gaps by providing an accurate, scalable, and dynamic tool that enables MAF and the broader humanitarian and development community to make data-driven decisions, optimise interventions, and improve outcomes for isolated communities. In this context, 'accurate' means offering precise, reliable data that reflects the true nature of rural isolation; 'scalable' refers to applicability across various geographic areas and populations; and 'dynamic' indicates the ability to capture changes in isolation over time.

2.1.1 The complexity in defining isolation

Understanding isolation is complex due to its varied definitions and implications across different contexts. Geographic isolation arises from physical remoteness, making access to essential services (such as healthcare), trade, and communication difficult. Isolation can manifest in the form of inadequate access to healthcare, where people in remote or marginalised areas struggle to receive medical attention, leading to preventable diseases and higher mortality rates. A lack of access to essential resources, including clean water, sanitation, and electricity, further exacerbates disparities, limiting the ability of communities to improve their living conditions. Food and sustenance insecurity also play a crucial role in isolation, as communities disconnected from supply chains, markets, or aid systems face chronic hunger and malnutrition. Economic isolation is experienced when individuals or regions are disconnected from financial opportunities, markets, or employment, often reinforcing cycles of poverty. Political isolation occurs when communities or nations are excluded from decision-making processes, governance structures, or international cooperation, leading to marginalisation and vulnerability. Social isolation, on the other hand, is rooted in a lack of meaningful relationships or participation in society, which can further enforce marginalisation.

Additionally, 'voluntary isolation' presents a unique dimension of isolation, as there are some communities that deliberately choose to remain disconnected from mainstream society. This is particularly evident among Indigenous groups (such as the uncontacted tribes of the Amazon and the Sentinelese of the Andaman Islands, among others). Their isolation is often rooted in a desire to preserve cultural traditions, avoid exploitation, or protect themselves from external threats such as disease and land encroachment. When considering isolation, their autonomy must be respected to avoid the unintended negative consequences of forced intervention or integration.

Recognising these different forms of isolation is not only key on ethical and moral grounds to ensure that any delivery of aid is not only welcome (and thus avoid infringing on a community's autonomy) but also key in ensuring that aid efforts are targeted and delivered effectively. Applying a broad, generalised definition of isolation could result in aid being 'imposed' on those communities that are not open to external intervention and aid being diverted from those who are in need but lack the means to advocate for assistance.

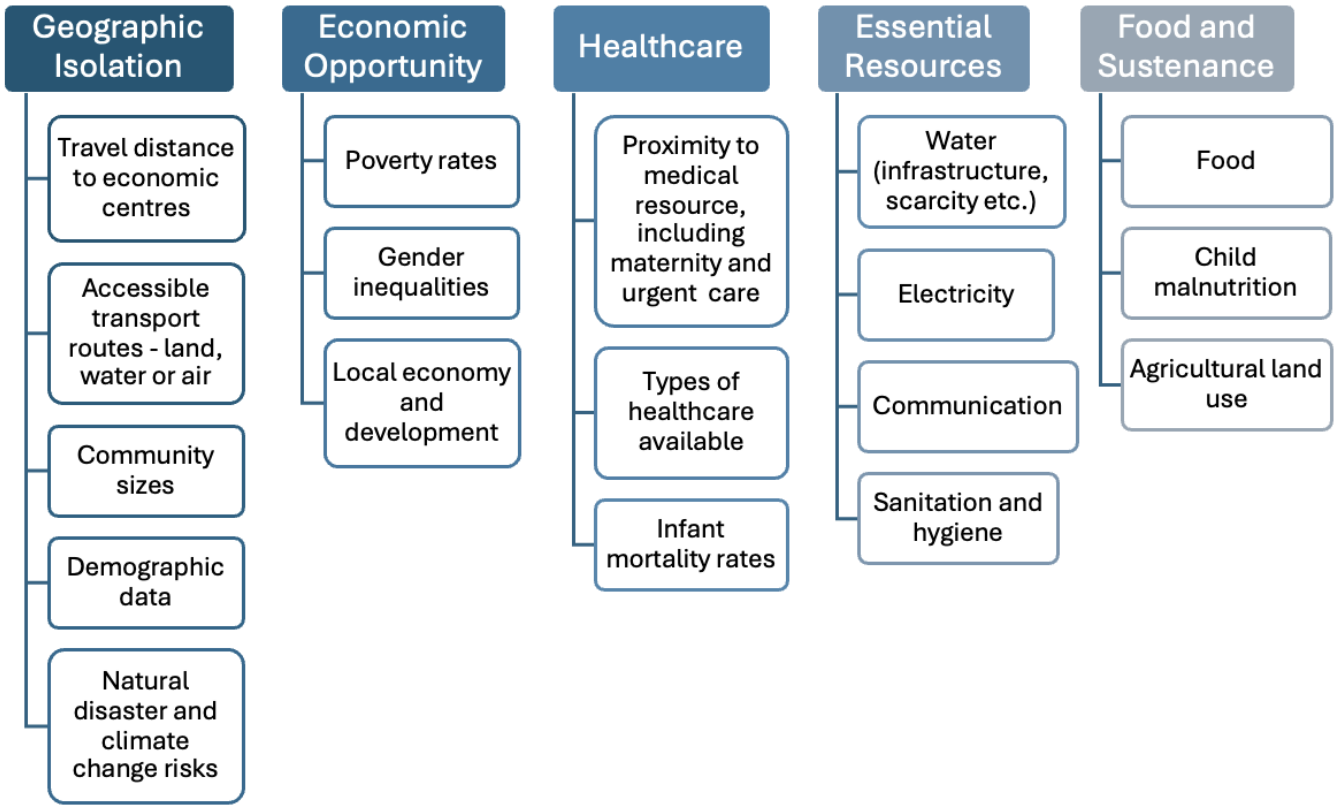
2.2 Defining an International Isolation Index

Defining isolation according to a singular dimension alone means that the underlying causes of isolation have not been considered, and whilst allowing for immediate temporary relief, it does not consider the various other areas in which a community might need support in order to yield long-term, more sustainable benefits (such as reduced exclusion, sustainable and inclusive growth, and community empowerment). In contrast, however, being too broad in defining isolation can result in diluted or ineffective interventions, potentially using resources (time, money, and personnel) ineffectively to deliver relief that is not sustainable, empowering, and meaningful.

The III will be designed to consider the complexity of isolation and is defined across **core dimensions linked to agency and access**. It will consider whether any given community is first and foremost **open to foreign intervention to maintain agency**, and thereafter be **assessed across five dimensions of access** (see chart below):

1. **Geographic access:** ability to access – or reach – a community safely and in a timely manner, or for people in remote areas to reach urban or semi-urban spaces to access better services, employment opportunities, markets, etc. This includes a consideration of the infrastructural (roads) and transportation connectivity available.
2. **Access to economic opportunity:** ability to access and participate in economic activities that benefit living standards, including financial services, trade, employment, etc.
3. **Access to healthcare and medical attention:** access to necessary healthcare and medical services without inflicting financial hardship, including clinics, medications, hospitals, doctors/midwives, and any preventative care
4. **Access to essential resources:** access to basic resources such as safe and clean water, sanitation, energy/electricity, etc. for survival and well-being
5. **Access to food and sustenance:** physical and economic access to sufficient safe and nutritious food that meets dietary requirements and cultural preference; potential access to future agricultural opportunities.

Chart 1: Core dimensions for isolation considered for III



2.3 Rationale for introducing the International Isolation Index

The development of the III is driven by the need for a more accurate and comprehensive measure of rural isolation, particularly for humanitarian organisations, including MAF. For a more detailed examination of current indices, see section 4 of this document. The following factors highlight gaps in existing methods and the importance of the III:

- **Existing indices fail to capture the multi-dimensional nature of isolation, leading to potentially inefficient aid delivery.** Isolation is shaped by geography, infrastructure, politics, socioeconomic factors, and access to services and care. However, most indices focus on a single aspect (e.g. geographic remoteness or income inequality) and/or exclude critical factors (e.g. digital connectivity, social exclusion, climate vulnerability, healthcare accessibility, and transportation networks). Different organisations assess isolation using varied frameworks, making coordination difficult. The III could potentially integrate satellite imagery, socio-economic data, infrastructure details, health system capacity, environmental risks, and conflict data to provide a new, comprehensive measure of isolation. By establishing a unified, standardised platform, the III could enhance collaboration, reduce duplication of efforts, and direct resources where they are needed most.
- **Few indices leverage recent technological advances to improve precision and rely instead on outdated methodologies that fail to capture the full picture of rural isolation.** Advances in satellite technology and data analytics now allow for more accurate measurements. The III could harness these innovations to capture granular, location-specific data on infrastructure, mobility patterns, and socioeconomic conditions.
- **Humanitarian decision-making requires stronger, data-driven evidence.** Many organisations rely on anecdotal evidence, outdated data, or local knowledge, leading to inefficient resource allocation. The III could provide objective and scalable data, enabling MAF and partners to prioritise the most vulnerable communities and optimise interventions. While organisations have invested years in developing valuable local expertise, there is an opportunity to augment these practices with more comprehensive and timely data. By combining new data collection techniques with established field knowledge and fostering inter-agency collaboration, humanitarian actors can develop a more nuanced understanding of crisis situations. This data-driven integration will enable MAF to prioritise the most vulnerable communities and optimise interventions.
- **Traditional isolation measures are reactive rather than proactive.** The III could enable real-time tracking of isolation levels, allowing MAF to anticipate and respond proactively to emerging access-limiting developments/challenges such as seasonal flooding and migration based on conflict. This could ensure a faster, more effective response to evolving needs in remote areas.

2.4 Benefits and impact

The creation of the III will transform the way MAF supports isolated communities. It will result in significant operational benefits for the aid community, as well as real social and economic benefits for end-line beneficiaries:

- **Targeted resource allocation reduces waste and maximises impact.** With data-driven insights, MAF and partners could prioritise the most isolated communities, ensuring that resources (e.g. flights, medical supplies, or infrastructure support) are directed where they will have the greatest impact. More efficient planning and intervention strategies could lead to a greater return on investment, ensuring that each dollar spent contributes to measurable reductions in isolation and improved community outcomes.

- **Reliable data strengthens evidence-based decision-making.** The III could provide MAF and partners with consistent data, replacing anecdotal evidence and outdated reporting methodologies. This would enhance transparency, improve planning accuracy, and support better-informed decision-making, allowing MAF to track progress, refine strategies, and demonstrate impact to donors and stakeholders.

- **A standardised isolation measurement enhances collaboration while also serving as a valuable asset to MAF's reputation.** A unified tool for assessing isolation could establish MAF as a leader in data-driven humanitarian efforts, strengthening credibility with donors, governments, and partner organisations.

- **Proactive monitoring enables faster crisis response.** By continuously tracking isolation levels, the III could help MAF anticipate and respond to emerging challenges (e.g. road closures, seasonal flooding, or infrastructure failures). This proactive approach could reduce long-term costs, improve response times, and increase the resilience of remote communities.

- **Long-term data insights support sustainable development.** Over time, the III could enable MAF to track trends in isolation, assess the long-term impact of interventions, and adapt its strategies accordingly. By providing a scalable tool, the III could ensure that isolation-reducing efforts remain relevant and sustainable in the long term.

3 Critical success factors

To ensure the successful development and implementation of the III, a set of critical success actors (CSFs) were identified. The table outlines the optimal features and outcomes to be delivered by the Index. It identifies key areas such as methodology, data quality, scalability, ethics, and usability, detailing the considerations, thresholds, and sources of evidence required to ensure the index meets stakeholder needs and maintains credibility.

Critical success factor	Description	Key considerations	Pass/Fail threshold	Sources of evidence
Clear and defensible methodology	Develop a robust, transparent methodology for defining and measuring isolation.	Should be evidence-based, replicable and aligned with global best practices (e.g. HDI, SDGs).	Methodology must be peer-reviewed and validated by at least two independent experts.	Peer-reviewed academic publications, expert validation.
Data coverage	Use high-quality data sources (e.g. satellite, geospatial, socioeconomic) to measure isolation accurately and precisely.	Data must be available at a granular level for different contexts (urban, rural, remote).	Must cover at least 80% of targeted geographical areas.	Data availability reports, GIS analysis, satellite data assessments.
Increased efficiency of aid delivery	Provides a data-driven foundation for MAF and partners to allocate resources effectively.	Must enable more precise targeting of aid efforts.	Evidence of improved aid distribution efficiency in pilot regions.	Post-implementation impact assessments, operational reports.
Improved insight for evidence-based decision-making	Supports strategic planning by MAF, humanitarian organisations, and policymakers.	Data must be actionable and provide insights relevant to diverse stakeholders.	Evidence of III influencing funding, policy, or operational strategies.	Stakeholder feedback, case studies of data use.
Accessibility and usability for MAF and partners	Ensures that the tool is practical for operational and strategic decision-making.	Interface must be user-friendly, with clear visualisations and reports.	Minimum 80% usability satisfaction in stakeholder testing.	User testing reports, stakeholder surveys.
Long-term sustainability and scalability	The III must remain relevant and adaptable as needs and technologies evolve.	Designed for scalability across different countries and regions.	Scalable model successfully tested in at least three diverse pilot regions.	Pilot study reports, expert validation.
Ethical and responsible data use	Ensure compliance with GDPR, data sovereignty laws, and ethical data handling.	Must consider biases in AI and geospatial data.	Fully compliant with GDPR and at least one other major data protection framework.	Expert validation.
Recognition as a trusted global benchmark	Establishes the III as a widely accepted tool for measuring isolation.	Endorsed by leading humanitarian and policy organisations.	Recognition from at least three reputable global institutions.	Letters of endorsement, independent validation reports, usage by other NGOs / broader International Development (ID) sector partners.

3.1 Risks

The development and implementation of the III involves several risks, ranging from technical challenges to stakeholder engagement. Below are key risk categories (design, development, implementation, sustainability, adoption, termination) and their corresponding mitigation strategies to ensure the project's success.

