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Methodology to assesssocio-economic impactsof climate services

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Summary

This report summarises the methodology to assess the socio-economic impacts of the climate services developed in the context of the FOCUS Africa, and in doing so help improve the design and maximise their impact. The proposed methodology was developed building upon identified challenges and recommendations from state-of-the-art literature as well as experience and learnings from similar projects, The report includes a description of its guiding principles, the three phases, the Global Indicator Framework for the Sustainable Development Goals used as a common framework to identify the thematic impact indicators and stories, the four macro-categories used for transversal and specific indicators tailored to each of the eight cases, the eight initial impact pathways, stories and grids.

Approval

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Methodology to assess socio-economic impacts of climate services

Deliverable D6.1

Lead Beneficiary: LGI Sustainable Innovation
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About FOCUS-Africa

FOCUS-Africa – Full-value chain Optimised Climate User-centric Services for Southern Africa – is developing sustainable tailored climate services in the Southern African Development Community (SADC) region for four sectors: agriculture and food security, water, energy and infrastructure.

It will pilot eight case studies in five countries involving a wide range of end-uses to illustrate how the application of new climate forecasts, projections, resources from Copernicus, GFCS and other relevant products can maximise socio-economic benefits in the Southern Africa region and potentially in the whole of Africa.

Led by WMO, it gathers 14 partners across Africa and Europe jointly committed to addressing the recurring sustainability and exploitation challenge of climate services in Africa over a period of 48 months.

For more information visit: www.focus-africaproject.eu

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Executive Summary

FOCUS-Africa is developing climate services for the Southern African Development Community region and four sectors of interest, namely agriculture and food security, water, energy and infrastructure. These services will be developed within eight case studies which seek to maximise socio-economic benefits in the Southern Africa region and potentially in the whole of Africa. As such, it is essential to define a **methodology to assess the socio-economic impacts** tailored to the FOCUS-Africa context, which constitutes the core objective of this task T6.1 and resulting deliverable D6.1.

This document highlights herein the key guiding principles of the proposed approach, envisaged as **a framework to help assess the short and long term impact** of the climate services developed in the context of the FOCUS Africa, and in doing so help **improve the design and maximise their impact**. The proposed methodology was developed building upon identified challenges and recommendations from state-of-the-art literature as well as experience and learnings from similar projects, summarised in this report and illustrated in Figure 1.

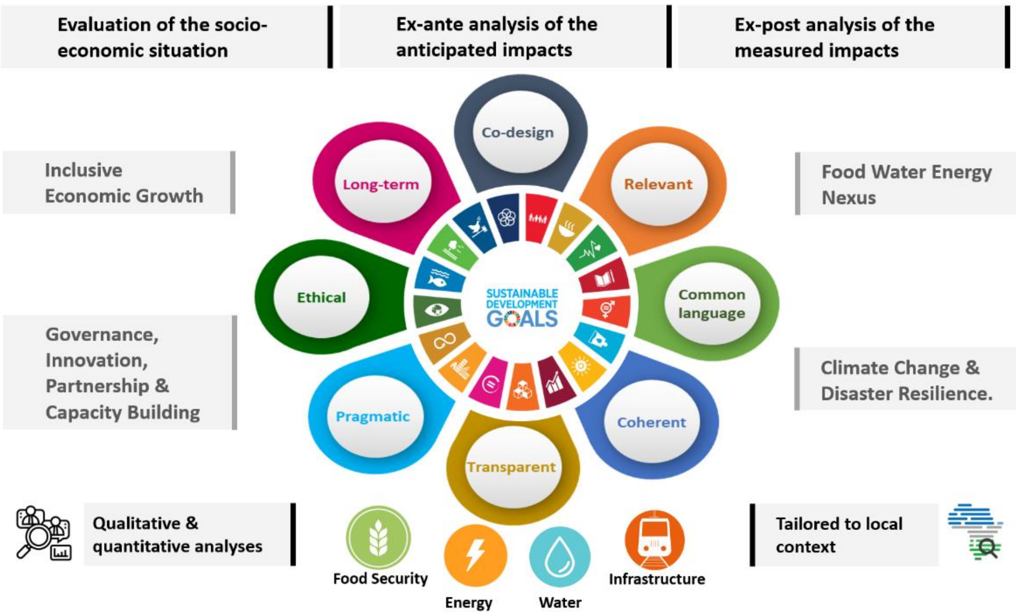

Figure 1: Focus Africa impact assessment methodology overview

The impact assessment is constituted of **three phases** starting with the evaluation of the socio-economic situation for each case study context, followed by the potential anticipated impact of the climate services (‘*ex-ante*’), to finish with the measured impact of the climate services (‘*ex-post’*). The impact assessment uses the Global Indicator Framework for the **Sustainable Development Goals** (SDGs) as a common framework to identify the thematic impact indicators and stories. Four macro-categories emerged as cohesive impact directions to help cluster the variety of relevant SDGs and indicators, namely ‘*Inclusive economic growth*’ (SDGs 1, 5, 8 & 10); ‘*Food Water Energy Nexus*’ (SDGs 2, 6 & 7); ‘*Governance, Innovation, Partnership & Capacity Building*’ (SDGs 4, 9, 16, 17); and ‘*Climate Change & Disaster Resilience*’ (SDGs 13, 11 & 12). These impact categories were used to define transversal indicators, common to all case studies, as well as specific indicators tailored to each case study, resulting in **eight impact assessment grids, one for each case study**. This quantitative analysis will be accompanied by a qualitative analysis through the development of **eight impact pathways** and **impact stories**, initiated in this report and to provide an understanding of the pathway that information and activities take to transform decision making processes and achieve socio-economic impacts. The combination of qualitative and quantitative components in the impact assessment is sought to provide the greatest value for the climate services’ designers and their users, keeping in mind the challenges posed with accessing data. Last but not least, co-design and **stakeholder engagement** are at the core of the methodology, which means that best efforts are placed for the proposed approach to be **flexible and tailored** to the reality of the local context and to the changes that can occur throughout the project, such as in the context of the COVID-19 pandemic.

Keywords

Socio-economic benefits, Climate services, Impact Assessment, Sustainable Development Goals, EU-Africa collaboration, methodology

Acronyms

BSC	Barcelona Supercomputing Centre
CS	Climate Service or Case Study
CSIR	Council for Scientific and Industrial Research of South Africa
DCCMS	Malawian Department of Climate Change and Meteorological Services
DSSAT	Decision-Support System for Agro-technology Transfer
EDF	Electricité de France (EDF)
FAO	Food and Agriculture Organisation
FOCUS-Africa	Full-value chain Optimised Climate User-centric Services for Southern Africa
FGD	Focus Group Discussion
GFCS	Global Framework for Climate Services
IEA	International Energy Agency
IAT	Impact Assessment Team
IAG	Impact Assessment Grid
IIAM	Mozambique's Institute of Agricultural Research
IRENA	International Renewable Energy Agency
JRC	Joint Research Centre
MO	Met Office
RIMA	Resilience Index and Measurement Analysis
RRI	Responsible Research & Innovation
SADC	Southern African Development Community
SDG	Sustainable Development Goal
SSSA	Scuola Superiore Sant'Anna
TANESCO	Tanzania Electric Supply
TARI	Tanzania Agricultural Research Institute
TMA	Tanzania Meteorological Agency
ToC	Theory of Change
UCT	The University of Cape Town
WITS	The University of Witwatersrand Johannesburg
WEMC	World Energy and Meteorology Council
WHO	World Health Organisation
WMO	World Meteorological Organisation
WRU	Water Resource Unit of Mauritius

1. Introduction

1. 1. Overview of Focus Africa and WP6

FOCUS-Africa is developing sustainable tailored climate services in the Southern African Development Community (SADC) region for four sectors: agriculture and food security, water, energy and infrastructure. To achieve this, eight case studies are being implemented in five countries involving a wide range of end-uses to illustrate how the application of climate services can maximise socio-economic benefits in the Southern Africa region and potentially in the whole of Africa (Figure 2). Led by the World Meteorological Organisation (WMO), it gathers 14 partners across Africa and Europe jointly committed to addressing the recurring sustainability and exploitation challenge of Climate Services (CS) in Africa over a period of four years.

Case Study	1	2	3	4	5	6	7	8
Country	South Africa	Malawi	Mozambique	Tanzania	Tanzania	Tanzania	Malawi	Mauritius
Sector	Food Security	Food Security	Food Security	Food Security	Infrastructure	Energy	Energy	Water
Leader	CSIR, Trevor Lumsden	BSC, Dragana Bojovic	SSSA, Matteo Dell'Acqua	BSC, Dragana Bojovic	MO, Nicolas Fournier	MO, Nicolas Fournier	EDF, Hiba Omrani	CSIR, Mohau Mateyisi

Figure 2: FOCUS-Africa Case Studies

The focus of Work Package (WP) 6 is to assess the climate services socio-economic benefits and prepare the exploitation of the most promising and impactful services. In this regard, the objectives of this WP are to:

- Explore new approaches for socio-economic benefits assessment of climate services;
- Assess the current socio-economic situation of each case study (baseline for evaluation);
- Evaluate the expected socio-economic impacts of climate services (ex-ante);
- Propose improvements to prototypes to increase their potential impacts;
- Measure and validate socio-economic impacts (ex-post);
- Define exploitation strategies for the provision of climate services;
- Study the replicability of climate services to other geographic areas and other socio-economic contexts.

1. 2. Description of T6.1

As part of WP6, Task T6.1 is the first out of three impact assessment tasks dedicated to define the socio-economic impact approach (T6.1), evaluate the socio-economic situation for each case study context and the potential anticipated impact of the climate services (T6.2 '*ex-ante*'), as well as measure the actual impact of the climate services (T6.3 '*ex-post*').

In particular, Task T6.1 focuses **on establishing the socio-economic impact assessment approach tailored to the *FOCUS-Africa* context.** This task sets the guidelines for the socio-economic benefit analyses, with co-production and adaptability at its core. It is indeed our ambition to provide a useful framework, designed to be flexible and tailored to the reality of the local context and to the changes that can occur throughout the project, and that can be used by project beneficiary countries beyond the project life time to assess the long-term impacts of climate services.

This task defines processes, methods and tools to be used all along the project to evaluate the socio-economic benefits of the developed climate services. It is co-developed by the **Impact Assessment Team (IAT)**, composed by LGI and BSC, together with WMO and CS leaders and local representatives of the case studies to ensure the consideration of local specificities while keeping a common baseline to allow cross-analyses.

It starts with a literature review of the latest publications on socio-economic impact assessments, as well as an analysis of approaches used in other projects (e.g. Climandes and Sustainable CIS) to understand the key considerations and challenges for assessing climate services. It also takes into account the sectoral, geographical, cultural and contextual dimensions that could influence the socio-economic analysis. In particular, a special focus will be placed on gender biases and the food water energy nexus.

The impact assessment uses the Global Indicator Framework for the Sustainable Development Goals (SDGs) (IAEG-SDGs, 2016) as a common framework to identify the thematic impact indicators and stories (Figure 3).

Figure 3: Sustainable Development Goals

Common guidelines to conduct the assessment were created by the IAT to ensure a harmonised approach between all case studies, with transversal indicators common to all case studies, as well as specific indicators for each case study. The approach and impact assessment grids were co-constructed iteratively with inputs from CS leaders and project local representatives to better adapt the evaluation to the local context. Grounded in the reality that are the challenges with accessing data, the proposed approach is a combination of qualitative and quantitative analyses, designed to provide the greatest value for the CS designers and their users. The assessment is meant as a co-creation exercise to help improve the design of the CS and maximise the impact of the CS beyond the lifetime of the project, rather than strictly an *ex-post* evaluation.

As such, stakeholder engagement is a key component of the approach and methodology development, keeping in mind its dynamic nature and flexibility to adapt and be improved as the development of CS progresses and the understanding of the local contexts and needs strengthens (Figure 4).

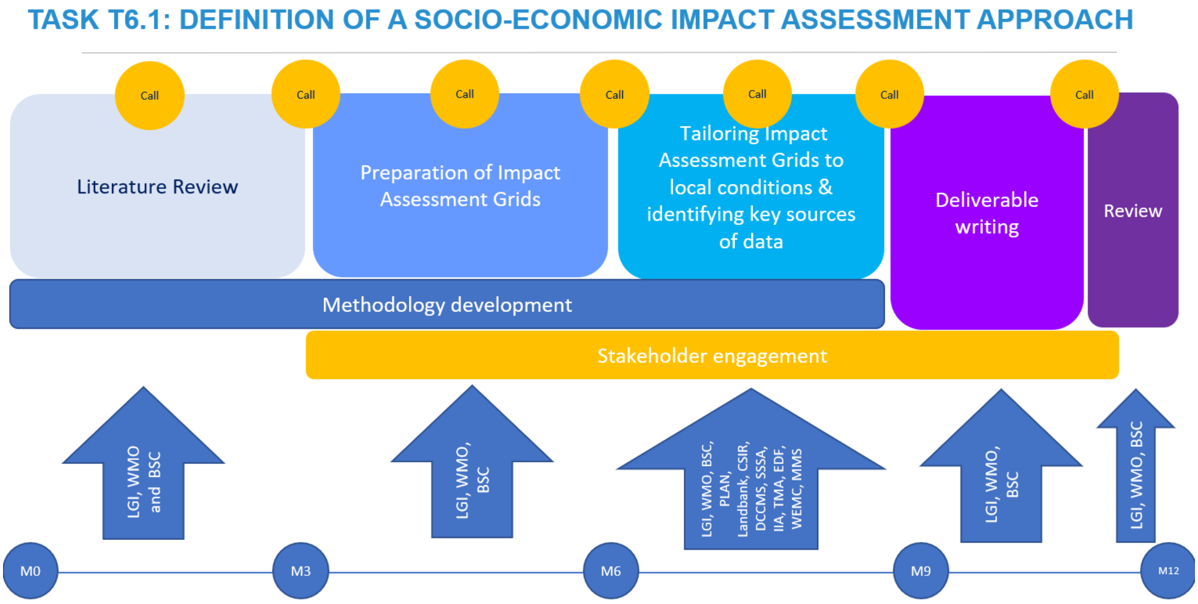

Figure 4: Task T6.1 Overview

Overall, this first deliverable *D6.1 Methodology to assess socio-economic impacts of climate services* starts with a description of the key considerations and challenges identified through our literature review on state-of-the-art impact assessments of climate services, but also on the specific sectors at stake as part of FOCUS Africa. It is then followed by an overview of the key components of the impact assessment methodology, a dive into the case studies and their specificities, before finishing with some overarching conclusions.

2. State of the art – Key Considerations & Challenges to assessing impact

2.1. Overarching considerations

- **Opening remarks**

The methodology described in this report, guides the approach to assessing the impact of the eight Focus Africa case studies, and was developed with the goal of producing knowledge that can ideally tangibly help improve the use-value of project results. This impetus to help improve the socio-economic impact of the project, while also measuring it, has influenced several of the methodological decisions made by the IAT. In particular, it is important to note that the IAT works as active participant observers in the project, and seeks to discuss insights from our socio-economic research with case study leaders as they develop their tools, rather than merely passively reporting the impact of the project from a position of external "neutrality". Our guiding ambition is that the impact assessment research helps support the project throughout its lifespan to maximise impact and progress towards the SDGs. In addition, the aim is for the methodology to be used when possible as a tool to assess the climate services socio-economic benefits for other projects, although with the required adaptations to the specific contexts.

The methodology was also developed in response to lessons regarding the assessment of climate service impact that have been identified in research literature. In particular, "Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services" published jointly by WMO and the World Bank offers several key considerations which our methodology seeks to address (WMO & World Bank Group, 2015). The report offers a concise definition of climate service value as the *net outcome of a decision taken with the climate service in question, versus the expected outcome without*. Based on this definition, it follows that a proper assessment of CS impact will require an in depth understanding of the existing context and decision-making processes in question, as well as the ways in which climate information is received and taken up by users. Therefore, we have adopted an approach that seeks to engage closely with key stakeholders, and qualitatively understand the way they engage with services developed through the project to change their decisions, behaviours, and outcomes achieved.

- **Lessons learned from similar projects**

Our approach to stakeholder engagement is inspired by the insightful work done by similar projects to assess CS impact while also co-developing services with local populations in developing countries. In particular, the projects *Climandes* and *WISER* both placed co-development and stakeholder engagement at the heart of their work and produced valuable guidelines for future research.

Climandes placed a strong emphasis on using CS for capacity building among the local community, which was in their case smallholder farmers in Southern Peru (MeteoSwiss & Senamhi, 2018). Based on their experience, effective socio-economic assessment of CS should focus on mapping key stakeholders, identifying local exposure and vulnerabilities to major climate risk factors, and understanding how the intersection of socio-economic status, gender and inequality can determine vulnerabilities. Moreover, socio-economic assessments can help to identify key constraints to using CS. By exploring the ways locals communicate and the cultural practices that determine how climate information is used, assessments can provide knowledge of the method for service delivery that would provide the greatest value for users. The project also emphasised that once a final assessment of the benefits of a CS has been conducted, it is key to ensure that benefits are communicated with policy makers and that a robust monitoring system is put in place for continued evaluation and improvement of results post-project.

The **WISER** project had many similar takeaways regarding the importance of working closely with stakeholders to maximise impact and ensure the viability of a CS (Carter, 2019). WISER also placed a clear emphasis on securing stakeholder buy-in to the co-development and co-delivery process. This requires developing a shared understanding of the project's ambition with local actors and allowing them to voice their major needs. Consistent evaluation over the life of the project, and after its conclusion, is key to ensure that all key actors have a voice and that identified issues can be remedied before they become major roadblocks.

The **Sustainable CIS** project for climate services in sub-Saharan Africa also offered several key learnings that inform the choice of impact assessment methodology (USAID, 2020). Sustainable CIS advocated for a mixed methods approach, combining quantitative metrics on project outcomes with a qualitative understanding of the pathway that information takes to transform decision making processes and achieve impacts. The project offered useful insights into how mixed methods social science can be used to evaluate climate services, and will inform the IAT's approach to integrating survey data, focus groups and semi-structured interviews into a cohesive assessment that includes a baseline study, with ex-ante and ex-post analyses.

- **Major challenges to conducting socio-economic impact assessment of CS**

Several major risks have been identified by researchers that indicate why assessing the impact of CS is more challenging than merely quantifying the change in a given variable before and after the implementation of the service. Correlation does not imply causality, particularly not in highly complex social systems where there are countless numbers of factors that influence the decisions actors take, whether they are related to food and agriculture, energy, infrastructure, or water (Vaughan & Dessai, Climate services for society: origins, institutional arrangements, and design elements for an evaluation framework, 2014). Vaughan et al. confirmed the fact that it is often very **challenging to isolate the relative contribution of CS** to a decision when faced with numerous, potentially confounding, other factors at play.

Another key issue that poses a major challenge to assessing the impact of CS within a limited timeframe is the **variability of the climate** over the course of different seasons and years (Vaughan, Hansen, Roudier, Watkiss, & Carr., 2019). It is possible that much of the time, business as usual decisions may align entirely with CS informed decisions, and a CS might only demonstrate its value over the long term as the climate changes or during extreme climate related events such as natural disasters. Any short-term evaluation of a CS risks overstating the value of the service if it effectively predicts an unusual extreme event or under-evaluating its value if it results in no change in behaviour over the short sample time. To robustly quantify the real-world impact of a CS, research over extended numbers of years would be needed, which is beyond the scope of this project's timeframe since the majority of the CS will only be operational in the final year of the project.

Alongside these major challenges inherent to the assessment of CS impact, several additional challenges particular to our project have been identified by the IAT. Key among these is the difficulty of **conducting social scientific research across widely dispersed geographies**. The IAT is based in Europe and will have only a limited amount of time to conduct field research in Africa, which could pose challenges in terms of **gathering data.** This has been made even more challenging due to the additional barriers to travel posed by the **Covid-19 pandemic**, which has made planning for travel extremely uncertain due to consistent fluctuations in national travel restrictions and sanitary situations. When site studies and interviews with local stakeholders can be undertaken, it will be key to consistently interrogate the relationship between researcher and research subjects. The wide array of linguistic and cultural diversity of people involved in the Focus Africa project poses **risks of misinterpretation** of research by the IAT, or that stakeholders may choose to selectively divulge information based on their own subjective perceptions of the project and its potential to benefit them.

The IAT has sought to develop a research method that responds to these many complex overarching factors. It is important to note that the existing approach is not a static methodology. Rather, the goal here is to develop a flexible approach to assessing impact that can adapt and evolve in response to new information and dynamic conditions over the life of the Focus Africa project.

2.2. Thematic considerations

Food Security

According to WMO's 2019 State of Climate Services report on Agriculture and Food Security 'Monitoring and evaluation of the results and benefits of the use of climate services remains consistently weak across all regions' (WMO, 2019). Although available WMO data suggests that there has been progress on governance and stakeholder engagement for CS, as well as in the implementation of basic hydrometeorological systems, demonstrating the results and benefits of the use of CS remains a challenge. This is in part due to the array of challenges highlighted in the previous section, and to additional considerations especially relevant to food security CS.