Risk category	Risk	Risk description	Mitigation(s)
Design	**Insufficient data availability**	Insufficient availability of high-quality, consistent data sources across all regions, leading to incomplete or skewed measurements. Issues with merging disparate, varying granularity, data sources into a single index.	Establish partnerships with multiple data providers (e.g. European Space Agency (ESA) UN, national statistics offices) to enhance coverage and diversity. Validate data completeness and use cross-referencing techniques (e.g. satellite imagery, ground-truth data) to reduce bias.
	Framework applicability challenges	Difficulty in creating a universally applicable framework due to variations in geographical, social, and economic conditions, and lack of agreement on weighting methodologies.	Develop a flexible, modular framework that allows for regional adaptations while maintaining core consistency. Conduct expert consultations and sensitivity analyses to establish a robust, defensible weighting approach.
Development	**Lack of technical expertise**	Limited technical expertise in geospatial data analysis and AI-driven insights within the team.	Engage external experts in AI, data science, and geospatial analysis as advisory partners.
	Regulatory and ethical barriers	Regulatory or ethical barriers to data access, particularly regarding sensitive datasets.	Ensure compliance with national regulations and ethical best practices in data handling, e.g. UN's Big Data for Sustainable Development.
Implementation	**Stakeholder engagement challenges**	Insufficient engagement with key stakeholders (e.g. humanitarian agencies, funders, academic institutions) may lead to credibility issues and slow adoption.	Implement a structured stakeholder engagement plan that ensures diverse input while maintaining a clear management and decision-making structure. Define roles, scope, and authority upfront to balance inclusivity with efficiency and avoid unnecessary complexity.
	Cost and scaling issues	Cost and resource overruns due to unforeseen technical complexities and challenges in scaling beyond initial partner arrangements.	Adopt an agile development approach with staged releases and continuous evaluation of resource allocation. Prioritise prototyping and user testing before full-scale development to validate assumptions and ensure the index meets user needs, minimising wasted effort on unnecessary or misaligned features.
Sustainability	**Funding constraints**	Constrained development and humanitarian aid funding environment.	Diversify funding sources, including private sector partnerships and philanthropic grants.
	Lack of long-term funding	Lack of long-term funding for index updates and maintenance.	Secure multi-year funding commitments from donors, development agencies, and research institutions.

Adoption	**Political resistance**	Resistance from governments or organisations that may perceive the index as politically sensitive.	Engage with policymakers early to co-develop metrics that reflect balanced perspectives.
	Environmental concerns	Growing environmental concerns affecting donor support and local buy-in.	Conduct environmental impact assessments and ensure transparency in addressing potential risks.
Termination	**Project discontinuation**	Project is discontinued due to lack of demonstrable impact or competing priorities.	Define clear impact metrics and a phased roadmap to demonstrate progress and relevance.

3.2 Constraints

Constraints are external conditions and agreed parameters that shape the scope of the III, over which the project team has little or no control.

Category	Constraint	Description
Design	**Data availability**	The III must rely on existing datasets from reputable sources (e.g. ESA, UN, World Bank) and cannot collect primary data independently. Lack of granular data, that is able to describe local regions, may impede the development of an efficacious index for the use cases as described in this paper.
	Methodological transparency	The index must follow a transparent methodology that can be reviewed and replicated by external stakeholders.
	Ethical considerations	The III must adhere to global data protection standards, avoiding the misuse or misinterpretation of sensitive information.
	Global applicability	The index must be relevant across different geographical, socioeconomic, and political contexts.
Development	**Computational feasibility**	The modelling, data analysis, and technology selected (software) should be computationally efficient enough to generate updates at an appropriate frequency (e.g. annually or semi-annually).
Implementation	**Funding limitations**	Development must occur within the available financial envelope, with staged releases to align with funding cycles.

3.3 Dependencies

Dependencies include external factors that influence the project but are outside direct control, requiring close monitoring and management.

Category	Dependency	Description
Design	**Regulatory and data compliance**	The project must comply with data protection regulations and data licensing terms of use, and obtain permissions where required to access restricted datasets.
Development	**Technical and computational infrastructure**	The III must be developed to integrate with existing platforms and software used by policymakers and researchers, requiring API development and interoperability. It will also rely on high-performance computing and cloud-based analytics for processing large-scale geospatial and socioeconomic data.
Implementation	**Data partnerships and stakeholder endorsement**	The index depends on continued access to external datasets from space agencies (ESA, Starlink), global development organisations (UN, World Bank), and national data providers. Redundancy can be developed by having multiple sources of data to cover each dimension. Success also requires endorsement from key institutions (e.g. UN, academic institutions, humanitarian agencies) to ensure credibility and adoption.
Sustainability	**Funding and hosting commitments**	Ongoing financial support from funders such as ESA, high-net-worth (HNW) donors, and international organisations is necessary for sustainability. Additionally, a host organisation with technical capacity is needed to maintain and develop the III, ensuring infrastructure scalability and long-term support.
Adoption	**Policy and institutional integration**	The III's success depends on alignment with global and national policy frameworks, such as the Sustainable Development Goals and humanitarian planning processes, ensuring it becomes a standard tool for decision-makers.

4 Existing indices measuring global isolation: a review of current approaches

The concept of isolation spans multiple dimensions, including geographical remoteness, digital exclusion, economic marginalisation, and social disconnection. Various indices have been developed to measure aspects of isolation; however, these tend to focus on individual dimensions rather than providing a holistic, multidimensional framework. This review examines key existing indices relevant to the development of an III, evaluating their methodologies, strengths, and limitations while identifying areas where an integrated index could provide additional insight.

4.1 Socioeconomic and human development indices

Socioeconomic and human development indices provide valuable insight into the overall well-being of populations, offering a broad view of various factors that contribute to development and quality of life. However, while these indices assess critical aspects such as health, education, and living standards, they tend to overlook the nuances of geographical isolation, remoteness, and infrastructural limitations.

Human Development Index (United Nations Development Programme, 2022): The HDI is one of the most widely recognised measures of national development. It combines three key indicators:

- Life expectancy (a proxy for overall health)
- Education levels (mean and expected years of schooling)
- Gross National Income (GNI) per capita (adjusted for purchasing power parity).

While the HDI provides a broad picture of human well-being, it does not capture subnational disparities or specific measures of isolation, particularly in rural or marginalised communities. Moreover, it does not account for spatial accessibility to essential services or connectivity constraints, both of which are crucial for understanding isolation.

Multidimensional Poverty Index (Alkire & Foster, 2011): The MPI expands on the HDI by assessing deprivation across three key dimensions: health, education, and living standards. The MPI is particularly useful in identifying populations experiencing multiple, overlapping disadvantages, including lack of access to clean water, sanitation, and electricity. However, it remains primarily socioeconomic in focus, failing to capture geospatial or infrastructural isolation that may prevent people from accessing services even when they exist.

Social Progress Index (Porter et al., 2017): Provides a broader measure of well-being, incorporating indicators related to basic human needs, foundations of well-being, and opportunity. It includes personal safety, access to information, and inclusiveness, elements that are critical for understanding social isolation. However, the SPI does not explicitly measure remoteness or physical accessibility to key resources, making it an incomplete tool for measuring isolation in rural or geographically marginalised areas.

Canadian Index of Multiple Deprivation (Canadian Government): This index identifies areas of deprivation in Canada across multiple dimensions, including economic, social, and health indicators, helping to target support for marginalised populations. While it addresses some aspects of deprivation, the CIMD does not provide direct measures of physical or digital isolation.

European Deprivation Index (European Union): Similar to the CIMD, the EDI measures deprivation at the national level across a variety of socioeconomic indicators. It offers insight into poverty and marginalisation but does not comprehensively address geographic or digital isolation.

Gini Coefficient (World Bank, 2021): Used by the World Bank, measures income inequality within a country. While high inequality can correlate with economic exclusion, this measure alone does not capture access to services or infrastructure, which are key determinants of isolation.

4.2 Geographic and transport accessibility indices

Geographic and transport accessibility indices are crucial tools for evaluating the physical accessibility of populations, especially in rural and remote areas. These indices focus on the proximity of individuals to essential services and infrastructure, such as roads, cities, and transport networks. While they provide valuable insights into the logistical challenges faced by marginalised communities, they often fall short in addressing the full scope of accessibility, which includes factors like digital connectivity, economic access, and real-time infrastructure changes.

Rural Access Index (Roberts et al., 2006): The RAI, developed by the World Bank, measures the proportion of rural populations living within two kilometres of an all-season road. This provides a direct measure of transport-based isolation, which is particularly relevant in developing countries where road infrastructure plays a critical role in access to healthcare, education, and markets. However, the RAI is limited by its focus on road proximity alone, neglecting other forms of accessibility such as public transport availability, digital connectivity, or economic barriers.

Global Accessibility Map (Nelson, 2008): Assesses physical remoteness by calculating travel time to the nearest city with a population of at least 50,000. Using GIS and satellite data, this index provides a global-scale analysis of accessibility. However, it remains static and does not account for real-time changes due to infrastructure development, conflict, or climate-related disruptions.

Accessibility/Remoteness Index of Australia (Australian Centre for Housing Research, 2023): The ARIA+ is an index that measures the accessibility of services in Australia, with a particular focus on the remoteness of areas. It takes into account the road distance to the nearest urban centre, specifically considering the time it takes to reach essential services, such as healthcare and education. The index has been refined to include multiple components related to accessibility, such as the road network, healthcare accessibility, and the remoteness of locations based on road distance.

Access to Essential Services Index (United Nations, 2015): This index measures access to essential services such as healthcare, education, sanitation, and clean water, which are fundamental for human well-being. It is often used to highlight areas where populations experience physical isolation from services. By assessing service delivery and geographic remoteness, the index provides insights into how infrastructure and connectivity gaps contribute to social exclusion. However, it does not fully capture digital or economic barriers to accessing services.

Global Human Settlement Layer (European Commission, 2020): The GHSL is a global dataset that maps human settlements worldwide. It is based on satellite data and includes information on population density, urbanisation patterns, and the distribution of built-up areas. This layer helps in assessing the degree of urbanisation and population concentration, which can be critical for understanding social isolation in both urban and rural areas. While the GHSL is useful for mapping settlement patterns, it does not account for access to services or digital inclusion, which are key drivers of isolation.

Rural-Urban Continuum Codes (US Department of Agriculture, 2017): The RUCC is a system developed by the USDA that classifies US counties based on the degree of urbanisation. It categorises counties into metropolitan and non-metropolitan areas, with additional sub-categories based on population size and proximity to urban centres. The RUCC is useful for understanding rural isolation in the US, as it highlights areas that are more likely to experience geographic and socioeconomic barriers to access.

Modified Monash Model (Australian Department for Health, 2020): The MMM is used in Australia to classify rural and remote areas based on access to healthcare services. The model considers factors such as the availability of healthcare professionals, transportation infrastructure, and population density to identify areas that require additional healthcare resources. While this model is essential for identifying healthcare needs in isolated areas, it does not incorporate other aspects of isolation, such as digital exclusion or access to education.

Index of Relative Rurality (Waldorf et al, 2018): The IRR ranks US counties based on their relative isolation compared to urban centres. It is particularly useful for assessing rural isolation, focusing on factors like geographic remoteness and access to essential services. This index has been employed in health research to target resources to isolated rural populations. However, its focus on geographic isolation may not fully address economic, social, or digital isolation.

4.3 Digital connectivity and inclusion indices

Digital connectivity and inclusion indices are instrumental in assessing the accessibility and effectiveness of information and communication technologies (ICT) on a global scale. These indices evaluate the extent to which digital infrastructure supports economic, social, and educational development, with a focus on internet penetration and affordability. However, while these tools offer valuable insights into the digital divide, they often overlook deeper barriers to connectivity, such as regional disparities, digital literacy challenges, and sociocultural factors.

Network Readiness Index (Portulans Institute, 2024): Assesses how well countries leverage digital technology for economic and social development. While useful for macro-level insights, the NRI lacks granular subnational data, making it less effective in identifying isolated populations within countries.

International Digital Connectivity Readiness Index (Farrpoint, 2024): This newer index evaluates countries' digital readiness by examining infrastructure quality, digital adoption, and policy frameworks. The DCRI highlights digital connectivity gaps and offers insights on how nations can strengthen their digital inclusion efforts to reduce social isolation.

Global Connectivity Index (Huawei, 2024): The GCI measures digital infrastructure, mobile connectivity, and internet accessibility globally, with a focus on reducing isolation through digital inclusion. This is particularly important in rural and underserved areas, where lack of connectivity is a significant barrier to economic and social participation. The index is increasingly used to gauge the impact of digital infrastructure on reducing social exclusion in both developed and developing countries.

4.4 Limitations and gaps in existing indices

Despite the considerable value of the indices discussed above, each has notable limitations that hinder their ability to fully capture the complexities of isolation. These limitations are outlined as follows:

- **Many existing indices focus on isolated dimensions of isolation, such as geography, digital access, or income, rather than providing a holistic, integrated approach.** For instance, while the RAI focuses on the accessibility of transport infrastructure, it does not account for other significant barriers such as digital connectivity, social isolation, or economic vulnerability.[1] Similarly, the HDI combines indicators related to health, education, and income, but it does not capture spatial isolation, which can be equally important in rural and marginalised areas (UNDP, 2022). A more comprehensive framework that integrates these dimensions would allow for a fuller understanding of isolation and its interrelated social, economic and geographical factors.
- **Many indices provide static snapshots that are insufficient for capturing rapid changes in accessibility, such as those arising from infrastructure development, economic shifts or disaster-related disruptions.** For example, the Global Accessibility Map (Nelson, 2008) relies on static data, which may not reflect real-time developments in road infrastructure or the impacts of crises such as natural disasters or conflict. Advances in technologies such as satellite imagery, artificial intelligence, and geospatial data could enable more dynamic, real-time monitoring of accessibility, making these indices more responsive and adaptable to current conditions. A more flexible index could provide real-time insights, enabling more timely policy interventions.
- **While many indices highlight important issues related to isolation, they often fail to provide actionable solutions tailored to specific regions or demographics.** The MPI, for example, is effective in identifying areas of deprivation but does not offer guidance on how to address these issues in specific geographical contexts.[2] This is particularly important for policymakers who need region-specific data to design targeted interventions. As highlighted by the OECD (2019), indices should be coupled with contextualised policy recommendations that

[1] P. Roberts et al, Rural Access Index: A Key Development Indicator. The World Bank Group (2006). Available at: https://documents1.worldbank.org/curated/en/721501468330324068/pdf/Rural-access-index-a-key-develpment-indicator.pdf

[2] S. Alkire & J Foster. Counting and multidimensional poverty measurement, *Journal of Public Economics*, 95(7-8), pp.476-487 (2011). Available at: https://www.sciencedirect.com/science/article/abs/pii/S0047272710001660

can guide effective interventions based on local needs, ensuring that resources are allocated efficiently to areas with the greatest need.

- **Many existing indices operate primarily at the national level, which can obscure significant subnational disparities that contribute to isolation.** For example, the HDI provides a national average that does not reflect disparities within regions or communities, particularly in countries with significant rural-urban divides (UNDP, 2022). The RAI, which measures the proportion of rural populations with access to all-season roads, also aggregates data at the national level, potentially overlooking remote or isolated communities that fall just outside the threshold of accessibility (Roberts et al., 2006). A more effective III should provide granular, regional data that highlights specific communities or populations experiencing higher levels of isolation. Such an index could incorporate factors such as local economic conditions, digital connectivity, and transport infrastructure, offering a more nuanced picture of isolation at a localised level.

5 Stakeholder ecosystem

5.1 Key stakeholder groups

The III requires engagement with various stakeholders across sectors and levels of society to ensure its success and broad adoption. Below is an overview of the key stakeholder groups and their role in the ecosystem.

5.1.1 Governments and public sector

Governments and public sector organisations at the national, regional, and local levels are crucial stakeholders in the III ecosystem. They can use the index to guide policy decisions, allocate resources efficiently, and assess the isolation of different communities. They also play a role in funding, regulatory oversight, and ensuring the integration of the III into national development strategies.

Key roles	Example stakeholders
• Use III for evidence-based policy-making • Coordinate and collaborate with international organisations and NGOs • Integrate III into national poverty reduction or emergency response strategies • Fund and endorse the index for national and regional projects • Facilitate data sharing and access to relevant government datasets	• National governments (ministries of health, education, infrastructure) • Local authorities (municipalities, city councils) • Regulatory bodies and public service agencies

5.1.2 International organisations and NGOs

International organisations and non-governmental organisations are pivotal in using the III to inform humanitarian response, aid allocation, and development planning. They provide expertise, resources, and support in areas of crisis response, poverty reduction, and sustainable development. The III can be used to improve targeting of aid and ensure that regions facing the greatest isolation are prioritised for intervention.

Key roles	Example stakeholders
• Implement the III in crisis response and disaster relief efforts • Advocate for the inclusion of isolated regions in global development agendas • Support the development and validation of the III • Collaborate with governments and private sector to expand coverage and impact • Provide field-level data, expertise and monitoring capabilities	• United Nations (UN) agencies (UNICEF, UNDP, WHO, World Bank, Food and Agriculture Organisation) • International Red Cross, Médecins Sans Frontières (MSF) • NGOs (Save the Children, Oxfam, CARE)

5.1.3 Private sector and industry

The private sector plays a vital role in developing the technological infrastructure, data analytics capabilities, and financial support for the III. Companies in tech, telecommunications, and data analytics can contribute their expertise in managing complex datasets, creating platforms for data sharing, and developing machine learning and AI models for continuous data refinement. The private sector also plays a key part in expanding the III's reach and capabilities.

Key roles	Example stakeholders
• Provide technological solutions for data collection, processing, and analysis	• Tech companies (Google, Microsoft, Amazon Web Services)

• Support platform development and scaling, including cloud hosting and cybersecurity • Develop partnerships with international organisations, NGOs, and governments to improve data collection and impact • Facilitate access to real-time data through satellite imaging, GIS, and mobile networks • Collaborate in building sustainable funding models, potentially through public-private partnerships	• Telecommunications companies (Vodafone, MTN, T-Mobile) • Data and satellite service providers (Planet Labs, Orbital Insight) • Corporations in sustainable development and infrastructure

5.1.4 Academia

Academia and research institutions are crucial in advancing the methodology and technical development of the III. They play a critical role in refining the index, validating data, conducting impact assessments, and advancing the scientific and academic understanding of isolation. Universities and research think tanks can also collaborate with governments and NGOs to improve data collection standards, ensure ethical data practices, and expand the III's application across diverse fields.

Key roles	Example stakeholders
• Conduct research to enhance the III's methodology, accuracy, and relevance • Validate data models, ensuring reliability and trustworthiness of the index • Provide evidence-based insights on the impact of isolation on different communities and sectors • Train professionals and provide thought leadership on issues of isolation and crisis management • Publish academic articles and reports to raise awareness of the III's value in development and humanitarian sectors	• Universities (e.g. University of Oxford, MIT, Stanford) • Research institutions (e.g. International Institute for Environment and Development, Global Development Institute) • Policy think tanks and academic networks • Data science and geospatial research hubs

6 Options for delivering the International Isolation Index

The table below outlines four potential approaches for delivering the III, each with varying degrees of complexity, scope and data integration. These generally range from 'do minimum' features to 'do maximum', from left to right. These are designed to cater to different needs, from simple geographic isolation measures to a fully adaptive global framework that evolves with emerging data and crises. Each column details what the III measures, its level of specificity, update frequency, accessibility, and data sources, as well as the required capabilities for successful implementation. Additionally, the table provides insights into the funding models and hosting arrangements, helping stakeholders evaluate the best fit for their needs and resources.

Design parameters				
Type	Single-dimension index (basic geographic isolation)	Multidimensional framework (geospatial, digital, economic)	Comprehensive integration (geospatial, digital, economic, social, infrastructure)	Fully adaptive global framework (evolving with data & crises)
Measurement	Basic binary metrics with equal weighting (e.g. access vs no access to key services)	Expanded metrics using graded impact scales, and weighted factors to reflect varying levels of isolation	Dynamic weighting using machine learning, incorporating regional variations, and continuous calibration	Adaptive index with real-time recalibration, trend analysis, and predictive modelling for anticipatory action
Precision	National-level boundaries	Global coverage	Subnational/regional granular detail	Global, with dynamic regional adjustments
Frequency	Annually, using periodic surveys and government-released statistics	Quarterly updates using new national/international datasets	Semi-automated updates integrating satellite imagery, mobile data, and periodic validation	Automated real-time updates using AI-driven data validation, ensuring rapid crisis responsiveness
Users	Public	Public, operating partners	Public, operating partners, NGOs and governments	Public, operating partners, NGOs, governments, and communities
Source(s)	Existing public datasets (e.g. UN, World Bank, national statistics, census data)	Multisource integration (satellite imagery, mobility patterns, telecoms, social vulnerability indices)	AI-enhanced ingestion (climate trends, crisis response, infrastructure monitoring, socioeconomic dynamics, transport data)	Fully adaptive data pipeline (integrating Earth observation, crisis response networks, open-source intelligence, community reporting)
Skills / capabilities	UX, data pipelines (ETL), web hosting, storage	UX, data pipelines (ETL), web hosting, storage, statistics, cybersecurity	UX, data pipelines (ETL), web hosting, storage, statistics, cybersecurity, machine learning, generative AI	
Rollout	Phased expansion: Pilots in priority countries, expanding as capabilities scale	Big bang with fixed functionality: Full-scale launch across all target regions and sectors	Iterative scaling: Expanding features and new geographies over time	Fully dynamic: Learning-based expansion, adapting to user needs and emerging challenges
Funding model	Internally funded	Public grants and institutional funding (e.g. development agencies, governments, academia)	Public-private partnerships with multilateral support (World Bank, ESA, UN, philanthropy, tech companies)	Hybrid humanitarian funding (blended public-private support, donor-backed sustainability, operational flexibility)
Hosting organisation(s)	Academic institution(s) (research-led hosting, methodology refinement)	Government bodies (policy integration, national strategy alignment)	Intergovernmental bodies (UN, WHO, World Bank) (ensuring credibility, standardisation, and integration)	Charities, humanitarian organisations, or hybrid partnerships (ensuring sustainability and operational flexibility)

6.1 Option 1: Basic geographic isolation index

This option represents the simplest version of the III. It focuses on a basic national-level indicator of isolation, using existing public datasets such as national statistics and census data. The index would measure access vs no access to key services, using basic binary metrics and simple geographical boundaries (e.g. rural vs urban areas).

6.1.1 Example use case for Option 1: A rural health NGO addressing healthcare access in remote regions

A rural health NGO is working in remote rural areas where healthcare access is limited. The organisation needs a simple and effective tool to measure geographic isolation and access to basic health services. The goal is to identify regions where people are most isolated from healthcare facilities, to target aid efforts and to advocate for infrastructure investment. The NGO primarily focuses on rural areas that are underserved by national healthcare systems and aims to address healthcare access gaps.

How Option 1 supports this use case:

- **Single-dimension index:** Option 1 offers a basic geographic isolation index that measures access versus lack of access to essential health services. The index is simple to understand and can be used to highlight areas where healthcare access is severely limited. For example, the NGO can use the index to determine regions where populations are located far from the nearest clinic or hospital, providing a clear visual representation of isolation.
- **Basic binary metrics:** Option 1 focuses on basic binary metrics, like whether a community is located within a certain distance of a health facility or not. This makes it a practical tool for the NGO, as it doesn't require complex data processing or sophisticated technology. It allows the organisation to focus on immediate priorities, such as advocating for building clinics in remote areas, or mobilising mobile health teams to serve isolated populations.
- **National-level boundaries:** The index is designed to work at the national level, allowing the NGO to assess isolation across various countries or regions within a country. While this is a limitation in terms of granularity, it is appropriate for initial assessments and helps the NGO set broad targets, focusing on national or regional priorities.
- **Annual updates:** Given that Option 1 is updated annually through government-released statistics and surveys, the NGO can track changes in isolation over time. For example, if the government constructs new healthcare infrastructure, the index can reflect these changes, and the NGO can monitor whether isolation in specific regions has decreased as a result. Although the annual updates are somewhat slow, they still offer a baseline for evaluating progress year-on-year.
- **Access for public and partners:** Option 1 is publicly accessible, allowing the NGO to share the data with local communities, partner organisations, and government bodies. This open access builds collaboration and helps in advocacy efforts, as the NGO can present solid data when lobbying for healthcare access improvements in isolated areas.

Impact:

Option 1 provides the rural health NGO with a clear, simple tool for assessing healthcare access in isolated areas. The basic geographic isolation index allows the NGO to prioritise regions that are most in need of intervention and help allocate resources effectively. However, the system's basic nature means that it may not capture complex factors like health outcomes or socioeconomic challenges, which could be relevant for comprehensive health interventions. The lack of real-time updates or granular data (such as subnational details) also limits its ability to respond quickly to emerging needs or track short-term changes. Nonetheless, Option 1 offers an entry point for data-driven decision-making in rural health interventions, especially for smaller-scale operations or organisations with limited resources.

6.1.2 Design parameters

The following table outlines the design parameters for Option 1, comparing its key characteristics across different levels of functionality. These design parameters provide a framework for understanding the scope, capabilities, and intended impact of the index.

Design parameters				
Type	Single-dimension index (basic geographic isolation)	Multidimensional framework (geospatial, digital, economic)	Comprehensive integration (geospatial, digital, economic, social, infrastructure)	Fully adaptive global framework (evolving with data and crises)
Measurement	Basic binary metrics with equal weighting (e.g. access vs no access to key services)	Expanded metrics using graded impact scales and weighted factors to reflect varying levels of isolation	Dynamic weighting using machine learning, incorporating regional variations and continuous calibration	Adaptive index with real-time recalibration, trend analysis, and predictive modelling for anticipatory action
Precision	National-level boundaries	Global coverage	Subnational/regional granular detail	Global, with dynamic regional adjustments
Frequency	Annually, using periodic surveys and government-released statistics	Quarterly updates using new national/international datasets	Semi-automated updates integrating satellite imagery, mobile data, and periodic validation	Automated real-time updates using AI-driven data validation, ensuring rapid crisis responsiveness
Users	Public	Public, operating partners	Public, operating partners, NGOs, and governments	Public, operating partners, NGOs, governments, and communities
Source(s)	Existing public datasets (e.g. UN, World Bank, national statistics, census data)	Multisource integration (satellite imagery, mobility patterns, telecoms, social vulnerability indices)	AI-enhanced ingestion (climate trends, crisis response, infrastructure monitoring, socioeconomic dynamics, transport data)	Fully adaptive data pipeline (integrating Earth observation, crisis response networks, open-source intelligence, community reporting)
Skills / capabilities	UX, web hosting, storage	UX, web hosting, storage, statistics, cybersecurity	UX, web hosting, storage, statistics, cybersecurity, machine learning, generative AI	
Rollout	Phased expansion: Pilots in priority countries, expanding as capabilities scale	Big bang with fixed functionality: Full-scale launch across all target regions and sectors	Iterative scaling: Expanding features and new geographies over time	Fully dynamic: Learning-based expansion, adapting to user needs and emerging challenges
Funding model	Internally funded	Public grants and institutional funding (e.g. development agencies, governments, academia)	Public-private partnerships with multilateral support (World Bank, ESA, UN, philanthropy, tech companies)	Hybrid humanitarian funding (blended public-private support, donor-backed sustainability, operational flexibility)
Hosting organisation	Academic institution(s) (research-led hosting, methodology refinement)	Government bodies (policy integration, national strategy alignment)	Intergovernmental bodies (UN, WHO, World Bank) (ensuring credibility, standardisation, and integration)	Charities, humanitarian organisations or hybrid partnerships (ensuring sustainability and operational flexibility)

6.1.3 Alignment with critical success factors

The following table evaluates Option 1 against the critical success factors, providing insight into its alignment with key objectives for success.