Smallholder farmers make up over 60% of the population in sub-Saharan Africa (Mckinsey, 2019). Therefore, evaluating the impact of climate services for agriculture in the region involves exploring the impact of climate information across broad swaths of the population, as opposed to other sectors such as energy or infrastructure where relatively few technical specialists are likely to engage with climate information in their work. This poses its own set of methodological challenges. As Tall et al. have argued, livelihood outcomes for smallholder farmers are primarily driven by the dynamics of complex social and economic systems, and isolating the impact of CS information of outcomes is particularly difficult (Tall, Coulibaly, & Diop., 2018). Moreover, they argue that climate information is 'leaky' and can spread widely across an agrarian community, making it difficult to conduct studies that isolate CS impacts using a control group (ibid.). The researchers therefore argue for a mixed methods approach that understands the qualitative way that CS information transforms livelihoods, while also seeking to quantify changes in outcomes.

Several assessments of existing climate services for agriculture in developing countries offered additional insights into the type of value CS can provide smallholder farmers. Partey et al. found for instance that the high dependence of smallholder farmers in West Africa on rainfall to water their crops, meant that climate services offered value by informing crop management practices to adapt according to seasonal variability (Partey, Zougmoré, Ouédraogo, & Campbell, 2018). Another study of the monetary value of climate services, which was conducted by Filippo and Vinogradova in Peru, found that the willingness of farmers to pay for climate information varied between farms. Their survey data indicated that forecast performance and the vulnerability of a crop to fluctuations in temperature and precipitation were the primary factors influencing willingness to pay, and that coffee growers were more likely to value climate information than maize farmers. Additionally, they found that larger, more productive farms were more likely to express a willingness to pay for climate information than smaller, less productive operations (Lechthaler & Vinogradova., 2017). Therefore, the impact assessment of Focus Africa will also seek to understand how farmers adapt their practices in response to climate variability, how crop selection and climate vulnerability intersect, and place an emphasis on understanding how different types of farms (smallholder vs industrial) obtain value from the Focus Africa food security CS. Adapting farming practices is also important for farmers to access credit. For example, the Land Bank, partner in this project, will include climate risk in credit modelling and the farmers will be provided with guidance for risk adaptation.

Another key aspect to improving Food Security through Focus Africa will be improved **climate resilience** among local populations receiving information from the CS. The IAT's understanding of resilience among rural households draws upon the existing work conducted by the Food and Agriculture Organisation (FAO) to develop their Resilience Index and Measurement Analysis model (RIMA-II), even though ultimately the IAT decided not to conduct a full analysis using RIMA-II during the project timeframe. The IAT decided not to conduct a RIMA analysis due to the logistical challenges related to a wide distribution of surveys and to establishing causality impact of the CS on local outcomes in a short time span. However, the Food Security case studies will borrow from RIMA's understanding of resilience as the capacity of agricultural households to respond to exogenous shocks. Moreover, the IAT will draw upon previous RIMA analyses conducted by the FAO in Tanzania and

Malawi, and qualitatively explore the potential impact of Focus Africa on the four pillars of resilience defined by RIMA: adaptive capacity, social safety nets, assets, and access to basic services (FAO, 2016).

Water

A study conducted by WMO and FAO revealed that water, together with agriculture and food security, is perceived worldwide as a top priority sector for climate adaptation. Africa is already suffering from the impacts of climate change and is expected to be hit harder over time, increasing the water availability stress particularly in semi-arid areas (WMO, 2019). The issue is exacerbated by the poor conversion ratio of the mean annual precipitation to mean annual runoff. This means that, compared to the rest of the world, Africa has a hydrological cycle with the lowest ratio of water that eventually becomes a river arising from water originally falling to earth as precipitation. This ratio varies across Africa, with southern Africa being the most exposed to this problem (WMO, 2019).

At the same time, water is a fundamental resource for society. According to the Council for Scientific and Industrial Research of South Africa (CSIR), "water availability is a limiting factor for future economic growth and development unless the management of the resource-base is conducted in a responsible manner that is informed by a robust scientific process" (Turton). In fact, water is a key commodity needed to supply drinkable water and for sanitation, for irrigation, for industry, for waste management as well as for energy production. The vast majority of the water in the SADC region is used by the agricultural sector (UNIDO, 2011). Due to a lack of infrastructure, only 61% of the SADC region's population has access to safe drinking water and 39% has access to adequate sanitation facilities. The lack of infrastructure also inhibits the development of the region's hydroelectric potential (SADC, 2021). Measures have been taken by SADC Member States to tackle water needs. For instance, the Regional Water Policy and the Regional Water Strategy have been adopted in 2005 and 2006, respectively. At the basis of this, the principle is to treat water as a regional resource to be managed and protected across national boundaries (ibid.).

Climate change is increasing rainfall variability posing an extra challenge to water management. Therefore, it is more than ever crucial to optimise water usage in all sectors (Ludwig, Slobbe, & Cofino, 2014) and integrated water management. Water is a flux (unlike other natural resources that are a stock, for example gold, coal, oil or iron) and it is fugitive in nature. These two characteristics can allow water to become a renewable resource if managed correctly. While the contribution of climate services in water resources optimisation for agriculture and energy is included in the respective thematic areas (and case studies 1, 2, 3, 4, 6, and 7), climate services can also contribute to the integrated water resource management (as case study 8 seeks to demonstrate). This is the responsibility of water authorities who manage the commodity at regional or national levels and coordinate with neighbouring countries.

The expected role of climate services is to support water authorities' decision-making. Climate data and information underpin the planning and management of surface water supplies and disaster risk reduction: calculations of the frequency and duration of heavy rainfall, the probable maximum precipitation, low-flow and flood forecasting, assessments of water resources, etc. Such data collected on weekly, seasonal and annual timescales and at national, regional and local levels are now more essential than ever to develop operational water management strategies, including flood and drought preparedness and response (GFCS). High resolution climate predictions of droughts, precipitation and temperature can support timely decisions to avoid water wastes and try to achieve an optimal allocation. Contrarily to the agricultural area, the climate services evaluation for the water sector will focus on a limited range of technical users from water authorities. The choice derives from the fact that water authorities are responsible for integrated water resource management, and therefore are the key users that can react to climate information to ensure optimal water management across sectors.

Energy

Energy in Sub-Saharan Africa persistently faces the issue of the lack of access to electricity and clean cooking, as well as the unreliability of electricity supply. According to IEA data from 2019, only 47.9% of the population in Sub-Saharan Africa has access to electricity. Therefore, the Sustainable Development Goal 7 aims to ensure access to affordable, reliable and sustainable energy for all. In order to achieve this, many new renewable energy projects are envisioned in the region. However, renewable energy supply faces the challenge of depending on climate and weather conditions. This challenge, combined with the fact that Sub-Saharan Africa is predicted to have more variability and extreme events due to climate change, means that the need for climate services for energy is rapidly increasing.

In several of the countries in the region, including Malawi and Tanzania, the electricity supply is hydro-dependent and thus vulnerable to hydrologic variability. A paper by Conway et al. found that 59% of total hydropower capacity will be located in one cluster of rainfall variability in southern Africa by 2030, which means that the risk of electricity supply disruption that is related to climate will increase. Linking electricity sharing mechanisms could help reduce the risk, but such solutions still face significant political and infrastructural challenges in the region (Conway D., 2017). Making earlier and more accurate predictions of climate risks (on different timescales) could also help mitigate this risk. Therefore, the impact assessment of FOCUS Africa will seek to understand how energy suppliers and operators integrate such information into their practices and to what extent it contributes to climate variability adaptation.

Climate change impacts have so far rarely been explicitly considered in hydropower projects in Sub-Saharan Africa. This is due to the fact that planning horizons of hydropower projects in the region are usually around 30 years, while current climate change projections show impacts of climate change after 2050, meaning that a focus on the natural variability of hydrological cycles is seen as enough and climate variability will likely not be considered (Lumbroso, 2015). However, hydropower projects can have a lifespan of up to 100 years and would thus benefit from including climate information in their decision-making processes. The integration of this information still faces some institutional challenges that should be considered in the impact assessment. For example, the regulation in the region rarely includes rules on considering climate change in investment plans.

Although CS impacts on energy supply cannot be verified during the lifespan of the FOCUS Africa project, it will be possible to make estimates in the long term. Furthermore, the energy sector is characterised by complex decision-making chains with climate being one of the many variables affecting the decisions. This makes the co-development of CS fundamental to meet user needs. In order to support the energy users, the CS is expected to simplify the decision-making processes therefore a useful service should be targeted to its user, and often requires experts' support. The degree of integration of the new climate information in operations and long-term planning can be considered as a measure of success observable during the FOCUS Africa project duration (S2S4E Climate Services for Clean Energy project, 2020), (Vigo, Orlov, Hernández, Asbjørn Aaheim, & Manrique-Suñén, 2019).

Infrastructure

As existing and planned infrastructure assets may not be sufficiently resilient to cope with climate variability, infrastructure is a priority sector for incorporating climate science into decision making to make sure that infrastructure design is based on forward looking risk maps that integrate future climate risks (Woolhouse, 2014). The literature review which was conducted highlighted the development of climate services in the infrastructure sector in several regions of the world including sub-Saharan Africa, Latin America, the Caribbean, Australia, Japan and Viet Nam (Deutsche Gesellschaft für Internationale Züsammenarbeit, 2019) (Miralles-Wilhelm, 2014) (OECD, 2018).

The following considerations are viewed as essential in the infrastructure sector:

Several measures for infrastructures to achieve climate change resilience are taken into consideration:

- Assessing climate hazards based on climate model projections (e.g., sea level rise, changes in rainfall and storm intensity) and their impacts on infrastructure design, operations and maintenance requirements;
- Identifying areas that are less exposed to climate hazards to build new infrastructure assets;
- Assessing indicative infrastructure lifetimes to determine the range of climate futures which the infrastructure may be subjected to over its lifetime;
- Adopting structural adaptation measures e.g., changing the composition of road surfaces so that they do not deform in high temperatures, adopting ecosystem-based approaches using natural infrastructure;
- Adapting the management measures to achieve climate resilience, e.g., changing maintenance schedules and including adaptive management to account for uncertainty in the future;
- Addressing the uncertainty of climate projections by selecting an adequate strategy: Adapting the design for future climate scenarios, or trying to maintain flexibility in infrastructure planning over time to reduce the investment 'lock in' to any one particular set of assumptions on future climate.

Moreover, studies highlighted that key stakeholders must be included and interact with the design and adaptation of climate-resilient infrastructure assets. This includes climate data providers, policy makers, decision makers and engineers, who will contribute to the strengthening of the environment. With this in mind, the mobilisation of public and private investment is key for climate-resilient infrastructure. Within power entities, the gender-dimension must be considered, as well as other socio-economic factors influencing climate change vulnerability (e.g., poverty and social status). Women's meaningful participation in decision-making and consideration of their needs and perspectives must be ensured. Finally, users' needs, economic development, population changes and technological changes are major considerations to take into account in the design of climate services.

3. Impact Assessment Methodology

3.1 Overview

The main objective of the impact assessment methodology is to assess the socio-economic impact of the climate services developed throughout the FOCUS Africa project. However, rather than approaching this assessment from a pure 'summative' perspective, and only evaluate the ex-post impacts of the climate services, the IAT seeks to provide a 'formative' evaluation in the spirit of continuous improvement of the design of the climate services through carrying out the reflective exercise that considers impact from within their conception. In this regard, the methodology is grounded in eight guiding principles as illustrated in Figure 5.

Figure 5: Key guiding principles

The impact assessment methodology was built through an iterative process that benefitted from the collaboration within the IAT and in **co-design** with CS leaders and key local project representatives. It is important that the assessment remains **relevant** and, in this regard, efforts were placed to tailor the approach to the range of sectors, CS and contexts addressed by FOCUS Africa. To remain relevant and useful, the methodology must remain flexible and have the capacity to adapt to the likely changes that the project and socio-economic contexts will bring. The theoretical approach is founded on the Global Indicator Framework for the SDGs, which gives it an internationally shareable perspective in using a **common language** understandable by other projects and organisations. As shown in the tasks represented on Figure 6, following on the methodology development, it is constituted of three phases: the evaluation of the socio-economic context, the ex-ante assessment of expected impacts and recommendations for improvement, and the ex-post analysis of the measured impacts. This **coherent** approach is grounded in the theory of change to help plan how the change can be created and identify the underlying assumptions. To be relevant, the approach must be and seeks to be participatory, welcoming inputs and fostering **transparent and open dialogue** with all stakeholders. With the best intentions, the IAT is also aware of the limits and challenges of CS impact assessments and therefore proposed a hybrid qualitative and quantitative methodology, grounded in **pragmatism** about the existing resources and limited access to statistical data. A seminal way to rigorously demonstrate the impact of CS on a given population, would be setting a 'control sample' not receiving the intervention and compare it with the population benefitting from the 'treatment'. This could usefully complement the diachronic methodology used. On **ethical ground**, and also because of the time and budget required for valid experimental research, such an experiment will not be created. Finally, the ambition for the methodology to be useful to other projects and contexts and therefore recommendations regarding indicators that could measure longer term impact, beyond the lifetime of the project, as well as mechanisms to foster this long-term impact are also included.

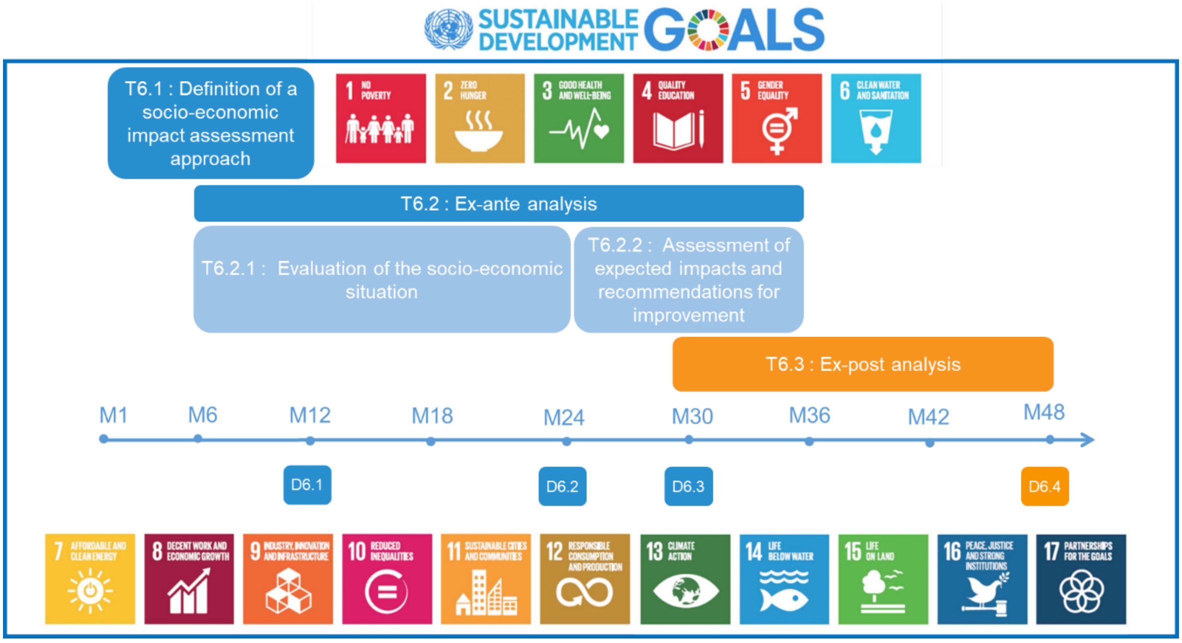

Figure 6: Impact Assessment Tasks Overview

3.2. Impact Pathways and Theory of Change

James (James, 2011) defines **Theory of Change** (ToC) as "an ongoing process of thinking about change in depth and how it happens - and what that means for the organisations that contribute to it in a particular context, sector, and/or group of people". ToC can thus be used as an illustration of how and why a desired change is expected to happen in a particular context (Center for Theory of Change, 2021). Therefore, ToC can be a powerful tool to help initiatives plan how they will create change, assess their effectiveness and communicate to stakeholders.

According to De Reviers (De Reviers, 2012), the steps of the ToC are as follows:

- Define the ultimate, long-term goal or change sought;
- Specify the different changes that must occur before the ultimate change becomes possible;
- Explain the assumptions and values that underlie the rationale;
- Specify the links between this rationale and the intervention.

A ToC should never be created in isolation but should be the result of a collaborative process and joint reflection. Considering different perceptions on the change process and involving people with local and context-specific knowledge is key. Therefore the ToC should be based on a thorough analysis of the socio-economic, political and environmental context; and deliverable D6.2 on the evaluation of the socio-economic situation for the FOCUS Africa case studies will serve as an important building block to the ToC. In order to help CS leaders and teams anticipate the impacts and steps needed to bring change, a ToC template, such as illustrated in Figure 7, could be used as a collaborative exercise as the CS evolve and in line with the future deliverable D6.3 on the ex-ante analysis.

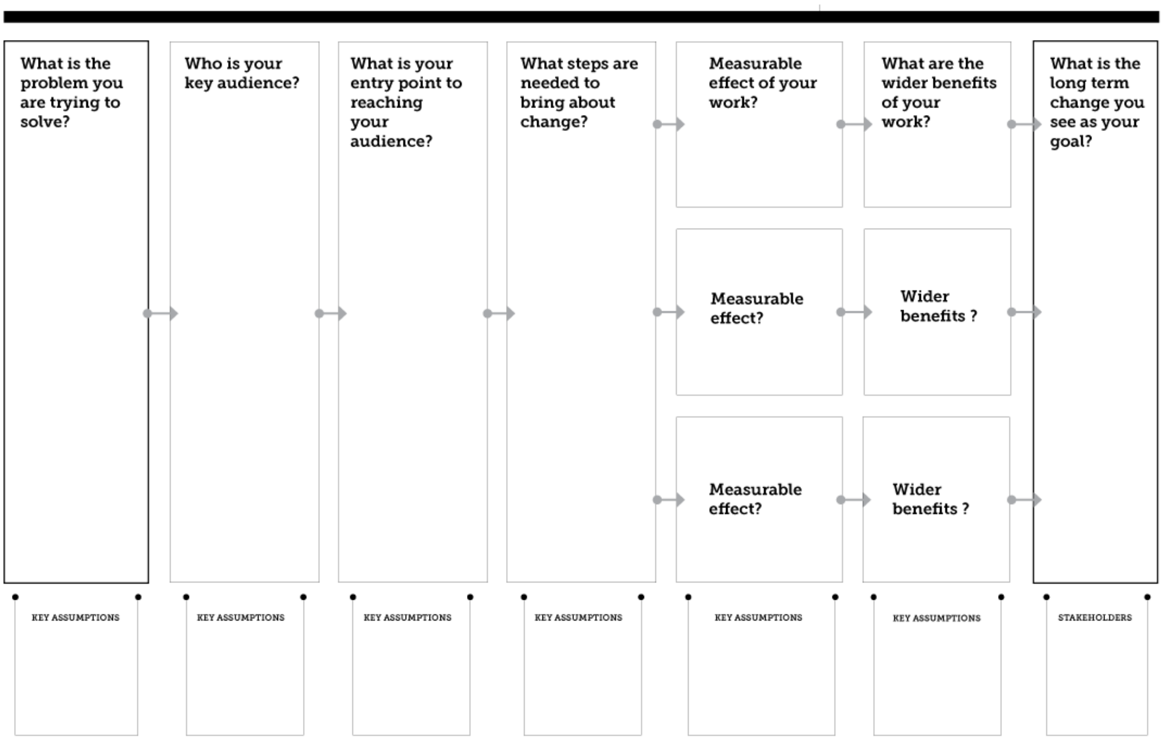

Figure 7: Theory of Change template (Development Impact & You by Nesta, 2014) *(Development Impact & You by Nesta licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License)*

Close to ToC, the logical framework methodology, first described by L. Rosenberg and L. Posner in 1979, is a planning tool based on the assumption of linear cause and effect relationships.

Before developing a full theory of change, outlining the causal relationships and assumptions, the IAT has used the logic model through **impact pathways** (Figure 8) to provide a first understanding and narrative of the case studies and climate services. The impact pathways, included as part of Section 4, provide a logical causal chain from input to impact, to describe how changes are anticipated to happen, based on assumptions made by the people undertaking the work (Thornton, et al., 2017). By identifying the CS mission, activities, short-term outputs, medium-term outcomes and long-term impact of the case studies and climate services under development, metrics or indicators were identified to evaluate the impact.

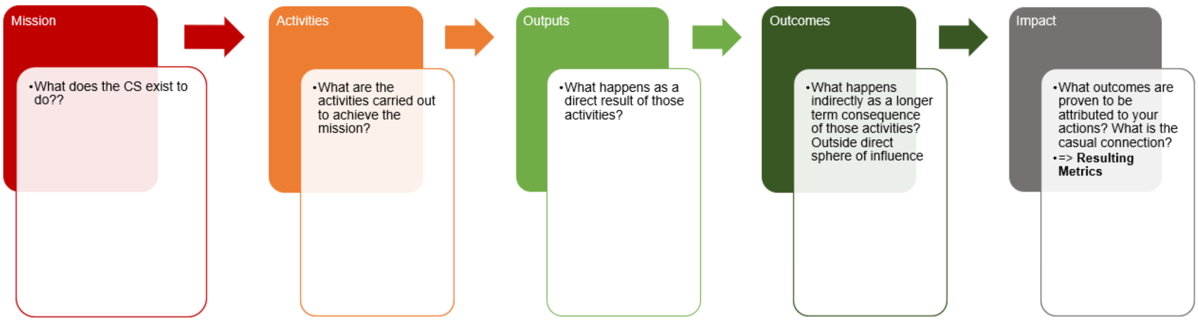

Figure 8: Impact Pathways

3.3. Impact Assessment Grids

Overview

Building from the Global Indicator Framework for the SDGs and the elaboration of impact pathways for each case study, Impact Assessment Grids (IAGs) were developed to enable the assessment of the climate services.

The IAG design and content benefitted from a collaborative approach, iterations and inputs from CS leaders and team members, and when possible local project representatives. The grids included in this first deliverable therefore reflect the current thinking at this point in time in the project and might be subject to more iterations if local considerations demand it. At the core of the impact assessment methodology is the idea that it cannot be static and must be flexible enough to adapt to the local needs.

A common IAG and approach was developed and used across all case studies, with the definition of macro categories and **transversal indicators** (Figure 9). Given the large number of SDGs, it was decided to define four **macro categories** to regroup SDGs by the following themes:

- Inclusive economic growth (SDGs 1, 5, 8 & 10 – indicator **EX**.);
- Food Water Energy Nexus (SDGs 2, 6 & 7 – indicator **NX**.);
- Governance, Innovation, Partnership & Capacity Building (SDGs 4, 9, 16, 17 – indicator **GX**.);
- Climate Change & Disaster Resilience (SDGs 13, 11 & 12 – indicator **CX**.).

In the development of the indicators, it became clear that a combined qualitative and quantitative analysis would provide more value than a strictly quantitative approach. Therefore the grid, as illustrated in Figure 9, proposes for some indicators to be described as **impact stories** rather than directly included in the grid as such.

Impact Assessment Grid							
Macro category	**SGDs**	**Goals and targets (from the 2030 Agenda for Sustainable Development)**	**Indicators**	**Grid / Story**	**Round 1**	**Round 2**	**Round 3**
Inclusive Economic Growth	1 NO POVERTY	**Goal 1. End poverty in all its forms everywhere**	**E1.** Proportion of country population living below the national poverty line, by sex and age *(derived from SDG Ind #1.2.1). Country context to provide broad understanding of what population would be targetted by the CS. For baseline.*	Grid			
	5 GENDER EQUALITY	**Goal 5. Achieve gender equality and empower all women and girls**	**E2.** Measures taken to incorporate gender considerations in the CS design and delivery.	Story			
	8 DECENT WORK AND ECONOMIC GROWTH	**Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**		Grid			
	10 REDUCED INEQUALITIES	**Goal 10. Reduce inequality within and among countries**	**E3**. Number and quality of measures taken by the CS team & project to be inclusive in the design and implementation of the CS - *to empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status (derived from SDG#10.2)*	Story			
Food Water Energy Nexus	2 ZERO HUNGER	**Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	**CSX(Food Security)-X**	Grid			
	6 CLEAN WATER AND SANITATION	**Goal 6. Ensure availability and sustainable management of water and sanitation for all**	**CSX(Water)-X**.	Grid			
	7 AFFORDABLE AND CLEAN ENERGY	**Goal 7. Access to affordable, reliable, sustainable and modern energy for all**	**CSX(Energy)-X**	Grid			
		2 ZERO HUNGER 6 CLEAN WATER AND SANITATION 7 AFFORDABLE AND CLEAN ENERGY	***N1(For Food Security CS).*** *How Food Security affects and is affected by Water and Energy sector coniderations (water and energy consumption of agricultural practices? (derived from 6.4)*	Story			
			N2(For Energy CS) *. How Energy affects and is affected by Food Security and Water sector considerations?*	Story			
			N3(For Water CS). *How Water affects and is affected by Food Security and Energy sector considerations?*				
			NX. Indicator highlighting synergies within project / across CS				

Figure 9: Transversal Impact Assessment Grid (1/2)

Impact Assessment Grid							
Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators	Grid / Story	Round 1	Round 2	Round 3
Governance, Innovation, Partnership & Capacity Building	4 QUALITY EDUCATION	**Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all**	**G1**. Participation in CS capacity building events *(Include number of participants in focus-groups, trainings, information downloads -- includes formal and non-formal events)*	Grid			
			G2. Participation rate of men and women in formal and non-formal trainings *(derived from SDG #4.3)*	Grid			
	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**	**G3.** Measures taken by the CS team to co-design the CS with key stakeholders (list steps and processes, *CS evaluation*).	Story			
			G4. Measures taken to enable the broader uptake of the CS beyond the project (list steps and processes, *CS & project evaluation*).	Story			
			G5. Improved access to IT services & local technology development thanks to measures taken by the project. *Ratings from 1 to 5 on perception? Include notion of bilateral flow of information?*	Grid			
			G6. Measures taken to embed impact management in the design of the CS (list steps and processes, *WP6 evaluation*)				
	16 PEACE, JUSTICE AND STRONG INSTITUTIONS	**Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels**	**G7**. Steps taken to support local communities in responsive, inclusive participatory mechanisms and access to CS information.	Story			
			G8. Proportion of population targetted by CS who believe decision-making is inclusive and responsive, by sex, age, disability and population group *(derived from SDG#16.7.2)*	Grid			
	17 PARTNERSHIPS FOR THE GOALS	**Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**	**G9.** Number of partnerships fostered with other projects, *project evaluation. Consider the categories outlined in SDG17.16*				
			G10. Measures taken to encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships (derived from SDG #17.17, list steps and processes, project evaluation)	Story			
			G11. Percentage of capacity building material & CS information shared with other projects (and steps taken to promote knowledge sharing)	Grid			
			G12. Steps taken to provide policy recommendations and influence decision makers *(from DoA Impact #1 Better policy making for climate adaptation in project and other countries, including Europe*)				
Climate Change & Disaster Resilience	13 CLIMATE ACTION	**Goal 13. Take urgent action to combat climate change and its impacts**	**C1.** Improved resilience to natural disasters in the period during which the CS was implemented *(derived from SDG#1.5). Improved decision making process, education and awareness of climate change and early warning systems. (List long-lasting mechanisms, project and CS evalutation -- derived from SDG#13.a-b).*	Story			
	11 SUSTAINABLE CITIES AND COMMUNITIES	**Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable**	**CS5(Infrastructure)-X**	Grid			
	12 CONSOMMATION ET PRODUCTION RESPONSABLES	**Goal 12. Ensure sustainable consumption and production patterns**	**C2**. Steps taken to raise awareness on sustainable development and lifestyles in harmony with nature *(derived from SDG#12.8, project evaluation?WP6 evaluation?)*				

Round 1: initial socio-economic situation assessment to establish the baseline
Round 2: Ex-ante assessment to evaluate the anticipated impacts of the CS
Round 3: Ex-post assessment to assess the short-term measured impacts of the CS

transversal indicators
monetisation social indicator
to include as part of project evaluation instead

Transversal Impact Assessment Grid (2/2)

In addition to the transversal assessment approach, **specific CS indicators** were developed in collaboration with case study leaders and local project representatives. This resulted in tailored IAGs for each case study, included as part of Section 4.

In particular, indicators were tailored to Food Security CS 1, 2, 3 & 4 under SDG 2 Zero Hunger (**CSX(FoodSecurity)-X**.); Energy CS 6 & 7 under SDG 7 Affordable and Clean Energy (**CSX(Energy)-X**.); Water CS 8 under SDG 6 Clean Water and sanitation (**CSX(Water)-X**.); and Infrastructure CS5 under SDG 11 Sustainable Cities (**CSX(Infrastructure)-X**.)

Monetisation

One way to evaluate the impact of climate services is to monetise them for individuals and groups. Despite the methodological and ethical questions this raises, monetisation will be used when it is relevant and feasible.

On the one hand, monetisation is not always appropriate, desirable or feasible. For example, it is not appropriate to monetise the impacts on lives or fundamental rights. In other cases, it may simply not be desirable because not adding any value to the analysis. Finally, monetisation may not be feasible due to lack of data. On the other hand, monetisation can be very powerful when it allows to appropriately quantify an outcome. In those cases, it can allow the quantification of value to an impact that can help improve understanding and comparison.

When monetising costs and benefits, there are a few good practices to consider. In economic analysis, using real monetary units is more appropriate than using nominal terms which are conventionally used in financial analysis. It is worth noting that real monetary units are inflation-adjusted (WMO & World Bank Group, 2015). This is particularly important to consider when performing the economic analysis in countries experiencing serious inflation as the results can change quite a lot from nominal to real values.

Secondly, the time value of money should be considered. This entails the fact that a person normally prefers to have a Euro today rather than in the future, reflecting a preference for near-term consumption. This implies that, when monetising socio-economic benefits over time, these have to be discounted to reveal the present value. This is done using a discount rate expressed as a percentage (for example, 3% per year). The discount rate (r) is greater the stronger the preference for immediate benefits is. The present value (PV) is calculated as follows:

$$\text{PV (time 0)} = \text{Future Value(time t)}/(1+r)^t$$

For each case study, as part of the impact grids, in addition to the qualitative analysis to be performed for all indicators, some indicators were selected for monetisation . Quantifying these indicators will provide an additional measure to understand the impacts of each climate service. The selection of the indicators to be monetised follows the criteria explained hereafter. Firstly, we consider whether it is appropriate to monetise the indicator based on ethical guidelines set by the project. For instance, the "number of households faced with hunger issues" could be quantified with non-market valuation techniques, but guaranteeing food security to household can be also considered as a fundamental right with "unlimited value". We believe that impact stories can better explain the effects achieved or not, because they disentangle the motivations and changes triggered by climate information. Secondly, sometimes it may not simply be desirable to monetise in the context of our study. For example, when looking at indicators such as "number of people benefitting from climate information". In this case, we could also translate the benefits of each person in monetary terms, but for the scope of our analysis this indicator investigates the inclusivity of the service. Depending on the sector and user-specific characteristics, the benefits of the service can vary but guaranteeing the access to the climate information is a key goal. Last but not least, data availability is a major limitation to monetisation, especially in the countries under study and comprehensive dataset may not be available. Alternatively, information will be gathered though surveys or interviews when possible (WMO & World Bank Group, 2015).

Finally, various valuation techniques exist and could be used to monetise the social indicators. Firstly, value can be distinguished between market and non-market value. The market value is the typical economic value that can be associated to a market price and it can be measured, for example, in terms of spending, sales, output, income, employment and tax revenues generated. The non-market value is not represented by market transactions but this does not make it less important, as it in fact generates benefits for the economy and the society. According to each case study's specificities, a set of indicators to be monetised has been selected, for which the quantification technique will be tailored. A collection of possible valuation methods has been collected by the WMO and is reported in Table 1, Annex 1 (ibid.).

Data

Data sources utilised include desktop research, interviews, focus group discussions, surveys, using the United Nations Statistical SDG database (United Nations, 2021), World Bank world development indicators database (The World Bank, 2021) and local databases whenever possible. It is worth noting that SDG indicators have custodian agencies which work with national entities and focal points to provide data back to the international systems (United Nations , 2021). This is worth noting that as a result, for some indicators and nations, the information is not available on the United Nations Statistical database. Custodian agencies include for instance the World Bank and the International Labour Organisation for SDG1, the Food and Agriculture Organisation (FAO) for SDG2, UNICEF, United Nations Environment Programme (UNEP), the World Health Organisation (WHO) etc. for SDG 6, the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) for SDG7, etc.

3.4. Impact stories

In this work, the **impact stories** refer to the qualitative description of the social processes at stake and the interactions the CS with these processes and their socio-economic, political and environmental context. The impact stories provide a qualitative assessment of the benefits of CS that could not be covered in the quantitative assessment.

These impact stories will be developed through a combination of desktop research, as well as interviews and Focus Group Discussions (FGD) with key stakeholders and fellow users.

Similar to the quantitative approach, the qualitative analysis will follow the three phases of establishing the socio-economic context baseline, the ex-ante anticipated impacts and the ex-post measured impacts. These impact stories will therefore be developed as the project advances and will be included, following the phased-approach in the upcoming deliverables (D6.2, D6.3 and D6.4). The qualitative analysis will also follow the four macro categories, which will create a dialogue with the IAG quantitative analysis.

Efforts will be placed to find visual ways of describing the impact stories and avoid extensive narrations. One of the projects that FOCUS Africa researchers are learning from, FRACTAL (a part of Future Climate for Africa research and development program) did a similar exercise to describe the non-tangible results and changes in processes that were achieved (FRACTAL Consortium partners, 2021). FRACTAL's impact stories are in the form of two-page briefs and include a short analysis and the key lessons learned. Each impact story is accompanied by at least one photo or infographic that helps illustrate the impact.

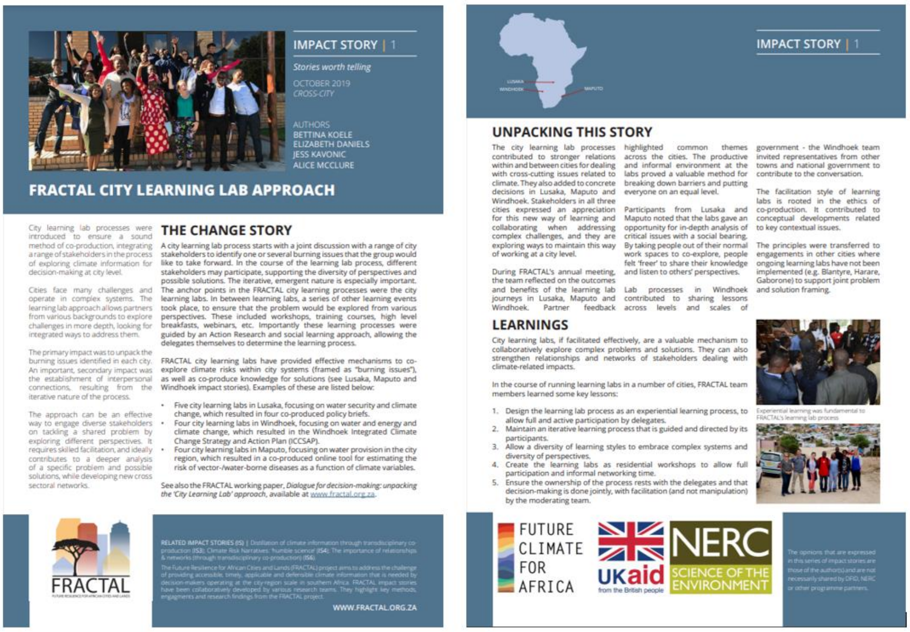

Figure 10: An example of an impact story from the FRACTAL project

For an even more visual approach, infographics with only the most important information can be made. For instance, for each major impact that is identified, the infographic can illustrate what are the effects at different timescales or for different stakeholders. A good practice in such infographics is to use direct quotes of the stakeholders involved as the main (or only) text in the document. When possible, a numerical value from the quantitative part of the impact assessment can also be included in a given impact description, to give more weight to a specific outcome, as exemplified in Figure 11 excerpt from the Streetwise Opera's impact work (Streetwise Opera, 2019).

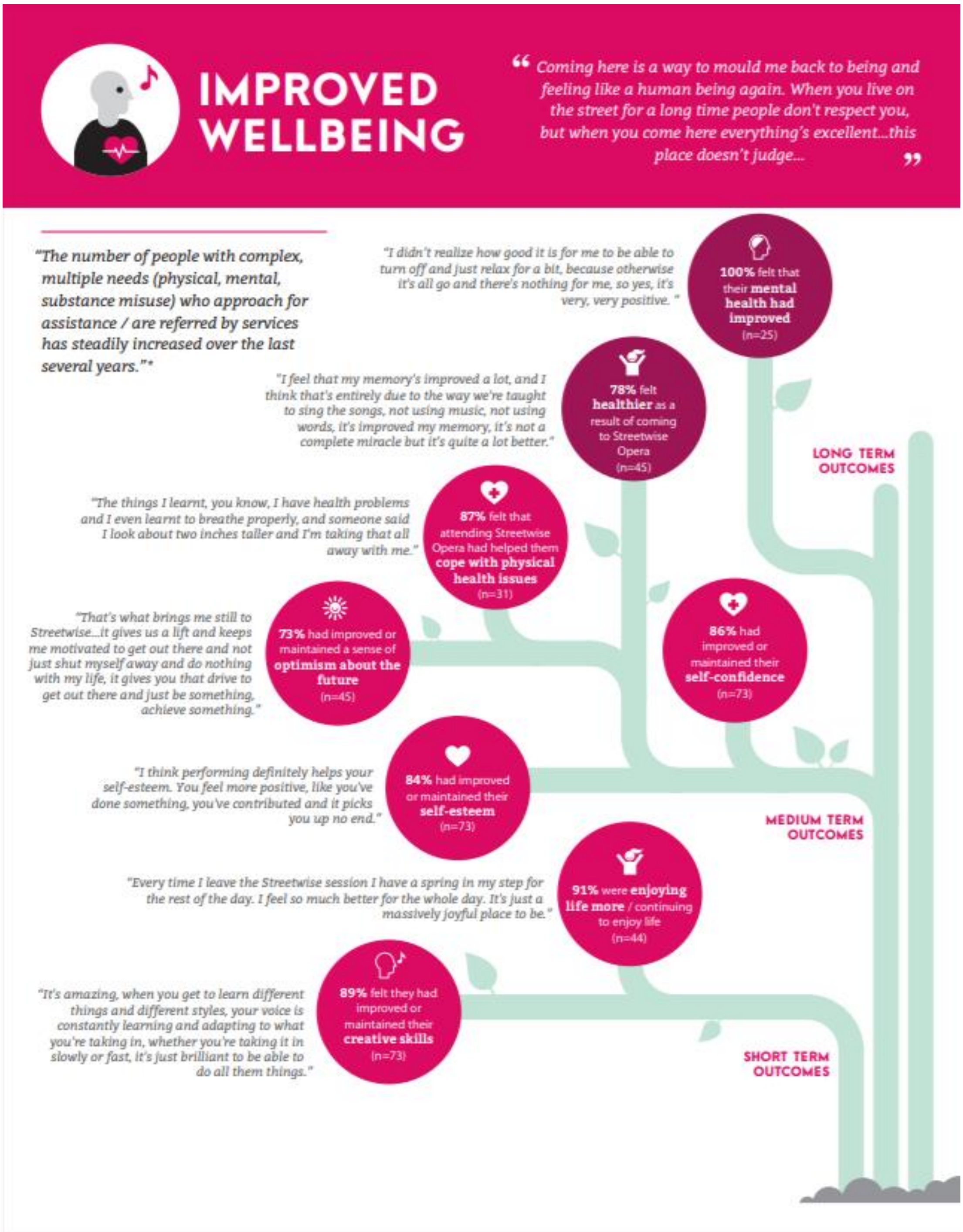

Figure 11: Excerpt from an impact story of Streetwise Opera, Arts charity in England

For FOCUS Africa, the impact stories will follow the same four macro-categories as for the quantitative assessment, as well as the three rounds of the impact assessment, for which guiding questions at each stage have been identified and summarised in Figure 12.

Macro category	SGDs	Socio-Eco Context Story	Ex-ante Story	Ex-post Impact Story	Indicators
Inclusive Economic Growth	5 GENDER EQUALITY 8 DECENT WORK AND ECONOMIC GROWTH 10 REDUCED INEQUALITIES	**E-S.** What factors structure the socio-economic conditions for CS fellow users in these countries?	What is the expected impact of the CS on the economy, particularly for the most marginalised populations (e.g. the poor, women, etc)? Have we identified risks that the CS could exacerbate inequalities (e.g. formal vs informal economy, gender/ ethnic divisions)? What steps will be taken to mitigate these risks? How, and what metric will demonstrate success (to be co-defined)?	Has the CS been designed to maximise the economic outcomes expected in the ex-ante analysis? Do users of the service feel that it offers them value, and can this be monetised?	**E2.** Measures taken to incorporate gender considerations in the CS design and delivery. **E3.** Number and quality of measures taken by the CS team & project to be inclusive in the design and implementation of the CS - *to empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status (derived from SDG#10.2)*
Food Water Energy Nexus	2 ZERO HUNGER 7 AFFORDABLE AND CLEAN ENERGY 6 CLEAN WATER AND SANITATION	**N-ES.** What subject matter practices are deployed in CS countries / target populations? Understanding the steps that could be impacted by the CS.	How is the CS expected to inscribe itself within existing operational processes in the target sectors?	Are there clear mechanisms in place for CS information to reach users and is this beginning to transform operational practices in the target sector? How are practices in the sector evolving thanks to the CS?	***N1(For Food Security CS).*** *How Food Security affects and is affected by Water and Energy sector coniderations (water and energy consumption of agricultural practices? (derived from 6.4)* ***N2(For Energy CS)*** *. How Energy affects and is affected by Food Security and Water sector considerations?* ***N3(For Water CS)*** *. How Water affects and is affected by Food Security and Energy sector considerations?*
Governance, Innovation, Partnership & Capacity Building	4 QUALITY EDUCATION 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 16 PEACE, JUSTICE AND STRONG INSTITUTIONS 17 PARTNERSHIPS FOR THE GOALS	**G-ES.** What is the existing relationship between CS providers and fellow users?	What is the CS strategy for consistent, transparent, and quality service delivery? What steps will be taken to ensure sustainable uptake and buy-in by service providers? Will the project boost capacity of local service providers? How, and what metric will demonstrate success (to be co-defined)?	Do local stakeholders feel that their inputs have been sufficiently considered in co-designing the CS? Are local service providers able to continue operating the CS autonomously after the conclusion of the project? Are their expectations for continued knowledge exchange between stakeholders involved in the project?	**G3.** Measures taken by the CS team to co-design the CS with key stakeholders (list steps and processes, *CS evaluation*). **G4.** Measures taken to enable the broader uptake of the CS beyond the project (list steps and processes, *CS & project evaluation*). **G7.** Steps taken to support local communities in responsive, inclusive participatory mechanisms and access to CS information. **G10.** Measures taken to encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships (derived from SDG #17.17, list steps and processes, project evaluation)
Climate Change & Disaster Resilience	13 CLIMATE ACTION	**C-ES.** What practices are deployed in CS countries / target populations?	What time scale and type of actor is the CS targeting (slow stresses due to climate change or immediate threats of disasters)? – this will inform the subsequent metrics on resilience Is the CS expected to improve local early warning systems? What mechanisms are going to be put in place to develop risk reduction plans in response to CS information?	Has the CS contributed to enhancing local early warning and climate change adaptation plans?	**C1.** Improved resilience to natural disasters in the period during which the CS was implemented *(derived from SDG#1.5). Improved decision making process, education and awareness of climate change and early warning systems. (List long-lasting mechanisms, project and CS evalutation -- derived from SDG#13.a-b).* **C2.** Steps taken to raise awareness on sustainable development and lifestyles in harmony with nature *(derived from SDG#12.8, project evaluation?WP6 evaluation?)*

Figure 12: Impact Stories overview

This project has received funding from the European Commission’s Horizon 2020 Research and Innovation Programme. The content in this presentation reflects only the author(s)’s views. The European Commission is not responsible for any use that may be made of the information it contains.