Critical success factor	Evaluation
Clear and defensible methodology	Simple and straightforward methodology using binary geographic metrics (access vs no access). Defensible but lacks complexity and granularity.
Data coverage	Limited to national-level data, which reduces its comprehensiveness.
Increased efficiency of aid delivery	Limited in improving aid delivery efficiency due to basic nature of the data and lack of granularity to address specific regional needs.
Improved insight for evidence-based decision-making	Provides basic insights but is insufficient for making nuanced, evidence-based decisions on regional or sectoral isolation.
Accessibility and usability for MAF and partners	Highly accessible and easy to use, with basic national-level data that is straightforward to interpret and apply.
Long-term sustainability and scalability	Limited scalability and sustainability due to its simplicity and reliance on static national data that may not evolve over time.
Ethical and responsible data use	Data sourced from public datasets like UN and World Bank. Ethical concerns are minimal, but its scope limits overall data diversity.
Recognition as a trusted global benchmark	*May gain recognition in specific contexts but lacks the depth and sophistication required to become a global benchmark.*

6.1.4 Benefits and challenges

The following table outlines the benefits and challenges of Option 1, highlighting the key factors that contribute to its potential success as well as the limitations that could impact its effectiveness.

Benefits	Challenges
• Allows for fast deployment and minimal user training is required (including for public) due to its accessibility and simple user experience • The reliance on established datasets from credible (or at least official) sources would minimise ethical concerns • Could allow for broad applicability across contexts, regardless of data infrastructure • Most cost-effective choice due to lower implementation costs, simplicity in maintaining, and low maintenance requirements • Provides an early or foundational benchmark on which to build future, more detailed indices	• The simplicity of the index might lead to oversimplification of complex isolation issues, reducing its effectiveness in addressing specific needs • The binary metrics/single national-level view will not capture nuances of isolated communities, potentially leading to critical areas in need being overlooked • Static data reliant on surveys can easily become outdated and fail to reflect changing conditions • Lack of depth and granularity may limit how readily and widely the index would be accepted as a global standard or benchmark within the ID landscape • Due to the superficial and limited data, this would not support – or influence – effective policy making

6.2 Option 2: Expanded multidimensional framework

This option expands on the basic framework by introducing a multidimensional approach that also incorporates data on economic, digital, and social dimensions of isolation. It uses graded impact scales and weighted factors to reflect varying levels of isolation. The index is updated quarterly using national and international datasets (e.g. mobility patterns, telecom data, satellite imagery).

6.2.1 Example use case for Option 2: A government agency allocating infrastructure funding

A government agency in a developing country is responsible for allocating infrastructure funding to rural and isolated areas. The goal is to address geographic isolation, poverty, and service gaps by improving access to essential services such as healthcare, education, and transportation. The agency aims to target areas where poverty and isolation intersect, focusing on the most vulnerable regions to ensure more equitable development.

How Option 2 supports this use case:

- **Multidimensional framework:** Option 2 combines geospatial, economic, and digital data to assess isolation from multiple angles. This allows the agency to understand not just where isolation occurs, but also the economic consequences and service availability in these areas. This approach provides a deeper understanding of the root causes of isolation and supports more informed decision-making.
- **Expanded metrics:** Option 2 uses graded impact scales and weighted factors to reflect varying levels of isolation. For example, a region with limited access to healthcare and high poverty rates will be prioritised over regions with only minor isolation. This allows the agency to allocate funds where the impact of isolation is most significant and where infrastructure investment can make the most difference.
- **Quarterly updates:** The framework incorporates quarterly updates using both national and international datasets. This ensures that the agency has access to the most current data to guide funding decisions, allowing them to adjust priorities in response to changing conditions such as shifts in population or new infrastructure needs.
- **Global coverage:** The system offers global coverage, allowing the agency to compare its own challenges and progress against other countries or regions facing similar issues. This can help align national strategies with international best practices and development standards, ensuring that the funding allocation is based on a wider view of global isolation trends.
- **Access for public and partners:** The framework is accessible to public authorities, operating partners, and NGOs, enabling better coordination among various stakeholders. Local governments, healthcare providers, and development organisations can all access the data, ensuring that infrastructure projects are aligned with local needs and that funding decisions are transparent and collaborative.

Impact:

Option 2 allows the agency to prioritise infrastructure projects more effectively, focusing resources on regions that face both geographic isolation and economic vulnerability. The multidimensional approach helps identify the most pressing needs and allocate funding where it can have the greatest impact on reducing poverty and improving access to services.

While the system provides significant benefits in terms of efficiency and evidence-based decision-making, it does come with challenges. The integration of diverse datasets requires robust data management systems to ensure accuracy and reliability. Additionally, the agency may need to invest in training and capacity building to effectively use the tool. Despite these challenges, Option 2 is a strong approach to targeting infrastructure funding where it is needed most, ensuring better long-term sustainability of development efforts.

6.2.2 Design parameters

The following table outlines the design parameters for Option 2, comparing its key characteristics across different levels of functionality. These design parameters provide a framework for understanding the scope, capabilities, and intended impact of the index.

Design parameters					
Type	Single-dimension index (basic geographic isolation)	Multidimensional framework (geospatial, digital, economic)		Comprehensive integration (geospatial, digital, economic, social, infrastructure)	Fully adaptive global framework (evolving with data and crises)
Measurement	Basic binary metrics with equal weighting (e.g. access vs no access to key services)	Expanded metrics using graded impact scales and weighted factors to reflect varying levels of isolation	Dynamic weighting using machine learning, incorporating regional variations and continuous calibration	Adaptive index with real-time recalibration, trend analysis, and predictive modelling for anticipatory action	
Precision	National-level boundaries	Global coverage		Subnational/regional granular detail	Global, with dynamic regional adjustments
Frequency	Annually, using periodic surveys and government-released statistics	Quarterly updates using new national/international datasets		Semi-automated updates integrating satellite imagery, mobile data, and periodic validation	Automated real-time updates using AI-driven data validation, ensuring rapid crisis responsiveness
Users	Public	Public, operating partners		Public, operating partners, NGOs, and governments	Public, operating partners, NGOs, governments, and communities
Source(s)	Existing public datasets (e.g. UN, World Bank, national statistics, census data)	Multisource integration (satellite imagery, mobility patterns, telecoms, social vulnerability indices)		AI-enhanced ingestion (climate trends, crisis response, infrastructure monitoring, socioeconomic dynamics, transport data)	Fully adaptive data pipeline (integrating Earth observation, crisis response networks, open-source intelligence, community reporting)
Skills / capabilities	UX, web hosting, storage	UX, web hosting, storage, statistics, cybersecurity		UX, web hosting, storage, statistics, cybersecurity, machine learning, generative AI	
Rollout	Phased expansion: Pilots in priority countries, expanding as capabilities scale	Big bang with fixed functionality: Full-scale launch across all target regions and sectors		Iterative scaling: Expanding features and new geographies over time	Fully dynamic: Learning-based expansion, adapting to user needs and emerging challenges
Funding model	Internally funded	Public grants and institutional funding (e.g. development agencies, governments, academia)		Public-private partnerships with multilateral support (World Bank, ESA, UN, philanthropy, tech companies)	Hybrid humanitarian funding (blended public-private support, donor-backed sustainability, operational flexibility)
Hosting organisation	Academic institution(s) (research-led hosting, methodology refinement)	Government bodies (policy integration, national strategy alignment)		Intergovernmental bodies (UN, WHO, World Bank) (ensuring credibility, standardisation, and integration)	Charities, humanitarian organisations or hybrid partnerships (ensuring sustainability and operational flexibility)

6.2.3 Alignment with critical success factors

The following table evaluates Option 2 against the critical success factors, providing insight into its alignment with key objectives for success.

Critical success factor	Evaluation
Clear and defensible methodology	More complex than Option 1, incorporating multiple dimensions (geospatial, digital, economic), making it defensible but more complex to implement and understand.
Data coverage	Broader data coverage, including multiple dimensions of isolation, but still national-level with some regional granularity.
Increased efficiency of aid delivery	More granular data enables better-targeted aid, but still limited compared to more advanced options.
Improved insight for evidence-based decision-making	Offers more comprehensive insights due to multidimensional data, improving decision-making in terms of resource allocation and aid deployment.
Accessibility and usability for MAF and partners	More complex than Option 1 but still relatively accessible with clear, though multidimensional, data. Training may be required for full interpretation.
Long-term sustainability and scalability	Better scalability than Option 1, with quarterly updates and the ability to integrate new data sources. However, it still relies on periodic updates and lacks automation.
Ethical and responsible data use	Involves multiple sources of data, including mobile and satellite, which may raise privacy concerns, but still remains ethical in its use.
Recognition as a trusted global benchmark	*Stronger potential for recognition as a global benchmark than Option 1 due to the increased data dimensions and broader coverage.*

6.2.4 Benefits and challenges

The following table outlines the benefits and challenges of Option 2, highlighting the key factors that contribute to its potential success as well as the limitations that could impact its effectiveness.

Benefits	Challenges
• Provides a more comprehensive and multidimensional view of isolation • Enables enhanced targeting of aid resources • Enhanced relevance and utility given that the data is regularly updated to reflect conditions as they change • Integration of diverse datasets would support insight-driven decision-making, thus allowing for more effective intervention and/or programmes	• More complex to implement due to sophisticated data integration and analysis requirements, increasing demand for resources and technical expertise • Potential difficulty in data interpretation, making it less immediately accessible • Resource-intensive in terms of integration, analysis and updating; complexity may necessitate user training, reducing accessibility for public and non-technical audiences • Privacy concerns when handling sensitive data (e.g. telecom and mobile data), requiring strict data management and ethical safeguards • Potential issues with data compatibility and standardisation when integrating diverse national and international sources • Weighted factors and graded scales must be carefully calibrated to prevent overfitting to specific datasets, ensuring generalisability

6.3 Option 3: Comprehensive integration with machine learning

This option takes a more advanced approach by incorporating machine learning and recalibration into the III. It integrates diverse data sources (e.g. satellite imagery, mobile data, climate trends) and continuously adjusts the weighting of isolation factors based on real-time data. The system uses AI to predict trends and recalibrate based on emerging patterns, ensuring that the index remains relevant even as circumstances change.

6.3.1 Example use case for Option 3: A disaster response organisation coordinating relief efforts

A disaster response organisation is tasked with aiding communities affected by natural disasters, such as floods or earthquakes. These events often lead to geographical isolation, where some areas become difficult to access due to damaged infrastructure. In addition to geographic isolation, these communities may face challenges such as economic hardship, poor healthcare access, and limited infrastructure that make recovery even more difficult. The organisation needs a tool to integrate multiple data sources – including geospatial, economic, social, and infrastructure data – to understand the full extent of isolation in the affected areas and prioritise regions in most need of immediate assistance.

How Option 3 supports this use case:

- **Comprehensive integration:** Option 3 allows the disaster response organisation to integrate geospatial data (e.g. access routes, road blockages), economic data (e.g. poverty levels, employment rates), social data (e.g. vulnerability indices, healthcare access), and infrastructure data (e.g. condition of roads, hospitals, schools) to form a complete picture of isolation. This multi-dimensional approach ensures that the organisation can understand how different types of isolation affect various communities in the disaster area, allowing for a more targeted and effective response.
- **Dynamic weighting:** The tool uses machine learning to dynamically weight the various factors contributing to isolation. For example, if a region experiences severe flooding, the system will automatically adjust the importance of geospatial isolation (e.g. roads being submerged) versus social isolation (e.g. vulnerable populations being cut off from support networks). The system's ability to adjust weights allows for an adaptive approach to prioritising response efforts based on evolving circumstances.
- **Semi-automated updates:** Option 3 supports semi-automated updates by integrating real-time data sources such as satellite imagery, mobile phone movement patterns, and reports from local governments or humanitarian organisations. This guarantees the data is continuously refreshed, reflecting changes in the disaster-affected regions, such as infrastructure damage or emergency response activity.
- **Access for multiple stakeholders:** In addition to the disaster response organisation, the system is designed to be accessible by operating partners, NGOs, and government agencies involved in the response. This collaborative model ensures that all parties have access to the data, enabling more coordinated relief efforts, avoiding duplication of resources and improving overall efficiency in the response process.

Impact:

Option 3 provides the disaster response organisation with a powerful tool that enhances the ability to coordinate rapid interventions in disaster-hit areas. By integrating multiple data sources into a single platform and dynamically adjusting based on real-time events, it allows decision-makers to prioritise relief based on multiple isolation factors and evolving needs. The system's semi-automated updates help ensure that the data remains accurate and actionable, which is crucial in time-sensitive disaster scenarios. However, the need for advanced capabilities, such as machine learning and data integration, requires significant technical expertise and continuous investment in data infrastructure, which may pose a challenge in terms of both cost and resources.

6.3.2 Design parameters

The following table outlines the design parameters for Option 3, comparing its key characteristics across different levels of functionality. These design parameters provide a framework for understanding the scope, capabilities, and intended impact of the index.