3.5. Stakeholder engagement and recursive methodology for WP6

During the first external stakeholder workshop organised by FOCUS Africa, the term 'fellow-user' emerged as a better alternative to the term 'end-user' from Professor Coleen Vogel's presentation who advised that the usage of 'fellow-user' would be considered a more collaborative way of looking at the relationship with the CS users, and was therefore adopted by the FOCUS Africa team.

Stakeholder engagement and co-design are at the core of the IAT's methodology guiding principles, and the Global Framework for Climate Services (GFCS) and other initiatives such as WISER, the WMO-led Climandes and Sustainable CIS implemented in the context of the GFCS, and from the literature, that highlight the importance of effective engagement between the developers and users of any CS. Among many others, Hewitt et al. stresses the necessity to bring the needs of the users into the design of the CS as early as possible and throughout the development cycle (Hewitt, 2020); which equally applies to the impact assessment approach. The quality of the exchanges, relationships and networks are also put forward by Weichselgartner & Arheimer, who promote the creation of polycentric, multi-partite processes in a sustainable dialogue built on non-hierarchical knowledge-action systems (Weichselgartner, 2019).

It is grounded in the IAT's approach to work side by side with the CS leaders and engage with the relevant stakeholders as a collaborative CS leader-IAT researcher pair. In this regard, the IAT also needs to adapt to constraints the CS leaders are facing regarding stakeholder engagement and the additional difficulties brought by the complex, global sanitary crisis.

The IAT members have sought and leveraged multiple opportunities and put in place several mechanisms to encourage stakeholder engagement. At a WP level, WP6 meetings are organised and WP6 quarterly reports shared with all WP contributors. IAT coordination calls take place every two weeks to harmonise the approach, share updates, raise questions and plan next steps. IAT researchers participate in regular CS meetings and additional ad-hoc calls when specific issues arise or need to be discussed. Bilateral conversations to co-design and improve the approach with CS leaders and local project representatives are also strongly encouraged. The IAT also takes advantage of the stakeholder workshops organised by WP1 focused on stakeholder engagement and participates in the organising committee. A stakeholder engagement plan was drafted and shared with the Executive Committee (WP and CS leaders) in the spirit of fostering and better aligning engagement with stakeholders and collectively plan visits to the targeted regions. This plan however suffers from the unexpected issues faced regarding the lack of stakeholder responsiveness, which is unfortunately magnified by the global pandemic. The Executive Committee therefore also provide a vehicle to raise risks and find collective solutions to overcome issues such as the difficulty to effectively engage with the local stakeholders.

To enhance the quality of the multi-partite engagement process, a **Recursive Multi-Stakeholder Consultations** (RMSC) process is envisaged for each case study (Figure 13); however given the new difficulties arising from the global pandemic, there will be a need to reassess whether this approach is feasible as the situation evolves. In a nutshell, the first step consists in mapping the stakeholders to be engaged in the RMSCs, targeting the main stakeholders but also representatives of civil society such as professional organisation and association. With insights from the stakeholder mapping exercise, the RMSC approach is structured in a two-fold consultation-analysis process as follows:

1. Conducting a first round of face-to-face in-depth individual stakeholder interviews in the different countries.

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2. Drafting a concise intermediate report highlighting major convergences and divergences (at the levels of perceptions and framing, interests and priorities, proposed solutions), based on the results of the first interview round.
3. Conducting a second round of stakeholder consultations, if the sanitary situation allows, on field or online, using the interim report as a basis for discussion.
4. Analysing the outcomes emerging from both consultation rounds.

This method allows to reverse the ordinary approach by which perceptions and priorities of local and final users are included in the picture only marginally and/or *a posteriori*. Inviting the IAT, CS leaders and key local stakeholders to react and position themselves with reference to structured inputs coming from 'fellow-users' represents an innovative approach capable to generate fresh and innovative policy perspectives. Further work into the stakeholder mapping for each case study will enable the IAT to refine the approach, as part of the next deliverable D6.2. This activity will be carried out in collaboration with WP1 and WP2.

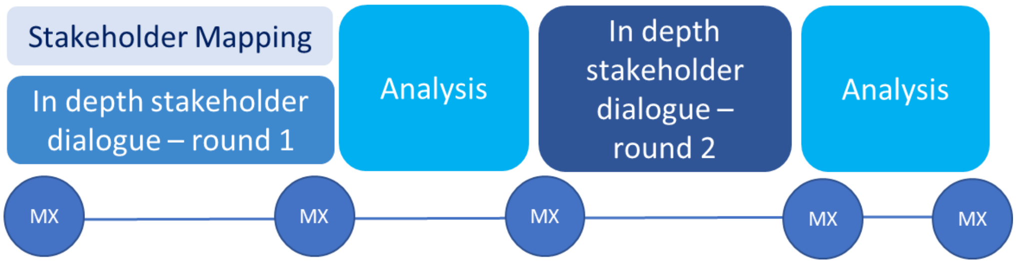
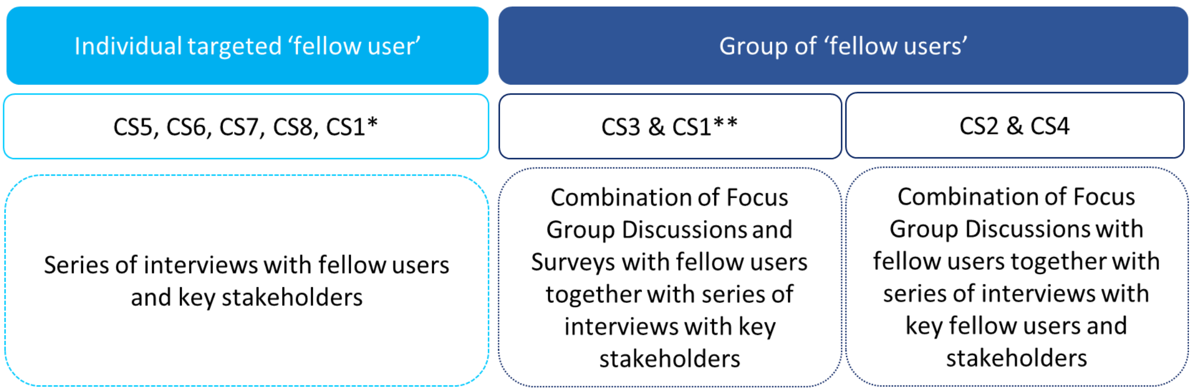


Figure 13: Recursive Multi-Stakeholder Consultations Approach

The engagement approach will be adapted to the type of 'fellow user' and the context for each case study. The engagement process will serve to shed some light during the three phases of the assessment to 1/ better understand the socio-economic context, 2/ establish the anticipated impacts and 3/ measure the impacts of the CS. As such and illustrated in Figure 14, two broad groups of CS can be distinguished, namely (i) the case studies targeting individual fellow users, for which a series of interviews will constitute the preferred engagement approach; and (ii) the case studies targeting mainly a group of fellow users, for which a combination of Focus Group Discussions and surveys will be organised depending on the resources available and the sanitary context. For all CS, targeted interviews with key stakeholders will complement the understanding of the situation.



**CS1 has both individual & group of fellow users* ***to be confirmed based on capacity for CS1 to conduct surveys*

Figure 14: Types of fellow users and corresponding engagement strategies

3.6. Link to Project Evaluation

The assessments complement the efforts to evaluate the project as a whole in order to:

- enable timely reactions in case of under or overachievement of targets, occurred delays, or new risks;
- ensure collection and exchange of lessons learned;
- facilitate the monitoring against Responsible Research & Innovation (RRI principles).

The work proposed by the WP1 team would follow a two-fold approach involving on the one hand the internal monitoring and evaluation of the project, and on the other hand the involvement of the Advisory Board to review the relevant information.

In this sense, the work of WP6 on the socio-economic assessment of the CS is envisaged as feeding into the broader project impact or evaluation, as illustrated in Figure 15. The synergies between the work of the two WPs are highlighted, with all works carried out as part of FOCUS Africa ultimately converging towards the achievement of the six impact categories proposed in the Description of Actions.

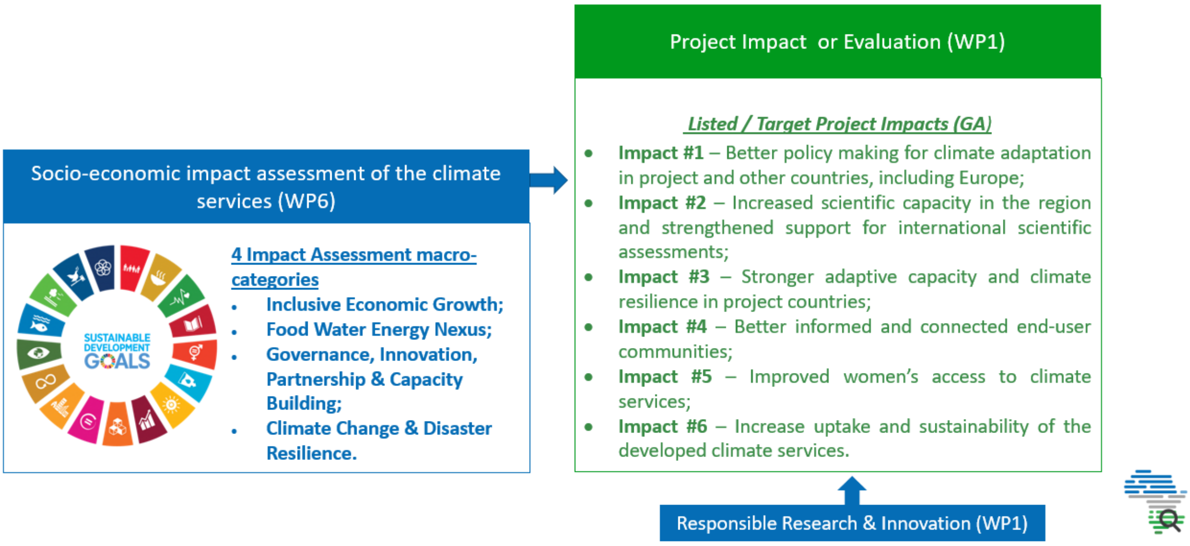


Figure 15: Synergies between CS and project impact

As part of the iterative elaboration of the IAGs and their respective indicators, the IAT considered whether the proposed indicators qualified strictly the CS or was also or better suited to the Project Evaluation. The decision making tree is represented in Figure 16 and the resulting indicators proposed to be included as part of the Project Evaluation are summarised in Figure 17.

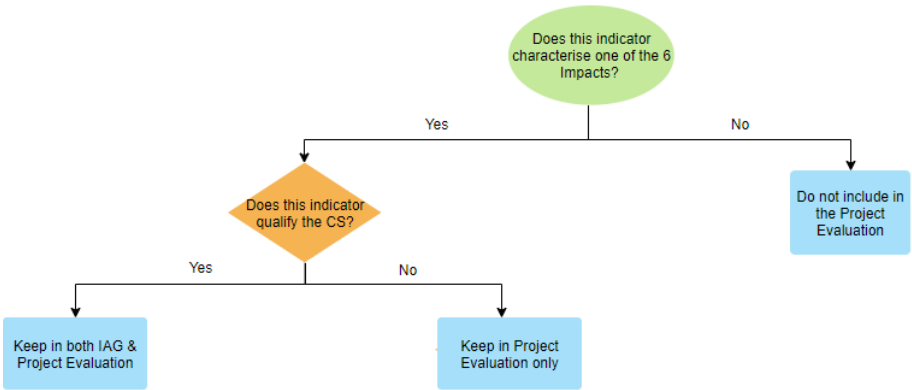


Figure 16: Project Evaluation Indicators Decision Making Tree

Impact	SGDs	Indicators
Impact #1 - Better policy making for climate adaptation in project and other countries, including Europe	17 PARTNERSHIPS FOR THE GOALS; 13 CLIMATE ACTION	**G12**. Steps taken to provide policy recommendations and influence decision makers
Impact #2 – Increased scientific capacity in the region and strengthened support for international scientific assessments	4 QUALITY EDUCATION	**G1**. Participation in CS capacity building events *(Include number of participants in focus-groups, trainings, information downloads -- includes formal and non-formal events)*
	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**G5.** Improved access to IT services & local technology development thanks to measures taken by the project. *Ratings from 1 to 5 on perception? Include notion of bilateral flow of information?*
	17 PARTNERSHIPS FOR THE GOALS	**G11.** Percentage of capacity building material & CS information shared with other projects (*and steps taken to promote knowledge sharing*)
Impact #3 - Stronger adaptive capacity and climate resilience in project countries	17 PARTNERSHIPS FOR THE GOALS	**G10.** Measures taken to encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships (derived from SDG #17.17, list steps and processes, project evaluation)
	13 CLIMATE ACTION	**C1**. Improve Climate resilience indicator TBD
	12 CONSOMMATION ET PRODUCTION RESPONSABLES	**C2**. Steps taken to raise awareness on sustainable development and lifestyles in harmony with nature *(derived from SDG#12.8, project evaluation?WP6 evaluation?)*
	2 ZERO HUNGER; 6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**CS X Food Security / Water / Energy / Infrastructure CS.** Reach Indicator Number of people benefitting from the CS
Impact #4 - Better informed and connected end-user communities	10 REDUCED INEQUALITIES	**E3**. Number and quality of measures taken by the CS team & project to be inclusive in the design and implementation of the CS - *to empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status (derived from SDG#10.2)*
	16 PEACE, JUSTICE AND STRONG INSTITUTIONS	**G7**. Steps taken to support local communities in responsive, inclusive participatory mechanisms and access to CS information.
	17 PARTNERSHIPS FOR THE GOALS	**G9.** Number of partnerships fostered with other projects,*concider the categories outlined in SDG17.16 Enhance the Global Partnership for Sustainable Development*
		G11. Percentage of capacity building material & CS information shared with other projects (and steps taken to promote knowledge sharing)
	2 ZERO HUNGER; 6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY	**Nexus**. Indicator highlighting synergies within project / across CS.
Impact #5 - Improved women's access to climate services	5 GENDER EQUALITY	**E2.** Measures taken to incorporate gender considerations in the CS design and delivery.
	4 QUALITY EDUCATION	**G2**. Participation rate of men and women in formal and non-formal trainings *(derived from SDG #4.3)*
Impact #6 – Increase uptake and sustainability of the developed climate services	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**G4.** Measures taken to enable the broader uptake of the CS beyond the project (list steps and processes, *CS & project evaluation*).
		G6. Measures taken to embed impact management in the design of the CS (list steps and processes, *WP6 evaluation*)

Figure 17: Proposed Indicators for the Project Evaluation based on SDG framework & 6 impact categories

3.7. Limits to the analysis

- **Data availability and quality**

A major challenge to assessing socio-economic impact in Southern African countries relates to gathering sufficient data about the sectors targeted by Focus Africa. The official databases relating to the SDG's in partner countries (such as the FAO's data related to SDG 2) are currently lacking data for certain geographies, years or specific indicators. Moreover, data gathered by national agencies is often not made publicly available or limited in scope. Local partners may also face professional barriers that prevent them from sharing sensitive information with the project, for instance data related to the energy sector or other economic of politically confidential information.

Additionally, the IAT is limited in its ability to travel and conduct ethnographic research. The Covid-19 global pandemic has brought about international travel restrictions that make it difficult to have visibility regarding when site visits can be conducted. Moreover, the IAT will still face difficulties in conducting ethnographic research if travel does become possible due to the challenges of conducting social science across cultures. There are likely to be language barriers at times between locals and researchers, which will require interpretation that could influence the quality of data. Moreover, there is the inherent risk in qualitative research of bias appearing in the data gathered through interviews and site visits, for instance due to subjects and researchers selectively interpreting results through observer bias or confirmation bias (Roulston, 2015).

In order to mitigate these risks, the IAT plans to work as closely as possible with local stakeholders through online discussions and to make efforts to travel when possible. As much as possible, site visits and interviews will be conducted in pairs to safeguard against researcher biases.

- **Limited timescale and challenges in establishing causal impact of CS**

The schedule of the Focus Africa project limits the ability to draw definitive conclusions about the impact of the project before it concludes. Depending on each case study, the IAT will likely have only one full year to conduct an *ex-post* assessment of the services. This limited sample size means that the IAT will not be able to draw definitive conclusions about the impact of the CS during the project timeframe. This is particularly the case because the impact of climate on outcomes should not be mistaken for the impact of climate services on outcomes. The single year of analysis for the *ex-post* analysis risks not being representative of more general patterns in the climate, and the CS could show a disproportionate value in this small sample size. In response to this risk, the IAT plans to offer recommendations and tools for continued assessment over longer time horizons by service providers during the exploitation of project results.

Moreover, the IAT faces more general challenges in demonstrating the causal impact of CS on target sectors. As has been mentioned, the CS are acting upon complex and multi-faceted social processes, making it difficult to isolate the impact of climate information on decisions. There is also a risk of confounding social factors influencing outcomes (Drost, 2011).

It is important to note that the IAT has chosen to avoid assessing impact by using a control group. On the one hand this was an ethical choice made to maximise the diffusion of information that could serve the public good. It was also a methodological choice given the challenges of finding two groups with nearly identical socio-economic criteria and exposure to climate risk while isolating the flow of information between them. Therefore, all participants in the ex-post impact assessment will have had access to CS information. It may be therefore difficult for users to speculate about the hypotheticals of how their decisions would have been taken without access to CS information.

In response to these challenges, the IAT will rely on a robust baseline assessment with extensive stakeholder engagement in order to make comparisons between the status quo and climate informed decisions. This will be done in order to better understand the mechanisms through which climate information transforms existing social processes.

4. Case Studies

4.1. CS1

Description of the CS

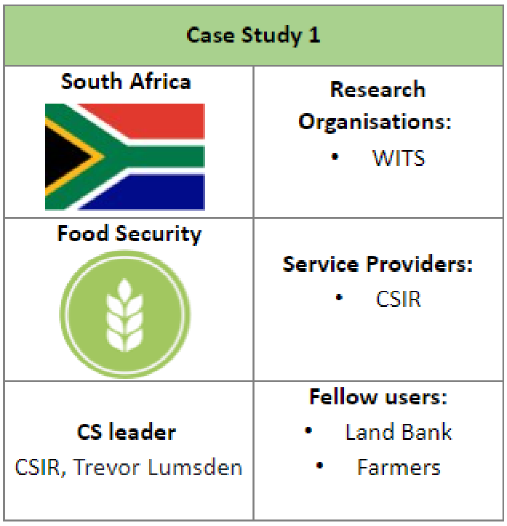


Figure 18: CS1 overview

CS1 tackles food security in South Africa. In particular, it focuses on maize production in the North West province of the country, which is important for food security. The area has suffered losses of crop production due to hot conditions and sporadic rains. It is projected to experience large impacts during this century both under high and low mitigation efforts. This case study will improve [CORDEX-Africa](#) (Coordinated Regional Climate Downscaling Experiment) climate projections to provide higher resolution. Moreover, it seeks to improve predictions of maize yields, shifting from a statistical model based on historical figures to a process-based modelling system for dynamic representation of climate change and maize yields using the **Decision-Support System for Agro-technology Transfer (**[**DSSAT**](#)**)**. The goal is to support the Land Bank in managing climate risk and ultimately to improve farmers' adaptation. While Land Bank will be enabled to adjust its credit models to account for projected climate change impacts and uncertainty, farmers will be trained to improve maize production practices under climate variability. Moreover, the Land Bank is expected to use this information for climate risk financial disclosure.

This case study is led by the Council of Scientific and Industrial Research (CSIR) of South Africa. The University of Witwatersrand Johannesburg (WITS) is the responsible for carrying out the research to improve climate and yields information supporting the co-creation of the climate service with the Land Bank. The engagement with the farming community is key for a successful outcome. The assessment of CS1 is informed by the thematic considerations for food security addressed in Section 2.2.

Impact Pathway

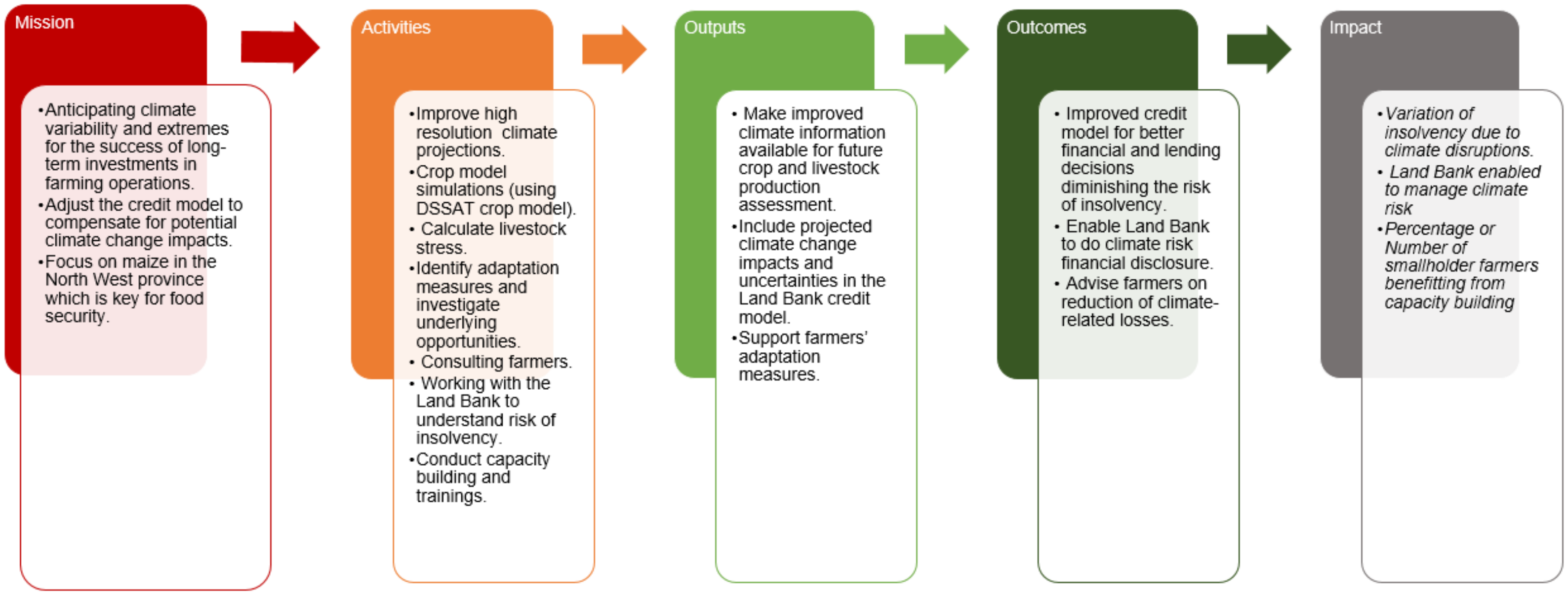


Figure 19: CS1 Impact Pathway

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Impact Assessment Grid

Specific indicators for quantitative assessment of CS1 are listed in Figure 20. For this CS, three out of four macro-categories are covered by CS-specific indicators: Inclusive economic growth, governance and climate resilience. It is important to notice that these indicators do not explain causal impact of the climate service, they rather support the analysis of the socio-economic conditions over time.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Inclusive Economic Growth	8 DECENT WORK AND ECONOMIC GROWTH	**Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**	**E-CS1(Food-Security)-1.** Number of LandBank employees that will be retained as a consequence of mitigating climate change impacts
			E-CS1(Food-Security)-2. Number of LandBank new employees absorbed for mitigating climate change impacts.
	5 GENDER EQUALITY	**Goal 5. Achieve gender equality and empower all women and girls**	**E-CS1(Food-Security)-3.**Proportion of women in the total of new employees absorbed by the LandBank for mitigating climate change impacts.
Governance, Innovation, Partnership & Capacity Building	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**	**G-CS1(Food-Security)-1.** Avoided credit losses due to climate disruption
			G-CS1(Food-Security)-2. Number of farmers with improved access to credit thanks to the implementation of climate adaptation practices
Climate Change & Disaster Resilience	1 NO POVERTY	**Goal 1. End poverty in all its forms everywhere**	**C-CS1(Food-Security)-1.**Farmers' access to credit
	12 CONSOMMATION ET PRODUCTION RESPONSABLES	**Goal 12. Ensure sustainable consumption and production patterns**	**C-CS1(Food-Security)-2.** Maize yield losses

Figure 20: CS1 Tailored Impact Grid Indicators

Impact Stories

The impact stories for CS1 will describe qualitatively how climate information can drive changes in maize investments and farming in South Africa. Land Bank's approach to climate risk management will be assessed over time. At the same time, the transformation in agricultural practices induced by capacity building activities will be analysed. Impact stories follow the same structure of macro-categories used in the grid, evolving across baseline, ex-ante and ex-post assessment. The information will be gathered in regular interactions with Land Bank and farmers, semi-structured interviews with stakeholders and complemented by desk research. The **baseline** assessment will describe the current climate risk management practices of the Land Bank (respecting confidentiality) and the socio-economic situation of the farmers in the Nord West province of the country.

- **Inclusive economic growth:** which factors structure the socio-economic conditions of the farmers in in South Africa? What are the challenges for farmers in accessing finance?
  Starting from the extensive experience of the CSIR with local farming communities, interviews as well as research will be performed to gain better understanding of the socio-economic conditions of the farmer with particular focus on the North West province and the reliance on maize production. Farmers invest in machineries and lands to sustain the production,

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therefore access to credit will be analysed to understand the demand for capital and credit requirements.

- **Food Water Energy Nexus:** What agronomic practices are deployed by maize producers in South Africa? Which type of investments are currently needed to sustain these practices? Research will seek to be tailored to decisions made by the CS developers regarding information they require to develop their service. Likely topics of research include planting methods and harvest timing, along with crop management practices including the use of inputs, irrigation, and food storage methods. Attention will be paid to supply shocks and their implications.

- **Governance & Innovation:** What is the existing relationship between CS providers, the Land Bank and the farmers? How is the Land Bank currently taking into account climate risks? Some farmers are clients of the Land Bank whereas others have no relationship with the bank. WITS and CSIR will be engaging with farmers and the bank. The agricultural economic and advisory division of the Land Bank has also strict contact with farmers. Land Bank's current approach to climate risk and disclosure will be presented as well.

- **Climate change resilience**: Is climate information currently used by the Land Bank and farmers? How is climate change challenging Bank's operations and farmers' activities? A first screening will be conducted on if/how climate information is currently used both by the Land Bank and in farming. The current impacts and most recent information on future disruptions will be collected.

The **ex-ante** assessment will be based on stakeholder interviews and data collection to understand the room the CS have to improve Land Bank's operations and the effects on the farmers' conditions in the North West province, including their access to credit. Moreover, the collaboration of the IAT with the Land Bank will outline the expectations from the CS based on the internal objectives of credit risk screening and climate risk disclosure. The following key questions will be addressed by the impact story:

- Does CS1 fill existing gaps in climate information provision?
- Is CS1 targeted to specific challenges on the ground?
- Will CS1 boost capacity of service provider to engage with those that need it?
- What are the major risk factors that could prevent CS1 from being adopted by the Land Bank?

The **ex-post** impact story will explore the findings, up to the end of the project, on the impacts generated by CS1. The main questions the ex-post analysis aims to answer are:

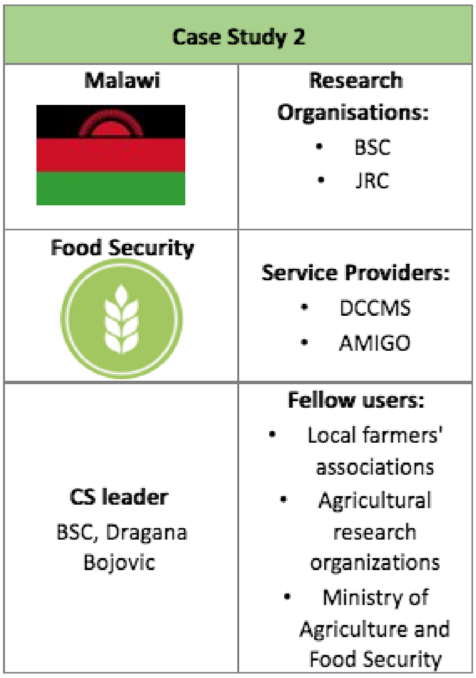
- Has the climate service been properly tailored to respond to identified climate needs?
- Does the Land Bank feel that the CS1 tools offer value to them?
- Is the climate service integrated in the credit risk model of the Land Bank?
- Is there a plan in place with clear mechanisms to support changes in agronomic practice and access to credit for maize producers?

Engagement Process

The IAT will work closely with CS1 leaders at the CSIR, the Land Bank and the climate service provider WITS. The CSIR will support the engagement with local stakeholders. Recurrent e-meetings will take place with the different divisions of Land Bank to understand their needs and ensure that the CS will address them successfully. The IAT relies mainly on CSIR for arranging interviews with farmers. This is important since the COVID-19 pandemic is preventing the IAT from travelling to South Africa as of the submission of this deliverable (August 2021). CSIR is facing also limitations to travel to the North West province due to the pandemic, however less limitation than the IAT travelling from Europe. The IAT aims at engaging directly with the farming community at all stages of the project. Interviews will be repeated over time to follow up from the baseline stage, to the co-development process until the climate services' full application.

4.2. CS2

Description of the CS



Case Study 2	
Malawi	**Research Organisations:** • BSC • JRC
Food Security	**Service Providers:** • DCCMS • AMIGO
CS leader BSC, Dragana Bojovic	**Fellow users:** • Local farmers' associations • Agricultural research organizations • Ministry of Agriculture and Food Security

Figure 21: CS2 overview

CS2 focuses on Food Security in Malawi. The CS seeks to provide updates to three existing climate services for agriculture in order to improve their performance and help Malawi's agricultural sector adapt to climate volatility. The first service is the Anomaly hot Spots of Agricultural Production (ASAP) warning system. The service provides an overview of 80 countries, with national and subnational data, and seeks to provide an early warning of anomalies that could impact agriculture production. CS2 will upgrade the service with optimised seasonal and decadal forecasts to improve the detection of drought. The second service is the African Postharvest Losses Information System (APHLIS) postharvest management tool. APHLIS is an international repository of post-harvest losses of grain in Sub-Saharan Africa. CS2 will contribute to improving the service by integrating seasonal climate data for use in forecasting risk of post-harvest crop losses. The third service is the WOFOST (World Food Studies) crop modelling tool. The WOFOST modelling tool allows researchers to quantitatively model the growth and production of food crops based on input data related to soil, crop variety, weather and management practices. CS2 will use new climate projections to identify emerging food security risks due to climate change, and help local stakeholders develop adaptation pathways.

This Case Study is led by Barcelona Supercomputing Centre (BSC), who will also contribute to the climate research used in updating the services. The European Commission's Joint Research Centre (JRC) will lead the research used in this CS. The service will be provided by European partner AMIGO and the Malawian Department of Climate Change and Meteorological Services (DCCMS). The users of the information provided by the services are expected to be agricultural organisations in Malawi, in the public, private and NGO sectors, who can also help convey the information to smallholder farmers.

The assessment of CS2 is informed by the thematic considerations for food security addressed in Section 2.2. Particular attention will be paid to describing the way that information about climate variability, particularly drought and precipitation, can produce tangible changes in agricultural practice.

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Impact Pathway

Mission

- In view of climate change projections that see strong warming trends, decrease in the mean number of rainy days and increase in heavy rainfall, this CS seeks to improve existing climate services in order to provide small farms holders with key information for better crop selection, harvest planning and post-harvest management.

Activities

- Analysis of the state-of-the-art climate projections and decadal forecasts
- Verification and optimization of seasonal forecasts
- Detection and assessment of drought: upgrade ASAP warning system using the optimized seasonal forecasts and decadal forecasts
- Seasonal climate information integration within the APHLIS postharvest management information system
- Application of the WOFOST-based crop modelling tool with end-user's local data (when available) and using new climate projections to identify risks, vulnerabilities as well as adaptation pathways.

Outputs

- More accurate seasonal forecast
- Earlier delivery of the seasonal product
- Better characterization of the future weather patterns and extremes
- Improve risk and vulnerability assessment and adaptation strategies

Outcomes

- Higher food quality and lower post harvest losses
- Lower malnutrition
- Higher wellbeing

Impact

- What outcomes are proven to be attributed to your actions? What is the causual connection?
- => **Resulting Metrics ideas: malnutrition (local data?), yield, post harvest loss, forecast skill improvement, accessibility (number of people trained to use the climate info tool), food security**

Figure 22: CS2 Impact Pathway

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Impact Assessment Grid

The specific indicators for quantitative impact assessment of CS2 will be focused on the Food Water Energy Nexus and Governance macro-categories, using indicators from SDG2 alongside the other indicators that will be assessed for all of the CS. The FAO is the custodian agency tasked with monitoring progress on these indicators and will be the chief source of data. The indicators included in the grid will be provided to offer a socio-economic context of the area being targeted by the CS. The intention is not to indicate a direct causal impact upon these indicators, but rather to highlight the food security situation in Malawi and (if possible given limited data availability) to highlight specific geographic areas and staple crops that are particularly at risk.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Food Water Energy Nexus	2 ZERO HUNGER	**Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	**CSX(Food Security)-1.** Number of people benefitting from the CS information (accessiblity, includes direct & indirect reach).
			CSX(Food Security)-2. Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES) (derived from SDG#2.1.2)
			CS2&4(Food Security)-5. Indicator of food price anomalies (SDG 2.c.1 price volatility)
			CS2&4(Food Security)-6. Food distribution & post-harvest losses: 12.3.1(a) Food loss index and (b) food waste index
Governance, Innovation, Partnership & Capacity Building	17 PARTNERSHIPS FOR THE GOALS	**Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**	**G-CS(Food Security)-1.** Food and agriculture policy: 2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector

Figure 23: CS2 Tailored Impact Grid Indicators

Impact Stories

The impact stories for CS2 will seek to qualitatively describe the way that CS information can transform agricultural practice to produce impact and improve food security in Malawi. Like the impact grid, it will be based around four macro-categories and evolve across a baseline, ex-ante and ex-post assessment. Academic research will be supplemented with data gathered from local stakeholders through semi-structured interviews.

The baseline assessment will describe the current socio-economic situation in the agricultural communities of Malawi that will benefit from CS2. The key research questions for the **baseline** are listed below.

- **Inclusive economic growth**: What factors structure the socio-economic conditions for farmers in Malawi ?

  Multiple factors will be explored, based on an inductive approach guided by feedback from stakeholder interviews along with a review of academic and other research. Likely topics for exploration include access to land ownership, inequalities between informal subsistence farmers and industrial commercial farmers, commodity markets and smallholder access to markets, major agricultural public policies in Malawi, and the gendered division of agricultural labor.

- **Food Water Energy Nexus:** What agronomic practices are deployed in Malawi and by target populations?

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Research will seek to be tailored to decisions made by the CS developers regarding information they require to develop their service. Likely topics of research include typical crop varieties in the region, planting methods and harvest timing, along with crop management practices including the use of inputs, irrigation, and food storage methods.

- **Governance & Innovation**: What is the existing relationship between CS providers and farmers?

  Research regarding this question will draw upon interviews to gauge how active relations are between service providers and locals, the level of trust between stakeholders, risk of institutional corruption, and the available budget for exploiting CS results.

- **Climate Change and Resilience:** What is the existing use of climate/ weather services if any?

  This will explore existing services provided by DCCMS for agricultural use. The method of delivery, forecast performance, influence on agricultural practices, and perceived value by users will be described.

The **Ex-ante** assessment will then draw upon stakeholder interviews in order to determine how the CS would fit within the existing socio-economic situation in Malawi. The following key questions will be addressed by the impact story:

- Does CS2 fill existing gaps in service provision?
- Is CS2 targeted to specific challenges on the ground?
- Will CS2 boost capacity of service provider to engage with those that need it?
- What are the major risk factors that could prevent CS2 from being adopted by DCCMS and local stakeholders, and from improving food security in Malawi.

Finally, the **ex-post** impact story will present the initial findings of CS2's performance for stakeholders in Malawi. The key questions addressed in the ex-post analysis are:

- Has the tool been properly tailored to respond to identified climate needs?
- Do users and service providers feel that the CS2 tools offer value to them?
- Are local service providers able to adopt the CS and use it autonomously after the project?
- Is there a plan in place with clear mechanisms to transform CS information into changes in agronomic practice?

Engagement process

The IAT will work closely with CS2 leaders at BSC to gather information from stakeholders in Malawi. DCCMS is actively engaged in collaboration with the project and has helped to provide a list of key stakeholders (from the public, private and NGO sectors) working at the intersection of agriculture and climate in the country. Ideally the IAT would like to travel to Malawi during the baseline, ex-ante and ex-post assessments in order to conduct site visits of agricultural operations and meet in person with local stakeholders. However, given the uncertainty of travel within the context of the Covid-19 pandemic, travel plans have been postponed until at the earliest late 2021. As a contingency plan, the IAT will conduct interviews with DCCMS and other stakeholders virtually whenever possible, and rely on online research.

4.3. CS3

Description of the CS

Case Study 3	
Mozambique 	**Research Organisations:** • SSSA • IIAM
Food Security 	**Service Providers:** • PLAN • SSSA • IIAM
CS leader SSSA, Matteo Dell'Acqua	**Fellow users:** Smallholder farmers in Mogovalas District, Nampula Province

Figure 24: CS3 overview

CS3 focuses on food security in Mozambique and is led by researchers from Scuola Superiore Sant'Anna (SSSA), Mozambique's Institute of Agricultural Research (IIAM) and PLAN International (PLAN), with offices in Italy and Mozambique. The case study develops around a unique roadmap bringing together climate science, genomics, and social sciences to develop climate services for smallholder farmers. CS3 relies on a bottom-up approach in which researchers together with farmers characterise crop varieties best adapted to current and future climate stresses and develop tailored climate forecasts and climate projections. At the end of the project, this information will be combined in an integrated climate service providing local farmers with i) climate-ready varieties and ii) a text-based weather forecasting service giving farmers key information on the outlook of the cropping season ahead. The activities to be conducted in the course of CS3 are divided into four interconnected research strands (hereafter, Strand 1, 2, 3, and 4).

- Strand 1: Engagement of smallholder farmer communities

With co-design and bottom-up approach at the core of CS3, the objective of Strand 1 is to engage with smallholder farmers in a selected area of Mozambique and learn from them what their needs are in relation to local adaptation of crop varieties and weather forecasting / climate prediction in relation to cropping. Activities include: i) identification of the area of study in Mozambique, ii) identification of households to be involved in the project, iii) development of survey and Focus Group Discussions (FGD) tools, iv) conduction of stakeholder meetings and workshops in Mozambique, v) conduction of surveys and FGDs with farmers and other stakeholders.

220 households have been identified in the Mogovolas district, Nampula Province, as they grow both crops of interest for CS3, namely rice and cowpea.

- Strand 2: Genotyping and landscape genomics

Strand 2 focuses on harnessing crop genetic resources for cowpea and rice crops, then characterising their genetic diversity by DNA sequencing in combination with climate data from reanalysis and projections. Traditional varieties / landraces are seed collections with a historical origin in southern Africa including Mozambique, South Africa, Zimbabwe, Malawi and Tanzania.

So far, IIAM has sourced 197 cowpea accessions and 150 rice accessions from the gene bank at the institution. SSSA has sourced 238 cowpea accessions from IITA, Nigeria and 600 accessions of rice from IRRI, Philippines.

- Strand 3: Agronomic evaluation

Strand 3 involves the planting of target cowpea and rice collections in Mozambique, with priority given to traditional crop varieties adapted to the local environment, and the participatory evaluation of their agronomic performance by farmers and agronomists. The seeds are first purified and amplified in experimental farms, taking into account the appropriate seasons.

Rice and cowpea sowing were performed by IIAM in Mozambique in December 2020 and February 2021, respectively, with the participatory evaluations to take place in the newt growing seasons. Amplification of accessions are being performed in both Italy by SSSA and Mozambique by IIAM.

- Strand 4: Climate research

Strand 4 deals with the development of seasonal prediction models tailored to the smallholder farmers' needs to be captured during the baseline round of survey and FGDs (Strand 1) and existing services.

Preliminary protocol development for climate data collection and analysis is ongoing.