Design parameters				
Type	Single-dimension index (basic geographic isolation)	Multidimensional framework (geospatial, digital, economic)	Comprehensive integration (geospatial, digital, economic, social, infrastructure)	Fully adaptive global framework (evolving with data and crises)
Measurement	Basic binary metrics with equal weighting (e.g. access vs no access to key services)	Expanded metrics using graded impact scales and weighted factors to reflect varying levels of isolation	Dynamic weighting using machine learning, incorporating regional variations and continuous calibration	Adaptive index with real-time recalibration, trend analysis, and predictive modelling for anticipatory action
Precision	National-level boundaries	Global coverage	Subnational/regional granular detail	Global, with dynamic regional adjustments
Frequency	Annually, using periodic surveys and government-released statistics	Quarterly updates using new national/international datasets	Semi-automated updates integrating satellite imagery, mobile data, and periodic validation	Automated real-time updates using AI-driven data validation, ensuring rapid crisis responsiveness
Users	Public	Public, operating partners	Public, operating partners, NGOs, and governments	Public, operating partners, NGOs, governments, and communities
Source(s)	Existing public datasets (e.g. UN, World Bank, national statistics, census data)	Multisource integration (satellite imagery, mobility patterns, telecoms, social vulnerability indices)	AI-enhanced ingestion (climate trends, crisis response, infrastructure monitoring, socioeconomic dynamics, transport data)	Fully adaptive data pipeline (integrating Earth observation, crisis response networks, open-source intelligence, community reporting)
Skills / capabilities	UX, web hosting, storage	UX, web hosting, storage, statistics, cybersecurity	UX, web hosting, storage, statistics, cybersecurity, machine learning, generative AI	
Rollout	Phased expansion: Pilots in priority countries, expanding as capabilities scale	Big bang with fixed functionality: Full-scale launch across all target regions and sectors	Iterative scaling: Expanding features and new geographies over time	Fully dynamic: Learning-based expansion, adapting to user needs and emerging challenges
Funding model	Internally funded	Public grants and institutional funding (e.g. development agencies, governments, academia)	Public-private partnerships with multilateral support (World Bank, ESA, UN, philanthropy, tech companies)	Hybrid humanitarian funding (blended public-private support, donor-backed sustainability, operational flexibility)
Hosting organisation	Academic institution(s) (research-led hosting, methodology refinement)	Government bodies (policy integration, national strategy alignment)	Intergovernmental bodies (UN, WHO, World Bank) (ensuring credibility, standardisation and integration)	Charities, humanitarian organisations or hybrid partnerships (ensuring sustainability and operational flexibility)

6.3.3 Alignment with critical success factors

The following table evaluates Option 3 against the critical success factors, providing insight into its alignment with key objectives for success.

Critical success factor	Evaluation
Clear and defensible methodology	Increasingly complex, the integration of machine learning and diverse data sources ensures a robust and adaptable framework, though it will require careful calibration to maintain transparency.
Data coverage	Broader and more comprehensive data coverage; potentially leverages real-time data from multiple sources to provide a more holistic view of isolation.
Increased efficiency of aid delivery	More detailed and enhanced granularity and real-time updates allow for more precise and targeted aid, improved delivery, and higher impact.
Improved insight for evidence-based decision-making	Allows for deeper insights to support robust and informed decision-making that is cognisant of the varied needs of a community as they may (or may not) evolve.
Accessibility and usability for MAF and partners	More advanced than Options 1 and 2, potentially limiting accessibility to those outside of the ID space (i.e. general public) etc. Training is more than likely to be required for full comprehensibility and application.
Long-term sustainability and scalability	Advanced integration of diverse data sets/sources and machine learning would ensure that the index is able to adapt and expand over time. However, this would require ongoing investment (time/resource/expertise/technology) to maintain and ensure effectiveness.
Ethical and responsible data use	Critical to understand and adhere to ethical guidelines and data privacy standards across multiple regions and sources, making this more complex to manage. Safeguarding is key to ensuring trust and preventing misuse or breaches.
Recognition as a trusted global benchmark	*The innovative and adaptive nature of the index positions it well for recognition as a leading global standard given its varied sources and real-time adjustments.*

6.3.4 Benefits and challenges

The following table outlines the benefits and challenges of Option 3, highlighting the key factors that contribute to its potential success as well as the limitations that could impact its effectiveness.

Benefits	Challenges
• Real-time data integration allows for more accurate and timely identification of isolated communities, improving intervention strategies • As with Option 2, diverse data sources allows for much more nuanced and multifaceted understanding of isolation, allowing for wider network of partners to use/benefit from the III	• Sophisticated nature of the index may require extensive training for users to fully leverage its capabilities and insights • Ensuring compatibility and seamless integration of diverse data sources can be challenging, thus requiring robust management systems • Ethical and data security rigour is required to prevent breaches and maintain trust • Potential investment and resource demands to ensure continuous updates and infrastructure maintenance

• The advanced approach can be scaled to include additional data sources and regions, once again enhancing its global applicability • By leveraging latest technologies, the III is positioned as a leader in its field – with potential to attract further support and future funding from a wider range of stakeholders	

6.4 Option 4: Fully adaptive global framework with crisis focus

The most advanced option, this model provides a fully adaptive and evolving III that incorporates real-time crisis data, AI-driven updates, and predictive analytics. The framework integrates a wide range of data sources (e.g. Earth observation, social media reports, real-time crisis data) and uses machine learning to predict trends and dynamically adjust the index based on new information. It is designed to evolve with emerging crises, ensuring that the index remains actionable and relevant at all times.

6.4.1 Example use case for Option 4: A humanitarian coalition coordinating global aid response

A humanitarian coalition comprising several international NGOs, governmental bodies, and community organisations is working together to deliver aid to regions worldwide that are facing varying degrees of isolation due to crises such as armed conflict, disease outbreaks, and natural disasters. The coalition needs a dynamic, real-time system that can track and measure isolation across multiple dimensions, such as geospatial, economic, social, and infrastructure. The coalition also needs to anticipate future needs and adapt the response strategies quickly based on emerging crises, such as political instability or environmental disasters, which affect different regions in real time.

How Option 4 supports this use case:

- **Fully adaptive global framework:** Option 4 provides the humanitarian coalition with a real-time framework that integrates all dimensions of isolation: geospatial (access to services), economic (poverty levels, lack of economic opportunities), social (healthcare access, vulnerable populations), and infrastructure (condition of roads, water, sanitation). It can adapt to new data sources and incorporate predictive modelling, enabling the coalition to anticipate and plan for emerging needs.
- **Real-time recalibration and predictive modelling:** The system's ability to provide real-time updates through AI-driven data validation ensures that the coalition has access to the most current information on isolation levels. For example, in the event of a sudden disease outbreak, the system can recalibrate data in real-time, adjusting for the new socio-economic factors, infrastructure issues, and healthcare gaps. Predictive modelling helps the coalition to foresee potential future crises based on trend analysis (e.g. a predicted refugee crisis based on political instability), allowing the coalition to deploy resources in a timely, anticipatory manner.
- **Integration of diverse data sources:** Option 4 supports a fully integrated data pipeline that brings together Earth observation data, crisis response networks, open-source intelligence, and community reporting. This integration is crucial for the coalition, as it allows them to act on data from a variety of sources (governmental, community-based, satellite imagery, mobile data), ensuring that no critical information is missed.
- **Collaboration across multiple stakeholders:** Given that the coalition is composed of NGOs, governments, international organisations, and local communities, the system is designed for shared access, ensuring that all stakeholders are on the same page. This enhances collaboration and reduces the risk of duplicating efforts. The system supports a tiered access model, where each partner can access data that is most relevant to their role while protecting sensitive information when necessary.

Impact:

Option 4 empowers the humanitarian coalition to manage global crises with a high level of responsiveness and adaptability. With real-time data integration and dynamic recalibration, the coalition can quickly adjust its strategy based on emerging trends, ensuring that aid is deployed where it is most needed, even in fast-changing or complex environments. The ability to anticipate future isolation risks through predictive modelling provides a critical advantage in managing ongoing and future humanitarian needs. However, the adoption of such a sophisticated system requires significant investment in technology infrastructure, ongoing funding, and collaboration among multiple stakeholders, which could be challenging to maintain long term. Furthermore, ensuring ethical and responsible data use, particularly in conflict zones or sensitive environments, is a key consideration.

6.4.2 Design parameters

The following table outlines the design parameters for Option 4, comparing its key characteristics across different levels of functionality. These design parameters provide a framework for understanding the scope, capabilities, and intended impact of the index.

Design parameters				
Type	Single-dimension index (basic geographic isolation)	Multidimensional framework (geospatial, digital, economic)	Comprehensive integration (geospatial, digital, economic, social, infrastructure)	Fully adaptive global framework (evolving with data and crises)
Measurement	Basic binary metrics with equal weighting (e.g. access vs no access to key services)	Expanded metrics using graded impact scales and weighted factors to reflect varying levels of isolation	Dynamic weighting using machine learning, incorporating regional variations and continuous calibration	Adaptive index with real-time recalibration, trend analysis, and predictive modelling for anticipatory action
Precision	National-level boundaries	Global coverage	Subnational/regional granular detail	Global, with dynamic regional adjustments
Frequency	Annually, using periodic surveys and government-released statistics	Quarterly updates using new national/international datasets	Semi-automated updates integrating satellite imagery, mobile data, and periodic validation	Automated real-time updates using AI-driven data validation, ensuring rapid crisis responsiveness
Users	Public	Public, operating partners	Public, operating partners, NGOs, and governments	Public, operating partners, NGOs, governments, and communities
Source(s)	Existing public datasets (e.g. UN, World Bank, national statistics, census data)	Multisource integration (satellite imagery, mobility patterns, telecoms, social vulnerability indices)	AI-enhanced ingestion (climate trends, crisis response, infrastructure monitoring, socioeconomic dynamics, transport data)	Fully adaptive data pipeline (integrating Earth observation, crisis response networks, open-source intelligence, community reporting)
Skills / capabilities	UX, web hosting, storage	UX, web hosting, storage, statistics, cybersecurity	UX, web hosting, storage, statistics, cybersecurity, machine learning, generative AI	
Rollout	Phased expansion: Pilots in priority countries, expanding as capabilities scale	Big bang with fixed functionality: Full-scale launch across all target regions and sectors	Iterative scaling: Expanding features and new geographies over time	Fully dynamic: Learning-based expansion, adapting to user needs and emerging challenges
Funding model	Internally funded	Public grants and institutional funding (e.g. development agencies, governments, academia)	Public-private partnerships with multilateral support (World Bank, ESA, UN, philanthropy, tech companies)	Hybrid humanitarian funding (blended public-private support, donor-backed sustainability, operational flexibility)
Hosting organisation	Academic institution(s) (research-led hosting, methodology refinement)	Government bodies (policy integration, national strategy alignment)	Intergovernmental bodies (UN, WHO, World Bank) (ensuring credibility, standardisation, and integration)	Charities, humanitarian organisations or hybrid partnerships (ensuring sustainability and operational flexibility)

6.4.3 Alignment with critical success factors

The following table evaluates Option 4 against the critical success factors, providing insight into its alignment with key objectives for success.

Critical success factor	Evaluation
Clear and defensible methodology	Use of AI-driven updates and predictive analytics ensures a robust and adaptable framework, though it requires rigorous validation to maintain transparency.
Data coverage	Extensive and dynamic, incorporating real-time crisis data and diverse sources to provide a comprehensive view of isolation.
Increased efficiency of aid delivery	As with Option 3, real-time updates and predictive analytics enable more precise and timely aid delivery, improving efficiency and providing high impact.
Improved insight for evidence-based decision-making	Multidimensional data and AI-driven analysis offer deeper insights, supporting more informed and effective decision-making for current and future programme delivery.
Accessibility and usability for MAF and partners	Technical training will be required, limiting accessibility to those with technical expertise/working knowledge. Unlikely to be user-friendly enough for the general public or those outside of ID. (Though a subset of the data could be exposed through a web UI for public consumption, for example).
Long-term sustainability and scalability	The adaptive framework ensures the index can evolve with emerging crises, though it requires ongoing investment in technology and expertise to maintain its effectiveness. On the other hand, the constantly-evolving nature of the data increases its value, which allows for potential fee-based access. The dataset could also form a basis for insight reports and other kinds of value-add activity which could generate revenue.
Ethical and responsible data use	As with Option 3, adherence to ethical guidelines and data privacy standards is crucial to maintain trust and prevent misuse/breaches.
Recognition as a trusted global benchmark	*The innovative and adaptive nature of the index positions it well for recognition as a leading global standard.*

6.4.4 Benefits and challenges

The following table outlines the benefits and challenges of Option 4, highlighting the key factors that contribute to its potential success as well as the limitations that could impact its effectiveness.

Benefits	Challenges
• The integration of real-time crisis data ensures the index remains immediately relevant and actionable, allowing for swift responses to emerging situations • The use of diverse data sources, including social media and Earth observation, offers a rich, multi-layered understanding of isolation • The index's ability to evolve with new information ensures it remains up-to-date and reflective of current conditions	• The need for continuous data collection, processing and AI model updates requires substantial investment in technology and skilled personnel • Managing and protecting sensitive real-time data, especially from social media and crisis reports, poses privacy and security challenges • The sophisticated nature of the index demands advanced technical expertise and robust infrastructure, which may be challenging to establish and maintain

• The advanced, real-time nature of the index fosters better coordination among MAF, ID organisations, and partners • Potentially, AI-driven predictive analytics provide foresight into potential future crises, enabling proactive planning and intervention	• Extensive training and ongoing support are necessary to ensure users can effectively interpret and utilise the complex, real-time data • Integrating diverse data sources from various platforms and ensuring they work seamlessly together can be technically challenging and time-consuming

7 Recommendation

Based on the evaluation of all options against the critical success factors, PA recommends Option 4 for delivering the III. This option is underscored by the principles of inclusivity, inspiration, and iteration; is user-centric; and considers the needs of isolated communities (section 2), whilst the User Journey Hypothesis (UJH) is used to validate and demonstrates improvement on current approaches (section 4) and covers the needs of the potential range of users (section 5). The Adoption Pathway ensures we engage the full range of enablers and adopters (also section 5). This option provides the most comprehensive, adaptable, and scalable framework, ensuring the III is not only a trusted global benchmark but also a valuable operational tool for improving evidence-based decision-making and aid delivery efficiency.