Impact pathway

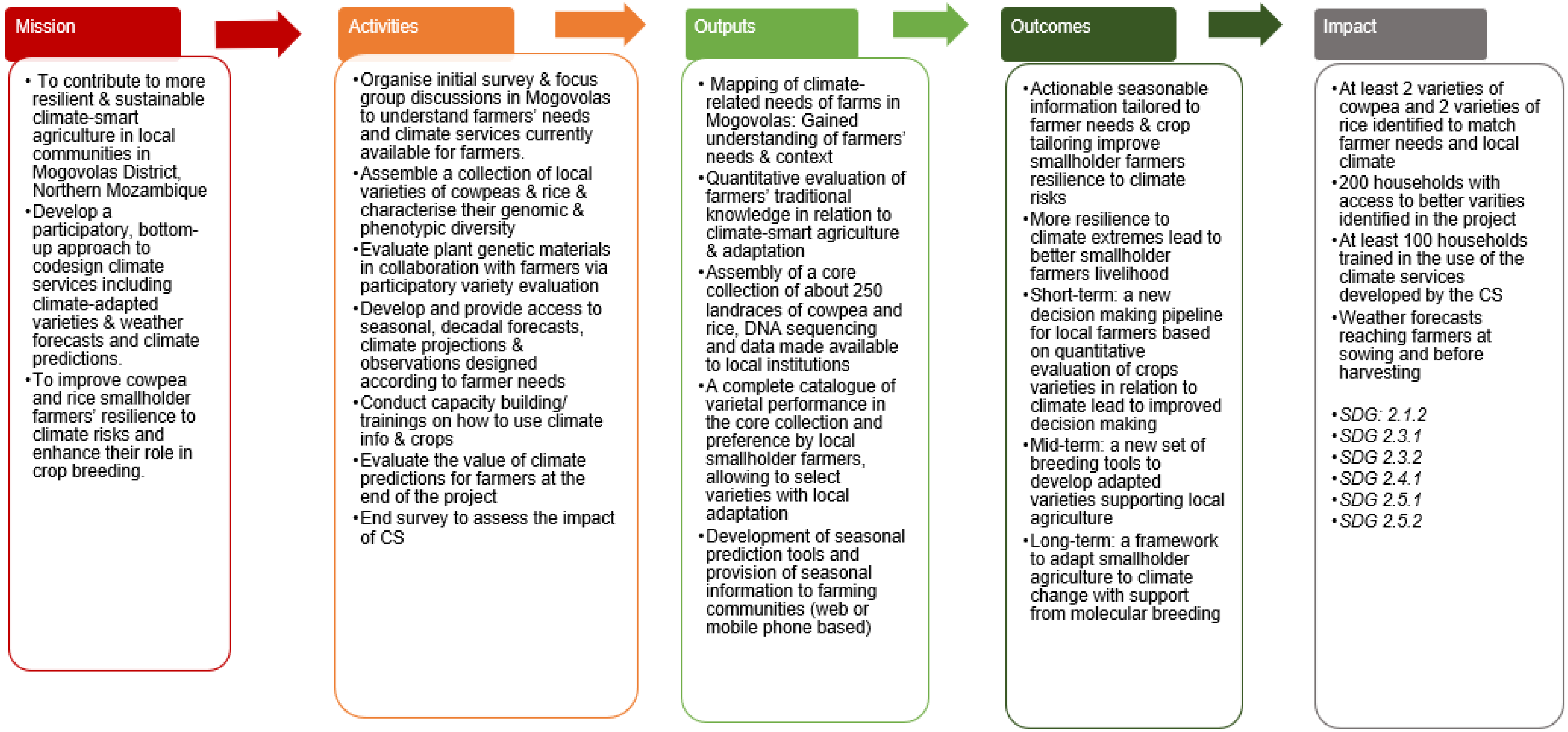

Figure 25: CS3 Impact pathway

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Impact Assessment Grid

In addition to the transversal indicators listed in Figure 8, we propose additional quantitative indicators, tailored to the specificities of CS3. It is important to note that some quantitative indicators are contingent upon successful engagement processes and the undertaking of local surveys, which will depend on the future COVID-19 pandemic developments. Further detail on the engagement process and the planning of surveys to collect the data is described in the following *Engagement process* section.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Inclusive Economic Growth	5 GENDER EQUALITY; 8 DECENT WORK AND ECONOMIC GROWTH	**Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**	**E-CS3(Food-security)-**.1. Percentage of income increase in the period during which the CS was implemented. *Measuring improved economic growth & work conditions thanks to the implementation of the CS (includes jobs) (derived from SDG8.1-8.5)*
			E-CS3(Food-security)-2. Percentage of income increase for the woman in the household in the period during which the CS was implemented. *Gender consideration in economic growth*
Food Water Energy Nexus	2 ZERO HUNGER	**Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	**CSX(Food Security)-1.** Number of people benefitting from the CS information (accessiblity, includes direct & indirect reach).
			CSX(Food Security)-2. Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES) (derived from SDG#2.1.2)
			CS3(Food Security)-3. Number of households faced with hunger issues (short term vs long term?)
			CS3(Food Security)-4. Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size (derived from SDG#2.3.1)
			CS3(Food Security)-5. Average income of small-scale food producers, by sex and indigenous status (derived from SDG#2.3.2)
			CS3(Food Security)-6. Proportion of agricultural area under productive and sustainable agriculture (derived from SDG#2.4.1)
			CS3(Food Security)-7. Number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities (derived from SDG#2.5.1)
			CS3(Food Security)-8. Proportion of local breeds classified as being at risk of extinction (derived from SDG#2.5.2)
Governance, Innovation, Partnership & Capacity Building	17 PARTNERSHIPS FOR THE GOALS	**Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**	**G-CS(Food Security)-1.** Food and agriculture policy: 2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector
			GCS(Food Security)-2. Measures taken by policy makers to integrate climate change into food planning policy

Figure 26: CS3 Tailored impact grid indicators

In Figure 26, the indicators highlighted in orange are intended to provide a monetisation of the socio-economic indicators (cf section 3.3).

It is worth noting that long-term impact is embedded within the framing of the indicators proposed in the grid. It is understood that with some indicators it will be difficult to measure an impact from the deployment and adoption of the CS during project timeframe. The idea is to highlight dimensions to consider regarding the current context and desired impacts during and beyond the lifetime of the project. This raises an interesting point in terms of how to foster the project sustainability and the potential for identifying local agents who could pursue the impact assessment beyond the lifetime of the project to maximise the sustainability of the CS outcomes.

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Impact stories

The proportion of qualitative vs quantitative analyses for the impact assessment of CS3 will be highly dependent upon the COVID-19 pandemic developments in Mozambique and subsequent decisions made regarding the engagement process, i.e. if and when surveys targeting smallholder farmers will be undertaken by the CS3 team. Impact stories will be crafted throughout the project to follow the three stages of the impact assessment and in line with the four macro-categories proposed for the impact assessment grid. Qualitative analyses would likely emerge from a combination of desktop research, Focus Group Discussions and interviews with local stakeholders.

- **Inclusive Economic Growth (E-S)**

  Baseline. *What factors structure the socio-economic conditions for farmers in Mozambique and in particular in the Mogovolas district, Nampula Province?*

  Access to land ownership, subsistence vs commercial farmers, market power/ access, commodity prices, major public policies in Mozambique, gendered division of labour in the country will be investigated.

  Ex-ante: What is the expected impact of CS3 on the local economy, particularly for the most marginalised populations (e.g. the poor, women, etc)? Could CS3 exacerbate inequalities (e.g. formal vs informal economy, if gender/ ethnic divisions were not considered in the target population)? What steps will be taken by the CS3 team to mitigate these risks?

  Ex-post: Does CS3 meet the socio-economic needs of the smallholder farmers? What is the smallholders' perception on the value brought by the climate services?

- **Food Water Energy Nexus (N-S)**

  Baseline. *What agronomic practices are deployed in the Nampula Province of Mozambique?*

  Research on the crops, planting and harvest time, inputs, irrigation, food storage etc. will be carried out to better understand how the various climate services developed under CS3 can impact decision making.

  Ex-ante: How are the CS3 services expected to influence the current agronomic practices?

  Ex-post: Are there clear mechanisms in place for CS3 information to reach the Mogovolas district smallholder farmers and is this beginning to transform the local agronomic practices? How are local practices evolving thanks to CS3?

- **Governance, Innovation, Partnership & Capacity Building (G-S)**

  Baseline. *What is the existing relationship between SSSA, PLAN, IIAM and the smallholder farmers?*

  The IAT will observe the relationships between CS providers and users, and level of trust between stakeholders. The risk of institutional corruption in Mozambique and the budget available to maximise the impact of CS3 will also be considered.

  Ex-ante: What is the CS3 strategy for consistent, transparent, and quality service delivery? What steps will be taken to ensure sustainable uptake and buy-in by local service providers? Will the project boost capacity of local service providers?

  Ex-post: Do local stakeholders feel that their inputs have been sufficiently considered in co-designing CS3? Are IIAM & PLAN able to continue operating CS3 autonomously after the end of the project? Are their expectations for continued knowledge exchange between stakeholders involved in the project?

- **Climate Change & Disaster Resilience (C-ES)**

  Baseline. *Are smallholder farmers in Mozambique currently using any climate services and how?*

  This will consider the current usage of climate services information by the smallholder farms and the current method of delivery, the smallholder farmers' preferred methods for receiving information, the forecast performance, as well as the perceived influence and value the climate services have on their agricultural practices.

  Ex-ante: What time scale is CS3 targeting? What mechanisms will be set up to develop risk reduction plans in response to CS3 information?

  Ex-post: Have CS3 services contributed to enhancing climate change adaptation plans by the smallholder farmers of the Mogovolas district and more broadly?

Engagement process

As described in section 3.5, this work results from the strong collaboration between the IAT and the CS3 team, taking several opportunities to discuss the socio-economic impact assessment since the beginning of the project with the first stakeholder workshop CS3 working group, food security RRI workshop session, participation in CS3 meetings, bilateral calls with CS3 leader and CS3 engagement strand 1 leaders, in order to co-create and validate the approach, as well as seeking synergies with other CS, regarding for instance the food water energy nexus and the use of the survey designed by CS3 through WP6 coordination meetings.

Important considerations

To achieve its objectives, CS3 requires a tight interaction with off-grid smallholder farming communities in northern Mozambique, most notably extensive field work to reach the farmer communities, conduct surveys, and evaluate crop genetic materials. Engagement with local stakeholders is at the core of CS3's design, identified as Strand 1 activities. In the wake of the COVID-19 pandemics, major disruptions of international travels and health risks related to meetings and field work urged a re-thinking of these activities.

The CS3 team prepared a survey questionnaire composed of a set of closed and open-ended questions, with a target duration of 1 hour, which covers socioeconomic aspects, agronomic aspects, and practices, climate perceptions and outlook of climate services usage, taking into account gender considerations.

Due to the farming calendar, CS3 partners identified that the month of September constitutes the only window to engage with famer communities, in order to interact with the farmers when they are not busy in the fields. This time constraint has led to two proposed Plans A & B regarding local stakeholder engagement:

Plan A – The initial plan was to organise a stakeholder meeting in late June 2021, with identified local stakeholders from institutions in Nampula including the local administrative government, National Meteorological office, University of Maputo and national cowpea and rice experts. Then, an initial survey designed to serve as baseline data collection regarding the current socio-economic context, the agronomic context and practices, as well as the current perception of climate risks and usage of climate services, would be conducted in September 2021.

This work would be carried out in collaboration with trained enumerators, translators and deployed across 220 targeted households, in conjunction with local partners.

It would be accompanied by an endpoint survey performed at the end of the project, after implementation of the climate services.

Plan B – In light of the sanitary crisis, CS3 leaders have prepared a contingency Plan B, with their proposition as follows.

The survey previously planned for September or early October 2021 would be shifted to the next available window one year later, that is in September/ October 2022. In order to preserve the participatory aspect of the CS3, the contingency plan replaces the survey with FGDs to be held in September/October 2021 in order to derive the baseline needed to develop the climate services and establish the socio-economic context. Given the sanitary crisis, FGDs would offer advantages given a lesser number of smallholder farmers consulted (20) and lifting the required travel from enumerators to households, as well as guaranteeing the compliance with the COVID-19 guidelines. The contingency plan entails a field visit to Mozambique planned between October 4th and 10th, 2021 in villages selected by PLAN. At the time of writing of this report and with the deterioration of the situation in Mozambique, it was agreed among CS3 team members to organise activities to enable Plan B and for the decision to pursue Plan B or even a potential Plan C, to be made in early September 2021.

Regarding the survey itself, the administration of the survey in 2022 would preserve the modules and the questions currently present. The finest degree at which the climate needs would be asked, combined with a larger sample more representative of the heterogeneity of households present in the district, would make the climate-related survey module an intermediate monitoring step before realising the first draft of the climate service. In a similar perspective, the survey would preserve its role of baseline data collection moment, as it would be performed immediately before the release to the communities of the first version of the climate services to be developed during the course of 2022. The survey would therefore register the status of the households according to different impact indicators (e.g., among others, food security, biodiversity conservation, nutritional equity, income diversification, gender equality, etc..), and would serve as a comparison with the endline version of the survey to be performed in 2023. However, given the latter date of the 'baseline' survey, this data would not be included in the Deliverable *'D6.2 Evaluation of the socio-economic situation in the 8 case studies'* due in M24 (August 2022), which due date is before the scheduled plan B survey (September/October 2022). Therefore D6.2 could include a qualitative description of the socio-economic context at first, thanks to outputs from the FGDs and parallel interviews with key stakeholders, and then the results from the initial survey could be incorporated into the next deliverable D6.3.

4.4. CS4

Description of the CS

Case Study 4	
Tanzania 	**Research Organisations:** • BSC • JRC
Food Security 	**Service Providers:** • TMA • AMIGO
CS leader BSC, Dragana Bojovic	**Fellow users:** • Tanzania Agricultural Research Center • Local farmers' associations

Figure 27: CS4 overview

CS4 is focused on food security in Tanzania. It will develop the same climate services as in CS2 (**ASAP, APHLIS**, and **WOFOST**) with a specific focus on the Tanzanian climate. More information on these services can be found in the description of CS2, section 4.2.

The CS is also led by BSC, with research support offered by JRC. AMIGO will also offer support as a service provider. The Tanzanian stakeholders supporting the project will be the Tanzania Meteorological Agency (TMA), and the Tanzania Agricultural Research Institute (TARI). Local farmers' associations will also be fellow users of the tool.

Because the services developed for CS4 are the same as those used in CS2, the method for impact assessment will be similar for both CS, while also exploring how local differences can transform outcomes.

Impact pathway

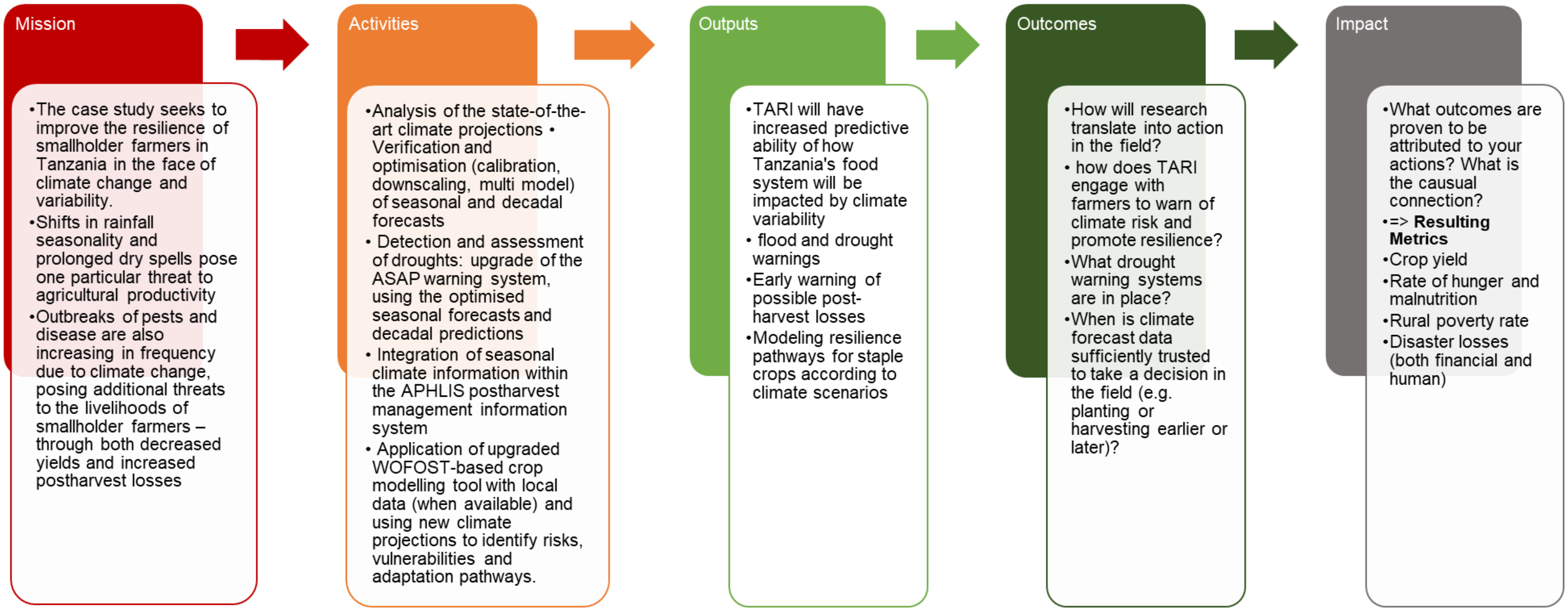

Figure 28: CS4 impact pathway

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Impact Assessment Grid

The specific indicators for the CS4 impact grid will be the same as those used for CS2. These draw upon indicators from SDG2, under the jurisdiction of the FAO.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Food Water Energy Nexus	2 ZERO HUNGER	**Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	**CSX(Food Security)-1.** Number of people benefitting from the CS information (accessiblity, includes direct & indirect reach).
			CSX(Food Security)-2. Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES) (derived from SDG#2.1.2)
			CS2&4(Food Security)-5. Indicator of food price anomalies (SDG 2.c.1 price volatility)
			CS2&4(Food Security)-6. Food distribution & post-harvest losses: 12.3.1(a) Food loss index and (b) food waste index
Governance, Innovation, Partnership & Capacity Building	17 PARTNERSHIPS FOR THE GOALS	**Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**	**G-CS(Food Security)-1.** Food and agriculture policy: 2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector

Figure 29: CS4 tailored impact grid indicators

Impact stories

The questions guiding the impact story for CS4 will also be similar to those developed for CS2.

The baseline assessment will explore similar themes to the baseline for CS2, but with an emphasis on the specific Tanzanian context. The following questions, which were elaborated in section 4.2, will be explored:

- **Inclusive economic growth**: What factors structure the socio-economic conditions for farmers in Tanzania?
- **Food Water Energy Nexus:** What agronomic practices are deployed in Tanzania and by target populations?
- **Governance & Innovation**: What is the existing relationship between CS providers and farmers?
- **Climate Change and Resilience:** What is the existing use of climate/ weather services if any?

The **Ex-ante** assessment will then draw upon stakeholder interviews in order to determine how the CS would fit within the existing socio-economic situation in Tanzania. The following key questions will be addressed by the impact story:

- Does CS4 fill existing gaps in service provision?
- Is CS4 targeted to specific challenges on the ground?
- Will CS4 boost capacity of service provider to engage with those that need it?
- What are the major risk factors that could prevent CS4 from being adopted by TMA, TARI and other local stakeholders, and from improving food security in Tanzania?

Finally, the **ex-post** impact story will present the initial findings of CS4's performance for stakeholders in Tanzania. The key questions addressed in the ex-post analysis are:

- Has the tool been properly tailored to respond to identified climate needs?

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- Do users and service providers feel that the CS4 tools offer value to them?
- Are local service providers able to adopt the CS and use it autonomously after the project?
- Is there a plan in place with clear mechanisms to transform CS information into changes in agronomic practice?

Engagement process

Similarly to CS2, the engagement process for CS4 will be based around interviews with local stakeholders working at the intersection of climate and agriculture. These interactions are facilitated by the support of case study leader BSC, and the national meteorological agency, TMA. The initial phase of engagement with actors in Tanzania has primarily focused on informing TMA and TARI of the benefits that CS4 can provide for them, in order to obtain institutional permission and buy-in to collaborate further. TMA can be a very valuable partner in enabling the IAT to contact key actors, and hopefully they will be able to support this work going forward. The IAT would ideally like to conduct three visits to Tanzania, one for the baseline, ex-ante, and ex-post assessments in order to perform site visits and in person interviews. However, just as for CS2, the uncertainty related to travel during the Covid-19 pandemic has limited the ability to plan for travel during 2021. If travel remains impossible, the IAT plans to continue efforts to engage with stakeholders in Tanzania virtually, and continue reviewing academic and other literature related to social conditions of agriculture in the country. An important element for the engagement with Tanzanian stakeholders is expected from the second project stakeholder workshop focused on Tanzania and scheduled as a virtual event in September 2021.

4.5. CS5

Description of the CS

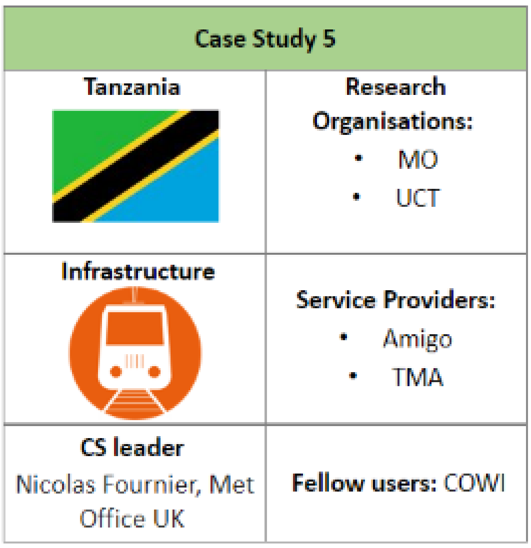

Figure 30: CS5 overview

CS5 focuses on infrastructure in Tanzania, and is developed by researchers from the Met Office (MO) and the University of Cape Town (UCT), with offices in England and South Africa. The case study aims to enhance the characterisation of the impacts of climate change on the design of railway infrastructure. Its mission is to allow infrastructure companies and state authorities to design climate-resilient infrastructure and prepare for climatic events through tailored maintenance planning. CS5 relies on close engagement with the end user COWI, who was responsible for the design of one section of the Standard Gauge Railway (SGR) running from Dar es Salaam to Morogoro, as well as close engagement with local authorities and the state.