However, due to the technical complexity and potential resource demands of Option 4, it is recommended to begin with a POC version that retains the full functionality of Option 4 but operates on a smaller scale. The POC version will allow for comprehensive testing and validation of the system, ensuring its functionality before expanding to full-scale implementation.

7.1 Preferred option and rationale

In the table below, we outline the key reasons why Option 4 is the recommended choice, demonstrating its alignment with critical success factors and its advantages in data coverage, decision-making, scalability, aid efficiency, accessibility, and ethical considerations.

Factor	Justification for Option 4
Alignment with critical success factors	✓ Meets or exceeds all critical success factors, offering granular, real-time insights and an adaptable global framework. Evolves with new data sources, technology advancements, and shifting global needs, making it the most sustainable and impactful choice.
Comprehensive data coverage	✓ Integrates multiple data sources from geospatial, digital, economic, social, and infrastructure domains. Uses real-time data pipelines to keep the index relevant, current, and responsive to emerging challenges.
Improved insight for evidence-based decision-making	✓ Incorporates AI-driven analytics, machine learning, and dynamic weighting models to go beyond simple isolation measurements. Provides predictive modelling and anticipatory analysis, enabling governments, NGOs and humanitarian actors to respond proactively rather than reactively.
Scalability and long-term sustainability	✓ Designed for long-term viability, evolving with new data sources, technological advancements, and global challenges. A hybrid funding model (public-private partnerships, donor-backed support, and multilateral funding) ensures financial sustainability and reduces dependence on a single funding source.
Increased efficiency of aid delivery	✓ Real-time, predictive capabilities allow precise identification of isolated populations. Facilitates smarter resource allocation and improves humanitarian and development intervention efficiency. Integrated crisis response networks and automated trend analysis enable pre-emptive resource positioning.
Accessibility and usability	✓ Open to public users, operating partners, NGOs, governments, and affected communities. Ensures inclusive participation and transparency, increasing trust and collaboration among stakeholders. For certain data, access controls (e.g. via API) may be used to enable fee-based funding models and/or manage ethical considerations.
Ethical and responsible data use	✓ Prioritises responsible data governance, privacy protection, and ethical AI implementation. Incorporates ground truth validation and community engagement to reduce biases and improve the credibility and accuracy of the index.

7.2 Development approach

7.2.1 A User Journey Hypothesis to prioritise technical implementation and enable the Adoption Pathway

As the III will be a new tool, it is important to ground any technical implementation in a validated use case. Without a clear understanding of where and how the tool will be used, we have no way to measure success or prove any real-world value. A UJH helps guide the technical specification and adoption planning process. The hypothetical journey should also evolve, informed by learning throughout the delivery process, to ensure that it is always as accurate and relevant as possible. By aligning the tool's design and functionality with the specific needs and expectations of its intended users, we can identify key features, specifications, and dimensions that will be needed to meet those user needs. We can then be confident that the functions of the index deliver value to its intended audience, which will be critical for any adoption; users are only likely to use an index if it provides them with meaningful, actionable information.

When developing the user journey, PA first defined and developed two potential scenarios – the first a 'disaster or conflict usage' and the second a 'general daily usage' (Figure 1). This helps bring to life how a future III would best align with a real-world context, and provide value to different groups of users. Scenarios help clarify the specifics of how the III provides value in context, who the key stakeholders are, what factors could influence adoption, and by inference what specific datasets would be useful to meet those users' requirements. It is important to validate these as-yet hypothetical use cases, as there is otherwise a risk of targeting the wrong audience, misunderstanding their adoption readiness, or building a tool that has no real value.

As part of the work to identify the users and define hypothesis user journeys for the tool, we can segment the users into distinct groups with particular objectives and needs. We can then prioritise these groups, tailor our future engagement strategies, and anticipate any potential resistance. This, in turn, will lead to a more effective and efficient adoption process.

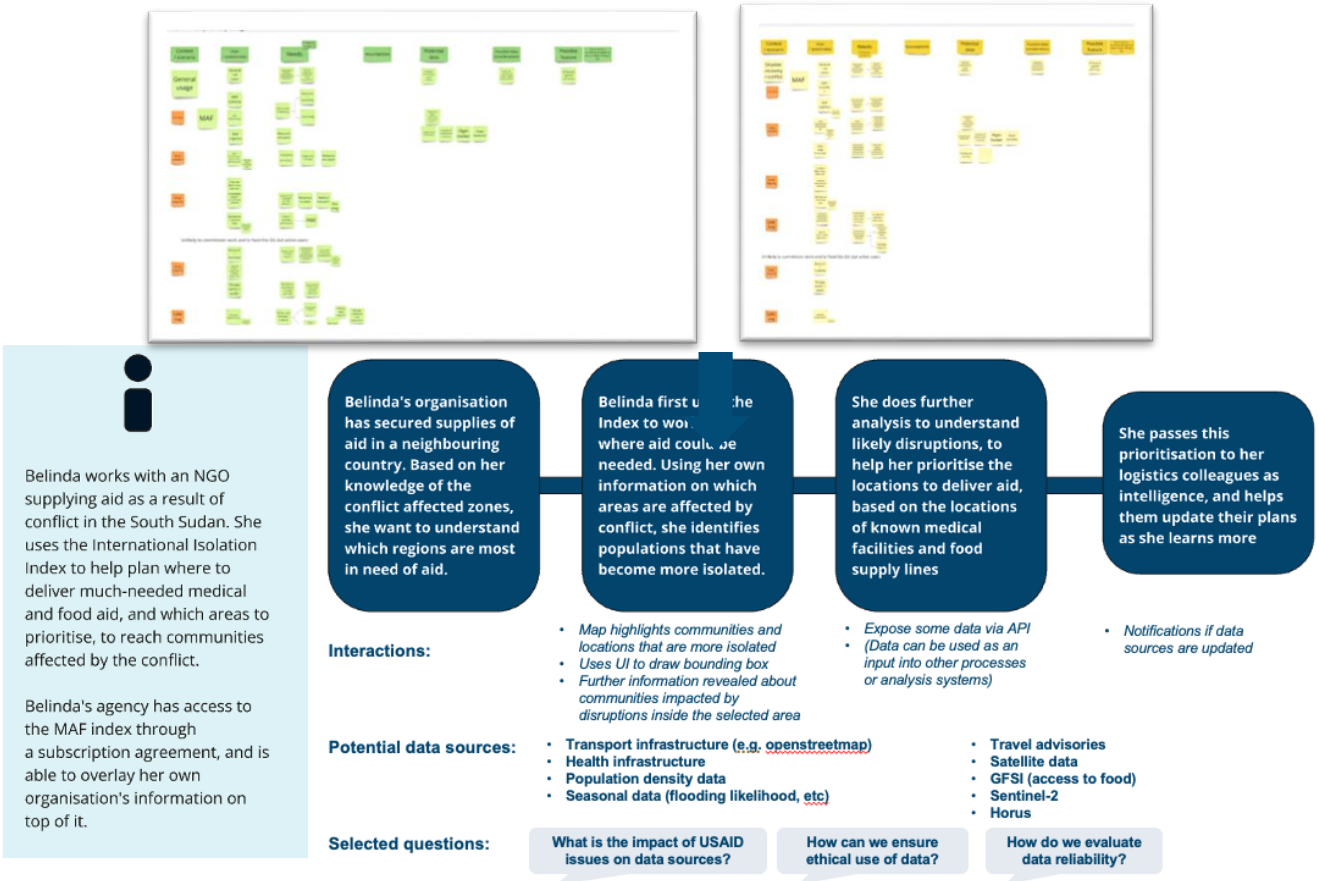


Figure 1 The scenario and use case mapping informs the final User Journey Hypothesis

7.2.2 Proof of Concept version of Option 4

7.2.2.1 Use cases for the Proof of Concept version of Option 4

The POC of Option 4 offers a scaled-back version of the full adaptive framework, retaining core functionalities essential for the III's effectiveness but with a reduced geographic and sectoral scope. This model incorporates real-time data integration, basic predictive analytics, and a simplified version of machine learning to update and refine the index. It integrates key data sources (e.g. satellite imagery, economic, and social datasets) and allows for real-time updates to track geographic isolation and accessibility. While not as complex or fully scalable as the full version, the POC is designed to be flexible and dynamic, evolving based on essential data streams to remain useful in a variety of real-world scenarios. The focus is on providing timely, relevant insights for decision-makers, while ensuring ease of use and accessibility for stakeholders across multiple sectors. The reduced geographic and sectoral scope ensures a manageable implementation while maintaining the framework's core value.

The following use cases demonstrate how the POC version of Option 4 can support critical initiatives, even with its reduced geographic scope. Each example highlights how the POC adapts to the constraints while still delivering valuable insights.

Use case	How the POC supports this use case	Impact
Disaster response organisation coordinating regional aid efforts A disaster response organisation needs to deliver aid to regions affected by crises such as natural disasters or disease outbreaks. They require a system to identify isolated communities and track changes in isolation levels to effectively allocate resources.	Despite its reduced geographic scope, the POC can still provide valuable insights for disaster response by focusing on high-need regions. It can track geographic isolation, infrastructure damage, and the accessibility of critical services in selected areas, offering real-time data to help prioritise immediate interventions. This helps coordinate aid in regions with the greatest vulnerabilities, even with a smaller coverage area.	Enables timely, data-driven disaster responses and efficient aid distribution, even with a limited geographic focus. The POC's reduced capacity may require additional data collection as crises expand beyond the areas covered.
Policy planning by a government agency allocating infrastructure funding A government agency aims to allocate infrastructure funding to areas that are most isolated or underserved, particularly in regions with poor connectivity and limited access to resources.	The POC, though limited in geographic scope, focuses on areas with the greatest infrastructure and accessibility gaps. By tracking basic geospatial data (e.g. access to roads, bridges, and essential services), the POC can provide critical insights for infrastructure funding decisions, especially for high-priority regions where intervention is most needed.	Supports targeted infrastructure investments in regions most in need of development. The limited geographic coverage might result in missed opportunities in broader regions requiring attention or greater detail.
Healthcare accessibility in rural areas A health ministry or NGO working in rural areas requires up-to-date information on healthcare access, infrastructure, and transport barriers.	The POC provides valuable data on geographic isolation, accessibility to healthcare facilities, and the condition of transport infrastructure in rural areas. It can support healthcare accessibility efforts by identifying the most isolated communities within the POC's geographic coverage, enabling organisations to focus on	Helps target healthcare interventions to rural areas with the greatest isolation, improving accessibility. While the POC can identify critical gaps in healthcare infrastructure, its limited geographic coverage could restrict the identification of

	those regions for intervention, even though its scope is more limited.	further isolated areas outside its scope.
Economic development in remote regions A development organisation is focused on improving economic opportunities in isolated communities by improving access to markets, infrastructure, and services.	Even with a reduced geographic scope, the POC helps identify isolated regions with poor infrastructure and limited market access. By tracking economic isolation (e.g. road conditions, market accessibility), it enables targeted interventions in areas where development efforts are most needed. The POC's focus on a smaller set of regions allows for in-depth analysis of the most economically vulnerable areas.	Facilitates targeted economic development efforts where they can have the greatest impact. However, the POC's limited geographic scope means that it may not capture broader economic trends or areas outside its focus that could also benefit from intervention.
Conflict and political isolation In regions affected by conflict or political unrest, organisations need to understand the isolation of communities due to disrupted infrastructure, restricted movement, or service availability.	The POC's limited geographic capacity can still support conflict and political isolation scenarios by focusing on conflict zones with the most critical isolation issues. It can track geographic isolation, infrastructure disruptions, and service access within selected regions, providing the real-time data needed for targeted aid delivery, evacuation, and peace-building efforts.	Enables targeted response in conflict zones by tracking isolation factors such as disrupted infrastructure and service accessibility. However, the POC's restricted geographic capacity may limit its effectiveness in understanding the broader geopolitical dynamics of larger conflict areas.

7.2.2.2 Operational and technical considerations for Proof of Concept version of Option 4

The successful implementation and long-term sustainability of the POC version of the III requires careful attention to several key operational and technical considerations. These include data collection and sources, technical infrastructure requirements, implementation challenges and mitigation strategies, and governance and ethical considerations. These components are essential to ensure the POC can deliver meaningful insights and be scaled effectively over time.

Data collection and sources

Data collection remains the backbone of the POC III. Despite its reduced geographic scope, the accuracy and relevance of the data directly influence its effectiveness in identifying isolation.

- **Sources:** The POC will rely initially only on publicly available data, with a view to building key private sector partnerships. Data from key international sources such as the UN, World Bank, and local governments will provide a foundation. Potential private data sources could include government statistics, satellite imagery, social media reports, and mobile data. Collaboration with telecom and tech companies will enhance data breadth, particularly for real-time insights.
- **Types of data:** The POC will focus on essential geospatial, economic, social, and infrastructure data to assess isolation across multiple dimensions. It will use both real-time (e.g. mobile data, social media) and historical datasets (e.g. census data, national statistics), though with reduced frequency compared to the full III.
- **Frequency of updates:** Data will be updated in real time or at a reduced frequency based on the scope of the POC. While full-scale options may incorporate annual, quarterly, or real-time updates, the POC version may focus on quarterly or semi-annual updates, reducing the infrastructure demand while still providing relevant data.

Proof of Concept data model

The POC III data model will be selected and built to suit the complex geospatial analytics requirements of the III, satisfying the immediate POC need to validate and test feasibility of the index, while aligning with the performance requirements and scalability of a final, larger product, accommodating future data complexity.