Impact pathway

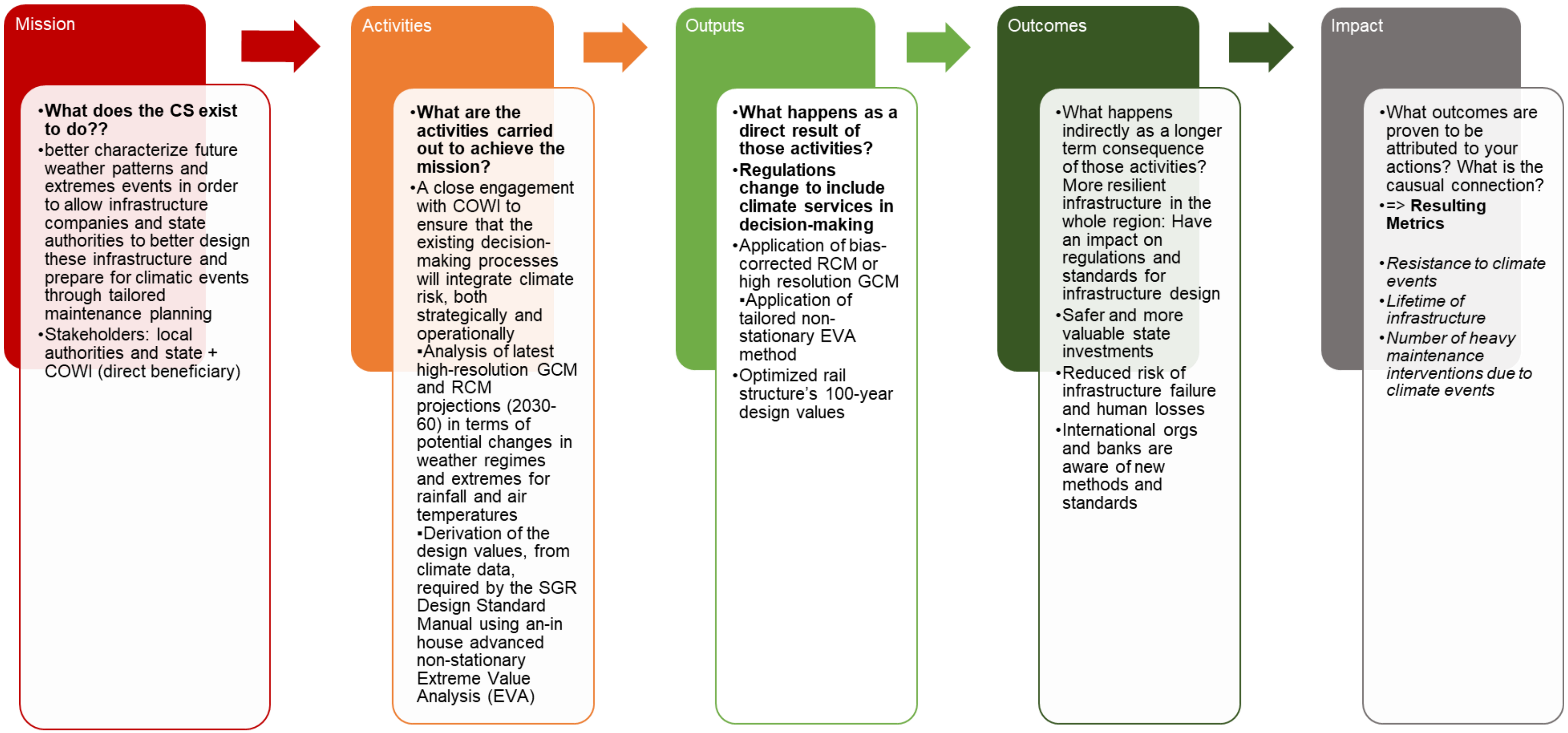

Figure 31: CS5 impact pathway

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Impact Assessment Grid

In addition to the transversal indicators listed in Figure 8, additional quantitative indicators tailored to the specificities of CS5 are proposed.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Governance, Innovation, Partnership & Capacity Building		**Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**	**G-CS5(Infrastructure)-1** Policy: climate adaptation incorporated into public policy
Climate Change & Disaster Resilience	11 SUSTAINABLE CITIES AND COMMUNITIES	**Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable**	**CS5(Infrastructure)-1.** Number of people reached by the CS information (accessiblity).
			CS5(Infrastructure)-2. SDG#11.5.1 Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
			CS5(Infrastructure)-3. Disaster risk reduction strategy (planning and improvement through CS)
			CS5(Infrastructure)-4. SDG#11.5.2 Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters

Figure 32: CS5 tailored impact grid indicators

Impact stories

IAT research will contribute to the collection of qualitative inputs, yet the amount of this data will also be dependent upon the COVID-19 pandemic developments in Tanzania and subsequent decisions made regarding the stakeholder engagement process, i.e. if interviews are conducted by the CS5 team. Several questions were identified for the CS5 impact assessment:

- **Inclusive economic growth:**

  What factors structure the socio-economic conditions of the infrastructure sector in Tanzania? Public investments, existing level access to public services, market structures and model distribution must be considered.

- **Climate change and disaster resilience**:

  What is the existing use of climate/ weather services if any? Expected elements of response include method of delivery, forecast performance, influence on practices, perceived value by users, existent disaster risk reduction/ climate change adaptation plans in the infrastructure sector and current gaps. The disaster risk reduction strategy (planning and improvement through CS), as well as data about the direct economic loss and damages to critical infrastructures will be collected through IAT research and interviews with fellow users.

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- **Food-water-energy nexus:**

  What practices are currently deployed in Tanzania? Elements of response include description of the situation of the surrounding agricultural areas and water bodies, impact of railway infrastructures on the food-water-energy-nexus

- **Governance and innovation:**

  What is the existing relationship between CS providers and CS users? Expected elements of response include the level of trust, risk of institutional corruption/bias, available budget etc.

The **Ex-ante** assessment will then draw upon stakeholder interviews in order to determine how the CS would fit within the existing socio-economic situation in Tanzania. The following key questions will be addressed by the impact story:

- Does CS5 fill existing gaps in service provision?
- Is CS5 targeted to specific challenges on the ground?
- Will CS5 boost capacity of service provider to engage with those that need it?
- What are the major risk factors that could prevent CS5 from being adopted by COWI and local stakeholders, and from improving infrastructure in Tanzania.
- What is the expected impact of CS5 on the local economy, particularly for the most marginalised populations (e.g. the poor, women, etc)? Could CS5 exacerbate inequalities (e.g. formal vs informal economy, if gender/ ethnic divisions were not considered in the target population)? What steps will be taken by the CS5 team to mitigate these risks?

Finally, the **ex-post** impact story will present the initial findings of CS5's performance for stakeholders in Tanzania. The key questions addressed in the ex-post analysis are:

- Has the tool been properly tailored to respond to identified climate needs?
- Do users and service providers feel that the CS5 tools offer value to them?
- Are local service providers able to adopt the CS and operate it autonomously after the project?
- Is there a plan in place with clear mechanisms to transform CS information into changes in practice?

Engagement process

To achieve its objectives, CS5 requires a tight interaction with the end-user COWI to ensure that the existing decision-making processes integrate climate risk, both strategically and operationally.

Currently, the engagement with the users is coordinated by the CS5 team (led by MO and UCT) with the help of Amigo and TMA. The interaction of the IAT with the users is highly dependent on the engagement process led by the CS5 team.

In order to retrieve key data and indicators to develop the climate services, the IAT will work closely with the CS5 leader and conduct a series of interviews with fellow users and key stakeholders (service providers and research organisations). The team aims to go on a field visit to Tanzania planned in late 2021 in order to carry out the interviews in person, yet depending on the evolution of the Covid-19 situation, interviews may be conducted via videoconference as an alternative option. Three rounds of interviews will be conducted for the ex-ante and ex-post impact assessment. They will be organised with local representatives in order to understand the current practices and baseline indicators used in the current context, understand the impacted stakeholders beyond the local focal point/organisation, validate the socio-economic survey with key organisation and contact the identified local stakeholders to establish the socio-eco baseline. In the ex-ante impact assessment, the objective will be to understand how the CS would fit within the existing socio-economic situation. In the last part of the project, the ex-post impact assessment will analyse if the tool has been properly tailored to respond to the identified needs and the added-value brought for users and service providers.

4.6. CS6

Description of the CS

Case Study 6	
Tanzania 	**Research Organisations:** • MO
Energy 	**Service Providers:** • TMA • WEMC
CS leader Nicolas Fournier, Met Office UK	**Fellow users:** TANESCO

Figure 33: CS6 overview

CS6 focuses on energy in Tanzania, and is led by researchers from the Met Office (MO), with offices in England. The case study aims to help the Tanzanian energy sector deal with climate change and seasonal variability impacting the electricity output of hydro, wind and solar power. CS6 relies on a close collaboration and co-production activities with the fellow user, Tanzania Electric Supply Company Limited (TANESCO), as well as the World Energy & Meteorology Council (WEMC), the Tanzania Meteorological Agency (TMA) and Total as climate services providers.

The case study aims to develop reliable climatology maps and long-term statistics, and to incorporate seasonal forecast data into the existing TANESCO production forecast model.

Impact pathway

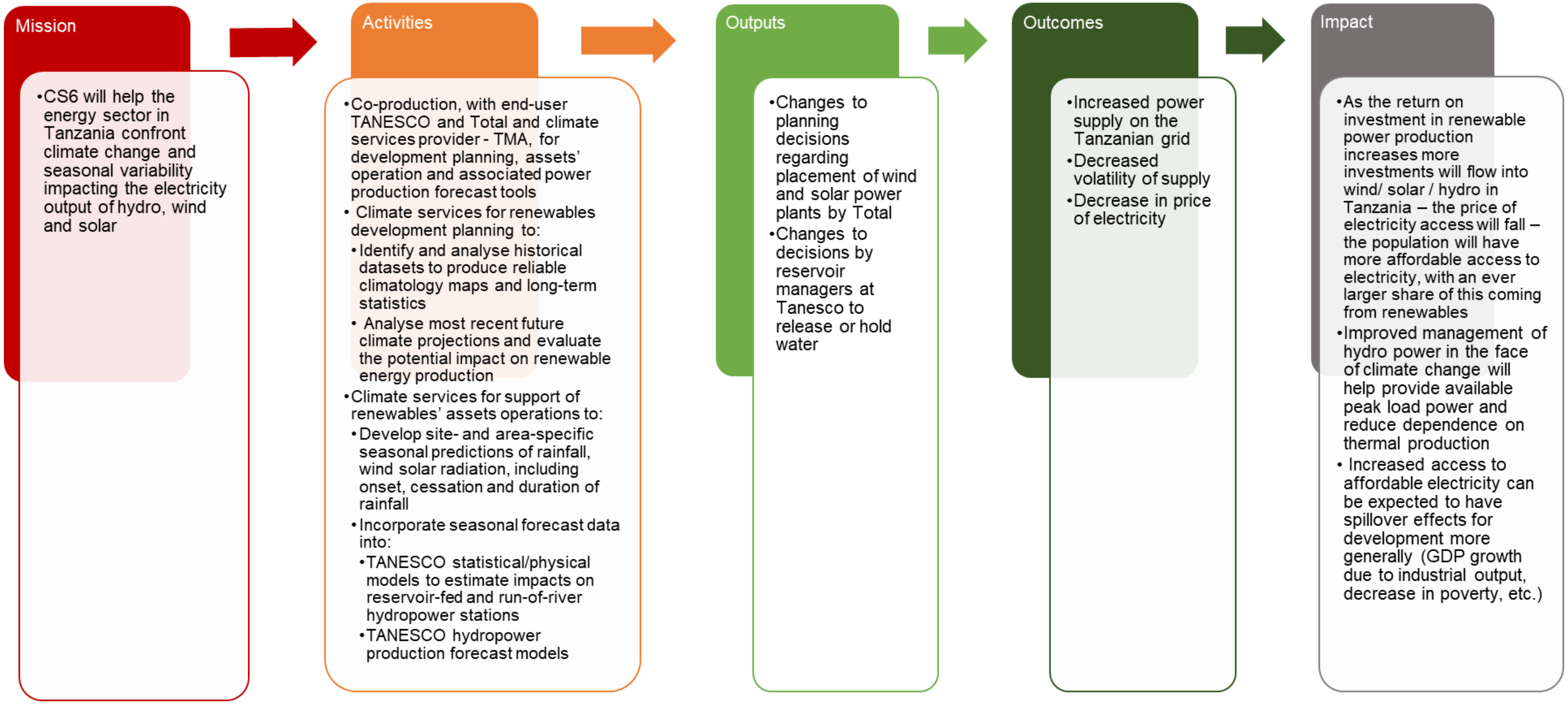

Figure 34: CS6 impact pathway

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Impact Assessment Grid

In addition to the transversal indicators listed in Figure 8, additional quantitative indicators tailored to the specificities of CS6 are proposed.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Food Water Energy Nexus	7 AFFORDABLE AND CLEAN ENERGY	**Goal 7. Access to affordable, reliable, sustainable and modern energy for all**	**CS6(Energy)-X** Success metric exploring the impact of CS on PPAs between IPP and TANESCO (on the decision making process, on the location of solar installation, on the contractual implicactions, TBD with Nicolas)
			CS6(Energy)-X Reliability of supply (could be measured in terms of power outages in region impacted by CS) **(express in terms of both demand & supply)**
			CS6(Energy)-X. Number of unproductive discharges per year

Figure 35: CS6 tailored impact grid indicators

Impact Stories

The proportion of qualitative vs quantitative analyses for the impact assessment of CS6 will be highly dependent upon the COVID-19 pandemic developments in Tanzania and subsequent decisions made regarding the stakeholder engagement process, i.e. if interviews are conducted by the CS6 team. Indicators can be refined through conversation with CS leader and fellow users.

- **Inclusive economic growth:**
  What factors structure the socio-economic conditions of the energy sector in Tanzania? Public investments, existing level access to public services, market structures and model distribution must be considered.
- **Food-water-energy nexus:**
  What practices are currently deployed in Tanzania? Elements of response include grid management practices to balance supply and demand, hydro management practices, impact of hydro sector on irrigation.
- **Governance and innovation:**
  What is the existing relationship between CS providers and CS users? Expected elements of response include the nature of relations between TMA and TANESCO, level of trust, risk of institutional corruption/bias, available budget etc.
- **Climate change and disaster resilience**:
  What is the existing use of climate/ weather services if any? Expected elements of response include method of delivery, forecast performance, influence on practices, perceived value by users, existent disaster risk reduction/ climate change adaptation plans in the infrastructure sector and current gaps.

The **Ex-ante** assessment will then draw upon stakeholder interviews in order to determine how the CS would fit within the existing socio-economic situation in Tanzania. The following key questions will be addressed by the impact story:

- Does CS6 fill existing gaps in service provision?
- Is CS6 targeted to specific challenges on the ground?
- Will CS6 boost capacity of service provider to engage with those that need it?

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- What are the major risk factors that could prevent CS6 from being adopted by TANESCO and local stakeholders, and service uptake.

Finally, the **ex-post** impact story will present the initial findings of CS6's performance for stakeholders in Tanzania. The key questions addressed in the ex-post analysis are:

- Has the tool been properly tailored to respond to identified climate needs?
- Do users and service providers feel that the CS6 tools offer value to them?
- Are local service providers able to adopt the CS and operate it autonomously after the project?
- Is there a plan in place with clear mechanisms to transform CS information into changes in practice?

Engagement process

To achieve its objectives, CS6 will work in co-production with the beneficiary TANESCO, as well as Total and climate services provider.

The CS6 team will conduct a series of interviews with fellow users and key stakeholders (service providers and research organisation) to collect key information. The CS6 aims to go on a field visit to Tanzania planned in late 2021 to carry out these interviews depending on the evolution of the Covid-19 situation. If the situation does not allow for international travels, interviews will be conducted via videoconference. Three rounds of interviews will be conducted for the ex-ante impact assessment and ex-post impact assessment. They will be organised with local representatives in order to understand the current practices and baseline indicators used in the current context, understand the impacted stakeholders beyond the local focal point/organisation, validate the socio-economic survey with key organisation and contact the identified local stakeholders to establish the socio-eco baseline.

Currently, the engagement with the users is coordinated by the CS6 team (led by MO) with the help of WMO and TMA. The interaction of the IAT with the users is highly dependent on the engagement process led by the CS6 team.

In case the engagement challenges persisted, the contingency plan would entail contacting Independent Power Producers (IPP) in Tanzania. IPP may then become fellow users and would present an opportunity to gain different perspectives and understanding of the climate services to will be developed.

4.7. CS7

Description of the CS

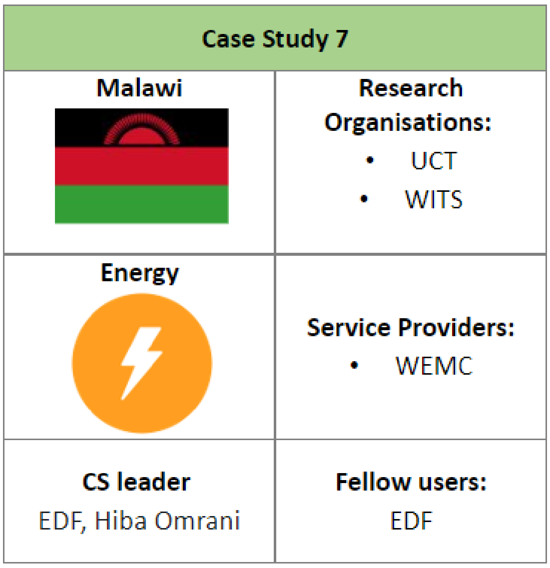

Figure 36: CS7 overview

CS7 focuses on energy in Malawi, and has contributions from researchers at the University of Cape Town (UCT) and the University of the Witwatersrand (WITS), with offices in South Africa. The researchers are working together with the service providers from the World Energy and Meteorology Council (WEMC) and the fellow user, Electricité de France (EDF), to better characterise the impacts of climate variability and its future changes on hydropower generation in the Shyre river basin. The leadership of the case study is shared between EDF and WEMC. CS7 partners are closely collaborating with each other to co-produce a reliable **climate projection** that will determine the feasibility of the Mpatamanga project and help EDF make an investment decision. Additionally, near the end of the project, seasonal variability may also be examined in partnership with CS6 in order to assess the electricity output of hydropower, in the case that EDF decides to invest in the project.

If EDF decides to invest in the Mpatamanga hydropower plant and go ahead with the project development, it would add 350 MW of electricity-generating capacity to Malawi's currently installed capacity of 482 MW, making it very significant for the country's energy security and economic development. The project investment cost is estimated to US$ 1.07 billion, which would be jointly provided by private and public finance. Private finance for energy infrastructure development is a recent occurrence in Malawi. Until now, the Government has owned most of the generation, transmission, and distribution assets.

The hydropower plant would be located around 40 kilometers west of the city of Blantyre, on the Shire River, between the existing Tedzani and Kapichira hydropower plants. The construction and operation of the hydropower plant at this location would have social and environmental impacts, such as displacing 121 households from 3 villages and affecting local ecosystems (Sahai, 2020). The preliminary assessment of these impacts has been done by the World Bank in the Project Information Document (ibid.), while the final environmental and social impact assessment will be reinforced by additional findings and recommendations. The analysis from the aforementioned document of the World Bank will serve as one of the resources for IAT's future impact assessment report. The IAT will also follow up on additional findings and any potential updates to the Project Information Document.