Technical specifications of the data model:

- **Geospatial resolution:** Handling multiple granularities of geospatial data (i.e. regional, countrywide, cities). Ability to aggregate datasets across different spatial areas and hierarchies.
- **Data transformation:** Standardisation of various data formats, dealing with regions with missing data using spatial interpolation techniques if required
- **Data storage and querying:** Fast spatial querying to process real-time data ingestion into isolation indices, and surfacing and filtering data for real-time visualisation. Ability to index the database to process spatial queries efficiently as the database size increases with time.
- **Data visualisation:** Ability to easily visualise the outputs in a web-based visualisation.

Additional future considerations:

- **Satellite image analysis**: Storage and processing of image (raster) data, to enable spatial analysis, and development and application of machine learning methods for computer vision classification.

To satisfy the technical specifications of the III, we will use a PostgreSQL database with H3 extension to add support for storing, querying, and analysing H3-indexed geospatial data. If necessary, in future development of the III, a separate database (with a PostGIS extension) can be created on the same PostgreSQL server to store satellite images. As both databases will exist in the same PostgreSQL instance, they can be queried and joined simultaneously using foreign data wrappers.

Figure 2 H3 Global Hierarchical Indexing System, visualised on the Earth

(Sourced from: https://www.uber.com/en-GB/blog/h3/).

H3 is a discrete global indexing system (Figure 2), developed by Uber, which indexes geographies into hexagons, providing a consistent hierarchical grid for geospatial applications and analysis. H3 has 16 sets of resolutions from coarse to fine, where the largest hexagons are subdivided into seven smaller hexagons, which repeats until reaching the smallest level of resolution. This hierarchical method allows for perfect aggregation of spatial data across different granularities, as well as efficient storage and querying of the multi-scale data.

The intended output, allowing for users to filter and visualise the III, will be a geospatial heat map, an example of which is shown below (Figure 3):

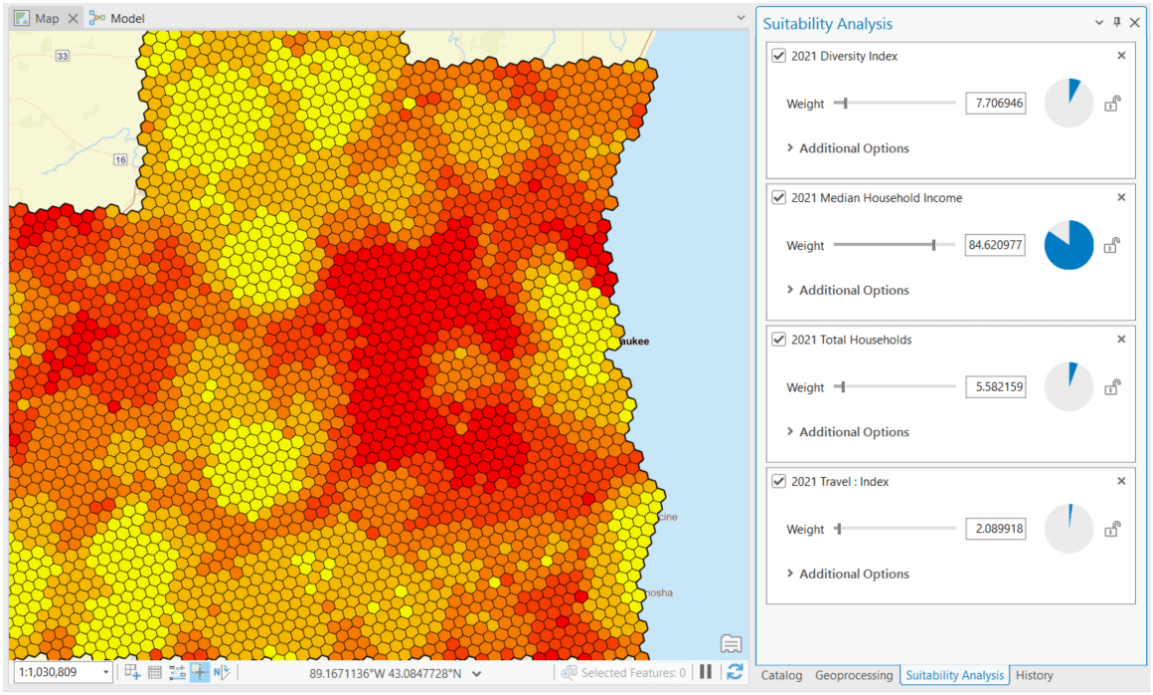


Figure 3 Example H3 grid heatmap output (sourced from: https://www.esri.com/arcgis-blog/products/bus-analyst/analytics/using-uber-h3-hexagons-arcgis-business-analyst-pro/)

Technical and infrastructure requirements

The technical infrastructure supporting the POC must be adaptable to handle reduced scope while ensuring scalability and secure data processing:

- **Docker container development:** The POC database and front-end visualisations will be developed using Docker, which ensures consistency of the application across different environments, including local machines and Cloud infrastructure. This will allow for rapid development of a local POC, which can easily be deployed on any Cloud platform when progressing to MVP.
- **Data integration and analytics:** While the POC version will handle a smaller set of data, advanced data analytics and machine learning tools will still play a crucial role in processing and analysing real-time data. Algorithms will support dynamic recalibration based on the available data, generating actionable insights to identify isolated regions.
- **User interface:** A simplified but user-friendly interface is vital for enabling various stakeholders to interpret and act on data. The POC version will prioritise basic but effective visualisation tools, ensuring ease of use for government agencies, NGOs, and local organisations working within the defined regions.
- **Cybersecurity:** Even with a smaller scope, the POC will require strong cybersecurity protocols to protect sensitive data. Compliance with international data protection standards (e.g. GDPR, CCPA) will be crucial to ensuring privacy and trust, particularly when handling data on vulnerable populations.

Governance and ethical considerations

The ethical framework for the POC III is vital to ensure the responsible handling of data, particularly for vulnerable populations and to guarantee transparency in its use:

- **Data privacy and security:** The POC will adhere to international privacy standards (e.g. GDPR), ensuring that sensitive data is protected throughout its collection, analysis, and dissemination processes. Special attention will be given to ensuring that data about vulnerable populations is handled responsibly.
- **Transparency and accountability:** Although the POC will have a reduced scope, its implementation will remain transparent. Regular audits and reviews will be conducted to ensure the correct use of data, and a public-facing platform will allow stakeholders to access and verify the data used in the index.

- **Bias and fairness:** The methodologies for assessing isolation will be designed to avoid biased outcomes, even within the smaller scope of the POC. Checks will be implemented to ensure that the POC reflects the realities of all included regions and populations, with careful attention paid to avoiding overgeneralisation from limited datasets.
- **Ground truth validation:** In line with the full III, the POC will also integrate ground truth validation, relying on local knowledge and on-the-ground verification. This will ensure that the data accurately represents the isolation experienced by communities, even in a reduced scope. Community engagement will play a key role in validating data and improving the overall accuracy and relevance of the index.

7.2.3 Adoption Pathway

Rogers' Adoption Curve (Figure 4) provides a useful framework for understanding how new innovations, such as the III, might gain traction among users. The Adoption Curve represents the diffusion of an innovation as a process (over time) that occurs via a social system distribution. Within this social system, there are several segments (or categories) in which people fall according to their different levels of willingness to embrace change: Innovators, Early Adopters, Early Majority, Late Majority. Each segment adopts innovative ideas or technology by observing the previous adjacent group, with the exception of Innovators who lead (or implement) change and innovation. The curve shows that adoption starts slowly with Innovators, picks up speed with Early Adopters, peaks with Early Majority, and slows down with the Late Majority.

Using the scenario and use cases in the UJH, we mapped potential users according to the adopter categories as follows:

- **Innovators:** Innovators in international development are the first to introduce new approaches, technologies, or policies to address global challenges. They are deeply engaged in research, pilot projects, and experimental initiatives, investing time and resources to explore new possibilities for aid effectiveness. This could be MAF or MAF plus partner organisations.
- **Early Adopters:** Early Adopters are the next group to embrace new development strategies. They closely monitor the work of Innovators and are quick to recognise the potential benefits of novel interventions. Willing to take calculated risks, they implement new ideas on a broader scale and serve as models for other stakeholders. This could be NGOs (WHO, UNDP, etc.).
- **Early Majority:** The Early Majority represents the tipping point in the adoption of aid innovations. This group could consist of smaller or more pragmatic development organisations, charities, etc., who prefer to adopt new approaches only after they have been tested and proven effective. They prioritise evidence-based solutions and require clear demonstrations of impact before committing to change.
- **Late Majority:** The Late Majority follows the Early Majority in adopting new development approaches. More cautious and sceptical, these stakeholders rely on widespread adoption and proven success before integrating innovations into their own aid programmes. They are heavily influenced by prevailing norms and require reassurance regarding the effectiveness and sustainability of new interventions. This may be national governments, private sector, or general public.

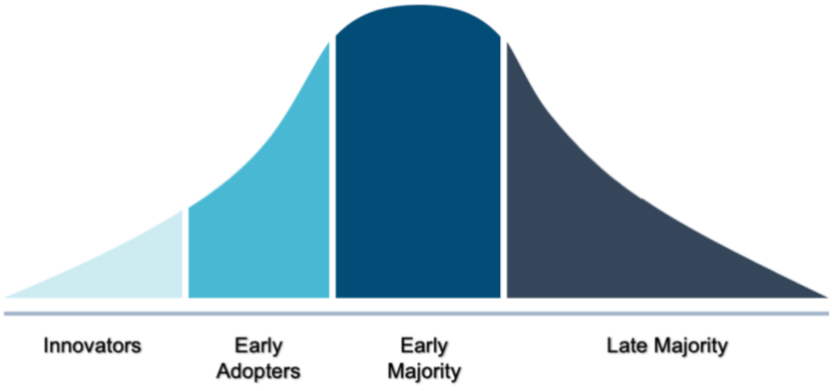


Figure 4 Rogers' Adoption Curve

In implementation, targeting Innovators and Early Adopters first can create momentum, as these groups are more open to experimentation and can act as champions for the III. Their endorsement will help build trust and credibility, encouraging uptake amongst the Early Majority. The Late Majority are typically more cautious or may have concerns, and anticipating this will allow for a more bespoke, proactive engagement to address resistance, ensuring that future adoption is as widespread as possible. The full To-Be Adoption Pathway can be found on the next page.

7.2.3.1 The To-Be Adoption Pathway

Groups	*Innovators*		*Early Adopters*		*Early Majority*		*Late Majority*	
Users	• MAF • If not only MAF funded, then funding partners		• Intergovernmental bodies • NGOs • Insurers and underwriters		• Charities • Adjacent humanitarian organisations / programmes • Multilateral financial organisations		• Public citizens • Press	
					• Research institutions and academia • NAAs • Private sector and public bodies • National government(s) *		• Communities themselves? *	
Assets	• Aviation indices / flight trackers • Community reporting / Ground truths • Partner data sources • Open-access datasets e.g. Global Food Security Index; Healthcare Access and Quality Index, GII; • Paid-for data sources (Planet, Google)	• Free EO data (NASA and ESA) • AI bespoke algorithms • Graph network databases • Academic papers / White Papers / Regulation / Policy • Geospatial data • Crisis data from identified sources	• Aviation indices / Flight trackers • Community reporting / Ground Truths • Partner data sources • Open-access datasets e.g. Global Food Security Index; Healthcare Access and Quality Index, GII; • Paid-for data sources (Planet, Google)	• Free EO data (NASA and ESA) • AI bespoke algorithms • Graph network databases • Academic papers / White Papers / Regulation / Policy • Geospatial data • Crisis data from identified sources	• Aviation indices / flight trackers • Community reporting / Ground Truths • Partner data sources • Open-access datasets e.g. Global Food Security Index; Healthcare Access and Quality Index, GII; • Paid-for data sources (Planet, Google)	• Free EO data (NASA and ESA) • AI bespoke algorithms • Graph network databases • Academic papers / White Papers / Regulation / Policy • Geospatial data • Crisis data from identified sources	• Aviation indices / Flight trackers • Community reporting / Ground Truths • Partner data sources • Open-access datasets e.g. Global Food Security Index; Healthcare Access and Quality Index, GII; • Paid-for data sources (Planet, Google)	• Free EO data (NASA and ESA) • AI bespoke algorithms • Graph network databases • Academic papers / White Papers / Regulation / Policy • Geospatial data • Crisis data from identified sources
Capabilities	• UX • Web hosting • Cloud-based • Manage, update, and adapt system • Statistical methodologies • Cybersecurity / Firewalls • Machine learning / Gen AI development, monitoring, and retirement	• Computer resource maintenance • Database management • Data pipeline builds and monitoring • Load handling / balancing • Security: Encryption / VPN / Access • Authentication and access control • Application software	• Web browser • Compatible operating system • Authentication (login/verification) • Application software (if applicable) • Cybersecurity / Firewalls • Encryption / VPN (secure access)	Future	• Web browser • Compatible operating system • Authentication (login/verification) • Application software (if applicable) • Cybersecurity / Firewalls • Encryption / VPN (secure access)	Future	• Web browser • Compatible operating system • Application software (if applicable) • Encryption / VPN (secure access) • Authentication (login/verification)? Or is this view access only?	Future
Authority	• MAF • Hybrid partnerships within International Development • Private sector partners		• Intergovernmental bodies • NGOs / Humanitarian organisations		Regulators		Regulators	
Ethics and Access	• Ethical and legal frameworks in place for data – both regional specific (e.g. GDPR, IDRC, DPWG) and organisational • Data sharing agreements • Open source / layered permissions		• Agreement to ethical codes of use/disclosures, etc. • Data sharing agreements • Open source		• Agreement to ethical codes of use/disclosures, etc. • Data sharing agreements • Open source		• Agreement to ethical codes of use/disclosures, etc. • Layered permissions – subscription based?	
Funding	• MAF only • If not only MAF funded, blended funding (PPPs, hybrid humanitarian funding, institutional donors, private sector)		• Intergovernmental bodies • NGOs • Insurers and underwriters		• Research institutions and academia • National Aviation Authorities • Private sector and public bodies • National government(s)		• Research institutions and academia • NAAs • Private sector and public bodies • National government(s)	
Innovation stream on/off	⏻		⏻		⏻		⏻	

**Unlikely to commission work and to fund the GII, but active users*

7.3 Conclusion and next steps

The POC version of Option 4 represents an effective, scalable approach to delivering the III. It retains all core features of the full version, such as real-time data updates, predictive modelling, and integration across multiple domains, but operates on a smaller, more manageable scale. This approach ensures the system is immediately useful, while providing a solid foundation for future expansion.

Starting with the POC allows for the testing and validation of all system components, gathering valuable feedback and making necessary adjustments before a global rollout. The phased expansion ensures that the system remains sustainable and ethical frameworks are adhered to as the system grows. As the POC evolves, it will enable the III to become a transformative tool for addressing isolation globally, improving aid delivery and influencing policy decisions for years to come.

7.3.1 Next steps

With the POC in place, the next steps focus on refining the tool, scaling it beyond a single country focus and incorporating broader stakeholder feedback. After the Ingenuity Festival, the POC will be further tested and iterated and adjusted based on gathered insight, and a scalable plan for future implementation will be developed. The Mansion House event in June will provide a platform for presenting a fundable solution that can expand the III to more regions, paving the way for a global rollout. Key next steps include:

1. **Refine the scope and concept for the POC:** Validate and refine the III concept with enablers and adopters, incorporating feedback from the Festival's participants to further iterate the concept for the POC
2. **Create a Community of Interest committed to developing the III:** Form partnerships with governments, NGOs, and tech companies, and expand data sharing agreements
3. **Secure funds to develop the POC:** Identify potential funding sources via government grants, international organisation partnerships, private foundations, and/or corporate sponsorships. Develop a compelling proposal, leverage networks and partnerships, demonstrate sustainability, and engage in fundraising activities.
4. **Develop and test the POC:** Develop the POC based on the updated scope and concept, and conduct thorough testing of the POC with target audience segment to gather feedback and refine requirements/solution architecture
5. **Refine and develop the MVP:**
    a. **Prioritisation:** Determine the key features that need to be included and prioritise builds for functionality and maximum value to users
    b. **Scalability:** Design the system for future expansion, allowing for the integration of more advanced features like real-time tracking and predictive modelling at a global scale
    c. **Sustainability planning:** Ensure that the system is sustainable in the long term by considering ethical, technical, and financial factors.

The successful implementation of the POC will enable MAF and its partners to start measuring and addressing rural isolation with precision, creating the foundation for global efforts to reduce isolation and improve access to critical services worldwide.

8 Annex A: Indices mapped to features table

The table below is a collection of existing indices created by multiple aid or government agencies, used to track dimensions pertaining to isolation. Each index is evaluated for geographic coverage, index construction, and update frequency, along with other details describing the index, and this list informed the basis of the concept paper and identification of core dimensions for a future III.

Index	Focus	Dimension measured	Geographic coverage	Subnational detail	Data sources	Geospatial data	Metric design and index construction	Update frequency	Real-time data	Policy actionability
Human Development Index (HDI)	Human development (health, education, income)	Health, education, income	Global	No	UNDP, World Bank	No	Composite index of three key indicators	Annual	No	Used for national development planning but lacks local granularity
Multidimensional Poverty Index (MPI)	Socioeconomic deprivation	Health, education, living standards	Global	Yes	National statistics, UN, surveys		Deprivation-based across multiple indicators	Annual	No	Helps governments target poverty alleviation but lacks geospatial detail
Social Progress Index (SPI)	Well-being and opportunity	Basic needs, well-being, opportunity	Global	Yes	Surveys, national reports	No	Weighted index of various social indicators	Annual	No	Supports social policy and SDG tracking but does not focus on remoteness
Canadian Index of Multiple Deprivation (CIMD)	Socioeconomic and community deprivation	Economic, ethno-cultural, housing, social	Canada	Yes	Canadian census data	No	Four dimensions of deprivation	Irregular	No	Used for targeted interventions in marginalised communities in Canada
European Deprivation Index (EDI)	Socioeconomic deprivation	Income, housing, employment, education	Europe	Yes	EU statistical sources	No	Multi-indicator deprivation measurement	Every 5+ years	No	Used in EU social cohesion policies but updates are infrequent
Gini Coefficient	Income inequality	Income distribution	Global	No	World Bank, national statistics	No	Measures income distribution inequality	Annual	No	Supports income redistribution policies but does not address access to services
Rural Access Index (RAI)	Rural transport accessibility	Transport accessibility	Global	No	Road network datasets, GIS	Yes	% of rural population near all-season roads	Every 5+ years	No	Used for rural infrastructure planning, but lacks real-time data

Global Accessibility Map	Physical remoteness	Travel time to cities	Global	No	GIS, satellite, travel time modelling	Yes	Travel time modelling-based index	Infrequent	No	Supports transport planning but does not capture economic barriers
Accessibility/Remoteness Index of Australia (ARIA+)	Rural service accessibility	Road distance to services	Australia	Yes	Road network, census data	Yes	Distance-based remoteness classification	~5 years	No	Guides rural service delivery but does not include digital connectivity
Access to Essential Services Index	Service accessibility	Healthcare, education, clean water	Global	Yes	UN, national health and education data	Yes	Measures proximity to key services	Irregular	No	Used to identify underserved regions for service expansion
Global Human Settlement Layer (GHSL)	Human settlement distribution	Population density, built-up areas	Global	Yes	Satellite imagery, census	Yes	Mapping of urbanisation and settlements	Periodic	No	Helps urban planning but does not include transport or service access
Rural-Urban Continuum Codes (RUCC)	Urban-rural classification	Population density, remoteness	US	Yes	USDA, US Census Bureau	Yes	Categorises counties by urbanisation levels	Decadal	No	Supports US federal rural assistance programs but is rarely updated
Modified Monash Model (MMM)	Healthcare accessibility	Distance and availability of healthcare	Australia	Yes	Census, healthcare data	Yes	Healthcare service access classification	~5 years	No	Used for rural healthcare resource allocation but does not address non-health factors
Index of Relative Rurality (IRR)	Rural isolation	Geographic remoteness and service access	US	Yes	Census, GIS, socioeconomic data	Yes	Weighted remoteness and service access score	Occasional	No	Helps identify resource gaps in rural areas but lacks a policy framework
Network Readiness Index (NRI)	Digital connectivity and adoption	Digital readiness and ICT use	Global	No	Telecom data, ITU, WEF	No	Digital adoption, affordability, infrastructure	Annual	No	Supports national digital policies but lacks local detail for interventions
International Digital Connectivity Readiness Index (DCRI)	Digital inclusion and policy	Digital infrastructure, adoption	Global	No	National and private sector telecom data	No	Infrastructure, affordability, policy focus	Annual	No	Helps guide telecom investment but lacks spatial and social dimensions
Global Connectivity Index (GCI)	Digital infrastructure and access	Internet penetration and mobile networks	Global	No	Huawei, ITU, national data	No	Digital connectivity and economic impact	Annual	No	Used for broadband expansion planning but lacks affordability measures

9 Annex B: Data sources

The table below provides an initial list of data sources, mapped by category of isolation, that can be used to construct the POC III. Each data source is evaluated for geographic coverage, open-source availability, update frequency, and if there is an API or method of automatically downloading and fetching the dataset, as required for constructing automatic data pipelines.

Category of isolation measured	Data source name	Dimension measured	Geographic coverage	Update frequency	Open source/licence	API/automatic download	Use in POC
Access to resources	World Resources Institute	Water scarcity, climate change risk, forest coverage	Global (granular)	Dependent on dataset (generally high frequency)	Open Data Licence	Yes	Yes
	UNICEF WASH	Access to water, sanitation, and hygiene	Global (regional)	Yearly reports	Open Data Licence	Yes	Yes
	Open Infrastructure Map	Electricity and telecoms access	Global (granular)	Daily	Open Data Licence	Yes	Yes
	Giga	Schools and access to internet	Global (granular)	Daily	Some public/some private data	Yes	Yes
Access to Food/ sustenance, access to economic opportunity	Gallup Poll resources Food Insecurity Experience Scale Global Findex database	Food insecurity, financial literacy	Not global coverage	Unknown	Public data	Yes	Yes
Access to resources, access to food/ sustenance	GeoWiki	Environmental datasets, cropland monitoring, agricultural land use, food security, and pollution	Global (granular)	Unknown	Open Data Licence	Yes	Yes
Access to healthcare/medical care	Healthsites.io	Healthcare facility mapping (updated by communities)	Global (granular)	Real-time	Open Data Licence	Yes	Yes
	WHO	Medical facility mapping	By country	Static reports	Open Data Licence	Yes	Yes
Access to healthcare/medical care, access to resources	ESPEN WHO tropical disease mapping	Demographics (regional), tropical disease mapping, sanitation and access to water	Global (regional)	Yearly reports	Open Data Licence	Yes	Yes
Access to food/sustenance	WHF HungerMap	Live hunger monitoring	By country (granular)	Real-time	Creative Commons Licence (CC0)	Yes	Yes
Access to economic opportunity	UN development reports	Gender inequality, male vs female employment	Country level data	Static reports	Open Data Licence	Yes	Yes

Access to resources, access to economic opportunity, geographic access	World Bank Group	Agriculture and rural development, infrastructure, economy and growth, financial sector, poverty	Global country level data	Static reports	Open Data Licence	Yes	Yes
Geographic access	Google Earth Engine (satellite data)	Rural isolation	Global (granular)	Daily	Free for academic and research use, paid commercial licence	Yes	No
	Global Human Settlement Layer (GHSL)	Rural isolation (map of human settlements)	Global (granular)	Unknown	Open Data Licence	Yes	Yes
	GRIP Global Roads Database	Roads (categorised from highways to local roads)	Global (granular)	Static from 2018	Creative Commons Licence (CC0)	No	Yes
	Global Disaster Alert and Coordination System (GDACS)	Isolation due to natural disaster	Global (granular)	Real-time	Open Data Licence	Yes	Yes

The table below provides an initial list of potential data sources mapped across the core dimensions used to define isolation for the III, namely: access to basic resources, access to healthcare and medical care, access to food and sustenance, access to economic opportunity, and geographical access. These indices and their sources should be explored and leveraged in developing the MVP of the III.

Category of isolation measured	Indices	Dimension measured	Source
Access to basic resources	Human Development Index (HDI)	Includes access to basic services as part of its measurement of overall development	UNDP
	Water Poverty Index (WPI)	Measures access to and availability of water resources	Centre for Ecology and Hydrology
	Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene (WASH)	Tracks global progress on access to safe drinking water and sanitation	WHO / UNICEF
	Energy Access Index (EAI)	Tracks access to electricity and clean cooking fuels	World Bank / International Energy Agency
	Multidimensional Poverty Index (MPI)	Includes lack of access to clean water, sanitation, and electricity as part of poverty assessment	Oxford Poverty and Human Development Initiative (OPHI)
	Global Energy Access Database	Monitors global progress in energy access	World Bank / International Energy Agency / Institute for Health Metrics and Evaluation
Access to healthcare/medical care	Universal Health Coverage (UHC) Index	Measures coverage of essential health services	WHO
	Global Health Security Index (GHSI)	Assesses health system capacity to respond to health emergencies	Johns Hopkins Center for Health Security / Nuclear Threat Initiative (NTI) / The Economist Intelligence Unit (EIU)
	Healthcare Access and Quality (HAQ) Index	Evaluates the quality and accessibility of healthcare services	Institute for Health Metrics and Evaluation (IHME)
	Demographic and Health Surveys (DHS)	Collects data on health service access and outcomes in developing countries	United States Agency for International Development (USAID)
	Health Equity and Financial Protection Indicators (HEFPI)	Tracks financial access to healthcare	World Bank
Access to food and sustenance	Global Hunger Index (GHI)	Measures hunger based on undernourishment, child wasting, child stunting, and child mortality	Concern Worldwide / Welthungerhilfe

	Food Insecurity Experience Scale (FIES)	Tracks individuals' access to sufficient and nutritious food based on self-reported experiences	FAO
	Coping Strategies Index (CSI)	Measures household food security by assessing the frequency and severity of coping strategies used when households face food shortages	CARE International
	Prevalence of undernourishment (PoU)	Measures the proportion of the population whose food intake is insufficient for maintaining an active, healthy life	FAO
	Household Food Insecurity Access Scale (HFIAS)	Assesses food security at the household level based on food availability and access	Food and Nutrition Technical Assistance III Project (FANTA)
	Integrated Food Security Phase Classification (IPC)	A global standard for classifying food insecurity levels, often used in humanitarian contexts	IPC Global Partners
	Global Food Security Index (GFSI)	Measures affordability, availability, quality, and safety of food in different countries	EIU
	Joint Child Malnutrition Estimates	Includes child wasting, stunting, and underweight prevalence as indicators of food access	WHO / UNICEF / World Bank
Access to economic opportunity	Global Competitiveness Index (GCI)	Measures economic conditions that enable productivity and opportunity	World Economic Forum
	Gender Inequality Index (GII)	Measures disparities in economic and social opportunities for women	UNDP
	Labour Force Participation Rate	Tracks participation in the workforce	International Labor Organization (ILO)
	Financial Inclusion Index (Global Findex)	Measures access to banking and financial services	World Bank
Geographical access to urban centres	Rural Access Index (RAI)	Measures the proportion of the rural population with access to all-season roads	World Bank
	World Bank's Logistics Performance Index (LPI)	Evaluates the efficiency of trade and transport infrastructure	
	Nighttime Lights Index	Uses satellite imagery to measure proximity to economic hubs based on light emissions	NASA Earthdata
	Transport Connectivity Index (TCI)	Measures the degree of connectedness within a transportation network, assessing accessibility to transport routes and services, and the frequency of service	Various

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