Impact pathway

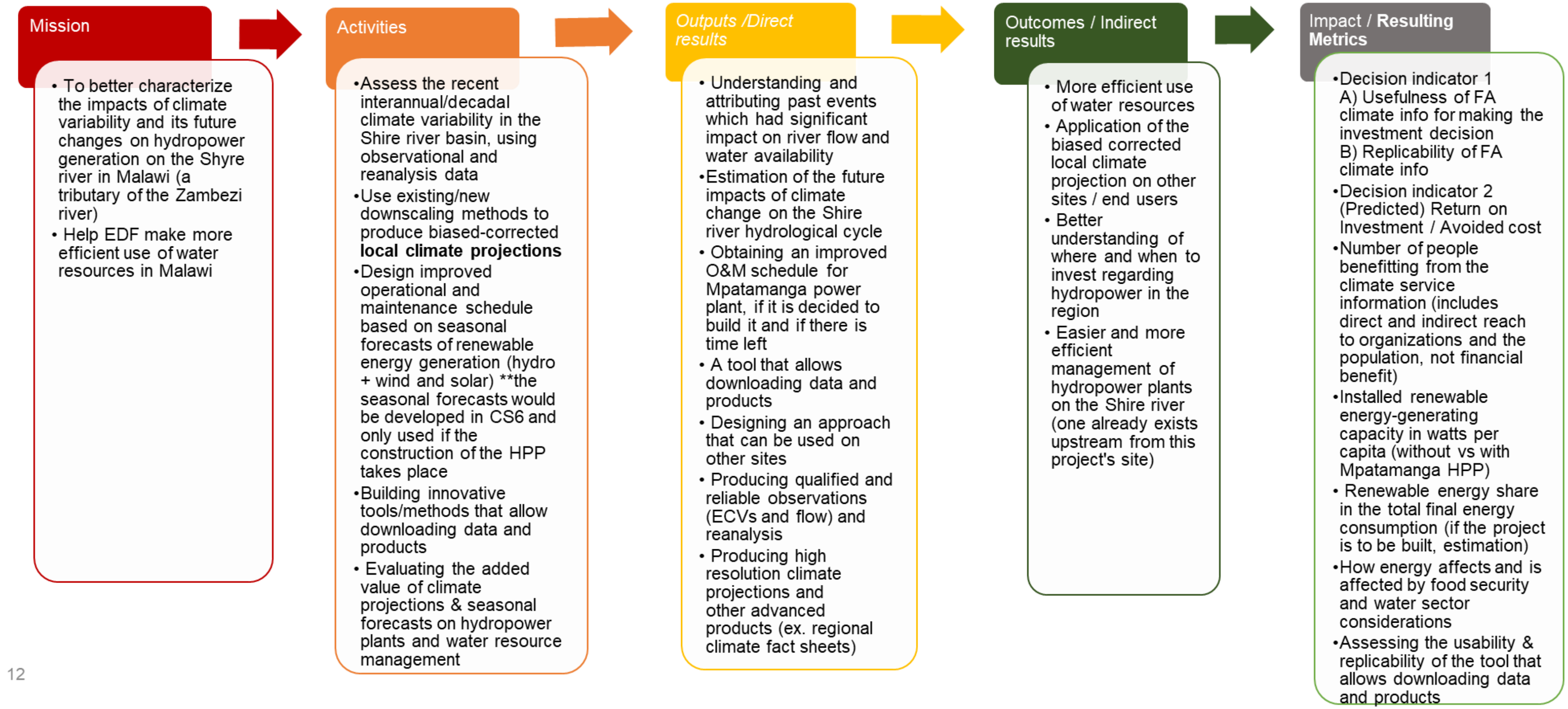

Figure 37: CS7 Impact Pathway

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Impact Assessment Grid

Specific indicators for quantitative assessment of CS7 are listed in Figure 38. All the case study specific indicators of CS7 belong to the same macro-category: Food Water Energy Nexus. Most of them are drawn from indicators under SDGs 6 and 7, whose data is collected by the World Bank, the IEA and IRENA.

Food Water Energy Nexus	2 ZERO HUNGER; 6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY	**Goal 7. Access to affordable, reliable, sustainable and modern energy for all**	**CSX(Energy)-1.** Number of people benefitting from the CS information. (organisations, population - specify what "benefit" means, not financial) (includes direct and indirect reach)
			CS6&7(Energy)- Investment 7.a.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems
			CS6&7(Energy)- SDG #7.b.1 Installed renewable energy-generating capacity (in watts per capita) without vs with Mpatamanga HPP
			CS6&7(Energy)- SDG Ind#7.2.1 Renewable energy share in the total final energy consumption (if the project is built, to be measured in the future or estimated now)
			CS7 (Energy). Decision1. A) Usefulness of FA climate info for making the investment decision. B) Replicability of FA climate info (can it be used by others?)
			CS7(Energy)- Decision2. (predicted) Return on Investment / Avoided cost.
			N2(For Energy CS). How Energy affects and is affected by Food Security and Water sector considerations?

Figure 38: CS7 tailored impact grid indicators

Impact stories

Impact stories will help determine the impact of the CS qualitatively, in cases where quantitative methods do not suffice to describe the changes occurred. They will be crafted throughout the project to follow the three stages of the impact assessment and in line with the four macro-categories proposed for the impact assessment grid. Qualitative analyses will emerge from a combination of desktop research, FGDs and interviews with the fellow-user.

The baseline assessment will describe the current socio-economic situation in the region of Malawi where the hydropower project is to be built. The key research questions for the **baseline** are:

- **Inclusive economic growth**: What factors structure the socio-economic conditions for hydropower plant development in Malawi?

  Academic research in combination with stakeholder interviews will inform the IAT on topics such as: How many people currently have access to electricity in the region? What steps should be taken prior to the implementation of the climate service, in order to take into consideration gender and other inequalities?

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- **Food Water Energy Nexus:** What energy practices are deployed in Malawi?

  Research will focus on questions where food, water and energy sectors' activities overlap, for instance: How is energy use, and more specifically electricity generation, affecting the food security and water sector? What are the current land and water use practices at the site of the project development? Are the existing hydropower plants in Malawi benefitting from any climate services? What is the time horizon considered for existing energy projects?

- **Governance & Innovation**: What is the existing relationship between CS providers, EDF, and local stakeholders?

  Research will draw upon interviews with EDF to determine how active is the relationship between EDF, the CS providers in FOCUS Africa, and local stakeholders, as well as determining any potential risk of institutional or budgetary challenges.

- **Climate Change and Resilience:** What is the existing use of climate/ weather services if any?

  The research in this category will explore the current use of climate projections and seasonal predictions on other energy projects in Malawi, as well as in other EDF hydropower projects in the region. This involves questions on forecast performance, its perceived value by EDF, and its influence on investment decisions and energy generation.

The **Ex-ante** assessment will then build upon interviews with stakeholders to determine how the CS would fit within the existing socio-economic situation in Malawi. Questions addressed in the impact story will include:

- **Inclusive economic growth**:
  Are there any marginalised groups that would be at risk of exclusion with the implementation of the climate service? What steps will be taken to mitigate these risks? What is the expected (indirect) impact of CS7 on the economy, particularly for the most marginalised populations (e.g. the poor, women, etc)? Of course, the fact this climate service will constitute one factor out of many to influence the local economy, will be taken into account.

- **Food Water Energy Nexus:**
  How many people are expected to benefit from the CS information? Both directly in EDF, and indirectly in Malawi, through the fact that the project has or has not been built. How is the construction and operation of the planned hydropower plant expected to affect the food and water sectors? How is the water availability expected to affect the hydropower plant's constructions and operation?

- **Governance & Innovation**:
  Will the climate service be usable by other projects in the future? What are the main risk factors that could slow down or prevent the adoption of the climate service by EDF?

- **Climate Change and Resilience:**
  What mechanisms are going to be put in place to develop risk reduction plans in response to CS information on both envisaged time scales (climate projection and seasonal prediction)? What is the expected forecast performance, its perceived value by EDF, and its influence on investment decisions and energy generation?

Finally, the **ex-post** impact story will present the initial findings of CS7's performance for stakeholders in Malawi. The key questions addressed in the ex-post analysis are:

- **Inclusive economic growth**:
  What is the impact of CS7 on the local economy? Which steps have been taken to mitigate risks of exclusion of marginalised groups during the climate service development? What is the predicted return of investment in the case the project is to be built? What is the avoided cost in the case that the project has been side-lined?

- **Food Water Energy Nexus:**
  How many people have benefitted from the CS information, directly or indirectly, and in what form is this benefit? Which steps have been taken to counter the impacts of the planned hydropower plant on the food and water sectors? What will be the situation of the surrounding agricultural areas and water bodies if the project is not built? Which steps have been identified to reduce risks of water availability on future energy generation? Is there a plan in place for transforming the climate service information into action during the power plant operation (besides the investment decision)?

- **Governance & Innovation**:
  EDF's perception of the usefulness of the climate service information for investment decision making will be described. Do users and service providers feel that the CS7 tools offer value to them? How replicable is the climate service information, can it be used by other projects in the future? Has the tool been properly tailored to respond to identified climate needs? Is the CS information or the accompanying tool developed easy to adopt by local users and can they autonomously use it after the project?

- **Climate Change and Resilience:**
  What mechanisms are going to be put in place to develop risk reduction plans in response to CS information on both envisaged time scales (climate projection and seasonal prediction)? What is the expected forecast performance, its perceived value by EDF, and its influence on investment decisions and energy generation?

Engagement process

The engagement process in CS7 has so far been done through bilateral calls between the impact assessment team and EDF, as well as through CS7 group meetings with all the partners. The cooperation established has been useful for validating the approach of the IAT, as well as finding synergies with other case studies in areas where food security, water and energy overlap. These meetings will be continued in order to achieve the CS7 objectives. It is important to note that EDF is both the CS leader and the fellow user, which allows the CS7 team to actively co-design the scientific framework and ultimately the climate service. This is a unique situation in the project and one of the reasons why the CS7 team is so well advanced in terms of natural science aspects (data, modelling approach, etc.).

It should be pointed out that the leadership of the case study has recently passed from EDF to a joint effort between EDF and WEMC, where WEMC is in charge of the socio-economic aspects of the case study. Therefore, the future meetings with case study leaders will be done in priority with WEMC.

For the rest of the engagement process, three rounds of interviews will be conducted for the ex-ante and ex-post impact assessment. They will be organised with the fellow-user, EDF, as well as other local stakeholders, in order to establish the socio-economic baseline and better understand the impacts of CS7 on the different stakeholders.

4.8. CS8

Description of the CS

Case Study 8	
Mauritius 	**Research Organisations:** • CSIR
Water 	**Service Providers:** • MMS • WEMC
CS leader CSIR, Mohau Mateyis	**Fellow users:** WRU

Figure 39: CS8 overview

Optimisation of water resources is becoming increasingly important in Mauritius. In fact, observations suggest that rainfall patterns have changed during the last decades. Extreme rainfall events and intra-seasonal variability are challenging the management of water resources. CS8 aims at improving the state-of-the-art seasonal forecasts to optimise water management for domestic, industrial and agricultural use. Currently, the Water Resource Unit (WRU) of Mauritius is relying on biannual seasonal forecasts derived from **SARCOF** (the Southern Africa Regional Climate Outlook Forum) and **SWIOCOF** (the South-West Indian Ocean Climate Outlook Forum) and quarterly seasonal forecasts with a simple downscaling analogue model. CS8 seeks to improve the spatiotemporal resolution of the forecasts. Information on current and expected rainfall and drought with related likelihoods will be provided. Thresholds for triggering drought or wet alerts will be also developed. This case study is led by Council of Scientific and Industrial Research (CSIR) of South Africa who will also have the role of service provider. The assessment of CS8 will be informed by the thematic considerations for water addressed in Section 2.2.

Impact Pathway

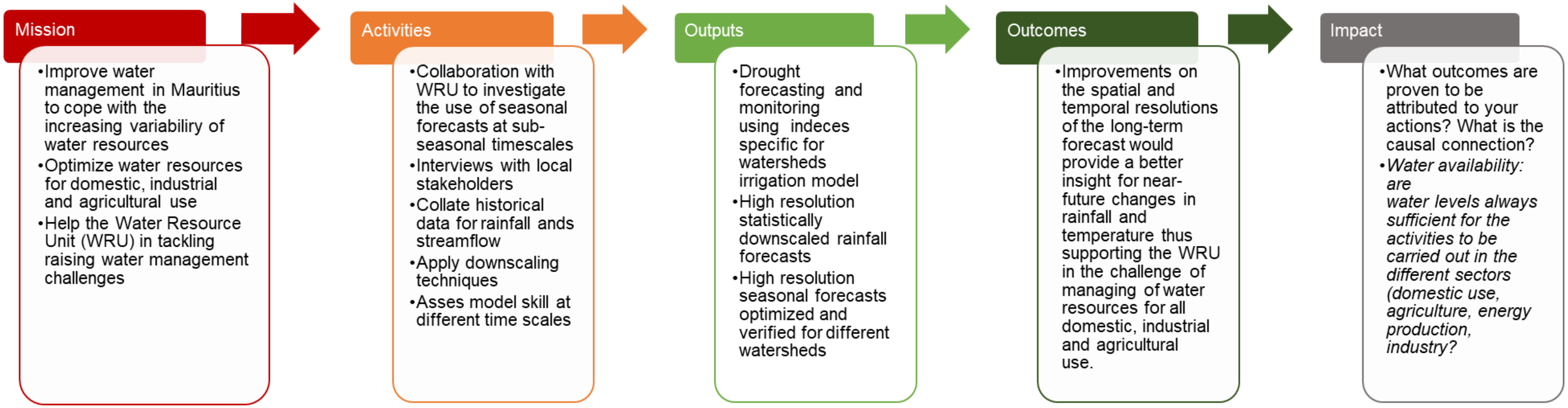

Figure 40: CS8 Impact Pathway

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Impact Assessment Grid

Specific indicators for quantitative assessment of CS8 are listed in Figure 41. For CS8, two out of four macro-categories are covered by CS-specific indicators: climate resilience and food-water-energy nexus. Similarly to the previous case studies, these indicators do not explain causal impact of the climate service, they rather support the analysis of the socio-economic conditions over time.

Macro category	SGDs	Goals and targets (from the 2030 Agenda for Sustainable Development)	Indicators
Climate Change & Disaster Resilience	12 CONSOMMATION ET PRODUCTION RESPONSABLES	Goal 13. Take urgent action to combat climate change and its impacts	C-CS8(Water)-1. Amount of unproductive water released
Food Water Energy Nexus	2 ZERO HUNGER	Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	N-CS8(Water)-1. Amount of water available for agricultural use
	6 CLEAN WATER AND SANITATION	Goal 6. Ensure availability and sustainable management of water and sanitation for all	N-CS8(Water)-2. Amount of water available for domestic use
	7 AFFORDABLE AND CLEAN ENERGY	Goal 7. Access to affordable, reliable, sustainable and modern energy for all	N-CS8(Water)-3. Amount of water available for energy production and industrial use

Figure 41: CS8 tailored impact grid indicators

Impact Stories

The impact stories for CS8 will describe qualitatively how sub-seasonal and seasonal forecasts can be used for water management. WRU's approach to water management will be assessed over time. Changes in the different sectors of the country depending on the water supply will be monitored. Impact stories follow the same structure of macro-categories used in the grid, evolving across baseline, ex-ante and ex-post assessment. The information will be gathered in regular interactions with WRU and local stakeholders including households, farmers and industry. Semi-structured interviews with stakeholders will be complemented by desk research. The **baseline** assessment will describe the current water management practices of the WRU and the socio-economic situation in the Mauritius.

- **Inclusive economic growth:** Which factors structure the socio-economic conditions of the population in Mauritius?

Desk research will be complemented with interviews with local stakeholders. Particular attention will be paid to the impact of water scarcity on the most vulnerable part of the population as well as on the local economy.

- **Food Water Energy Nexus:** What are the challenges that water scarcity poses to different sectors in the country?

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At first place, the goal is to gain deep understanding of current water availability for households and farmers and which measures, if any, they have in place to tackle dry periods. The dependency of industrial and energy sector will be also analysed.

- **Governance & Innovation:** What is the existing relationship between CS providers and the WRU? What are the governing bodies that operate closely with the WRU?

The CSIR will act as service provider, therefore we observe the starting point of co-development building the path for a fruitful collaboration. Flows of information between WRU and other governing bodies will also be investigated to envisage how the climate service information can fit in the complex decision-making context encompassing different sectors.

- **Climate change resilience**: Is climate information currently used by the WRU and other? How is climate affecting WRU?

WRU has currently access to sub-seasonal and seasonal forecasts that the case study aims to improve. There is a gap between access/understanding and usage of climate information, therefore a first screening will be dedicated to understand current forecasts' usage and associated challenges. The study will also explore the threats that climate variability is posing to the WRU.

The **ex-ante** assessment will be based on interviews with WRU and stakeholder as well as data collection to set the expected impacts of CS8 on water resource management and subsequently on the interested sectors in the Mauritius. The following key questions will be addressed by the impact story:

- Does CS8 fill existing gaps in climate information provision?
- Is CS8 targeted to specific challenges on the ground?
- Will CS8 boost capacity of service provider to engage with those that need it?
- What are the major risk factors that could prevent CS8 from being adopted by the WRU?

The **ex-post** impact story will explore the impacts of the implementation of CS8, at least those measurable before the end of the project. The main questions the ex-post analysis aims to answer are:

- Has the climate service been properly tailored to respond to identified climate needs?
- Do the WRU feel that the CS8 tools offer value to them?
- Is the climate service integrated in the water management optimisation practices of the WRU?
- Is there an impact on the different sectors strictly depending on water resources allocation?

Engagement process

The IAT will work closely with CS8 leaders at the CSIR, the WRU and will foster engagement with local stakeholders facilitated by the Southern African partners. Recurrent e-meetings will take place with the WRU to understand their needs and ensure that the CS will address them successfully. The IAT relies on CSIR and WRU for interviews with stakeholders, as long as the Covid-19 pandemic is preventing the IAT from travelling to Mauritius.

5. Conclusion

This report introduces the methodology to assess the socio-economic impacts of the climate services developed within the FOCUS-Africa project. The project being centred around **eight case studies spanning across four sectors** (food security, water, energy and infrastructure) and five countries in the Southern African Development Community (South Africa, Malawi, Tanzania, Mozambique and Mauritius), sectoral and local characteristics were considered.

The methodology for the impact assessment of climate services in FOCUS Africa is constituted of **three phases** starting with the evaluation of the socio-economic situation for each case study context, followed by the potential anticipated impact of the climate services ('ex-ante'), and finishing with the measured impact of the climate services ('ex-post'). The **Global Indicator Framework for the SDGs** was used to identify relevant impact indicators and stories. The SDG indicators were adapted to fit the context of FOCUS Africa and clustered into **four macro-categories**: 'Inclusive economic growth'; 'Food Water Energy Nexus'; 'Governance, Innovation, Partnership & Capacity Building'; and 'Climate Change & Disaster Resilience'. This categorisation helped build **eight impact assessment grids, one for each case study**. Every grid is composed of transversal indicators, common to all case studies, and of case study specific indicators, allowing to produce a context-adapted impact assessment. In addition to the **quantitative indicators** in the grids, a **qualitative assessment** complements the approach, in order to capture the complexity of the changes in processes and address the potential challenges in data collection. The qualitative analysis takes the form of impact pathways, initiated in this report, as well as impact stories that aim to document any changes in decision making processes triggered by the climate service, which may not otherwise be captured in the assessment.

The methodology is designed so that it is not focused exclusively on assessing the short- and long-term impacts of the climate services, but also on **helping improve the design of the services** through the process of co-production, thus increasing their potential impact. **Co-design and stakeholder engagement are therefore at the core of the methodology**, in order for the approach to be flexible and tailored to the reality of the local context and to the changes that can occur throughout the project.

Such flexibility is essential for effectively responding to the **limits and challenges** identified for the impact assessment.

- **Isolating the relative contribution of a climate service to a given decision** constitutes a key challenge. The climate services of FOCUS Africa are being developed in complex social systems, where climate information is only one of many different factors that can affect the stakeholders' decisions. Therefore, it is important to keep in mind that correlation does not imply causality, when interpreting the results of the assessment.
- **The limited timescale of the project and climate variability pose another challenge.** Most of the climate services will be developed near the end of the project, leaving a maximum of one year to conduct the ex-post analysis, while it can take years to observe a general pattern in the climate. This means that any short-term evaluation risks misinterpreting the impact of the climate service, either by overstating or understating it, depending on the climate conditions in the year of the analysis. To minimise this risk, the IAT will offer tools and recommendations for further assessment after the project is over, allowing the fellow-users and service providers to assess the results over longer time horizons.
- **Data availability and quality could also limit the impact assessment**. Gathering data through field research in Africa is particularly challenged by the COVID-19 pandemic and its associated

travel restrictions. Further to this, linguistic and cultural differences, and therefore researcher bias, will be considered when interpreting the qualitative research data. To mitigate these risks, the IAT will continuously work with local stakeholders through online discussions and conduct site visits whenever possible, in pairs and following a recursive multi-stakeholder consultation process, to minimise researcher biases.

Flexibility and adaptability therefore sit at the core of the methodology described in this report, which relies on **strong collaboration and stakeholder inclusion**, paramount to the development of the climate services and the assessment of their socio-economic impact**.**

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7. Annex

Table 1 summarises typical valuation methods (WMO & World Bank Group, 2015). Each FOCUS-Africa case study will select, if any, one or more of these approaches for the quantification of the indicators.

Table 1: Valuation Methods

	Method	Description	Advantages	Disadvantages
Non-market valuation – Stated preference	Contingent valuation (CV)	– Survey-based elicitation of individuals' preferences and values (for example, WTP)	– Estimates use and non-use values – Incorporates hypothetical scenarios that closely correspond to policy case	– Time intensive and expensive to implement – Challenging to frame survey questions that elicit valid responses – Potential response biases
	Conjoint analysis	– Similar to CV, except respondents are surveyed about a set of choices		
Non-market valuation – Revealed preference	Averting behaviour	– Determines values based on expenditures that would have been made to reduce impacts of weather or climate events, but were avoided because of improved met/hydro information	– Uses observed data to conduct ex-post analyses – Tailored to specific policy case – Expenditures easy to estimate through surveys	– Values interpreted as lower bound estimates because averting expenditures only capture a portion of an individual's WTP to avoid a particular harm
	Travel cost or expenditure modelling	– Uses observed tourist and recreational trip-taking behaviour to determine whether people pay more to visit sites for which forecasts are available – Can rely on other expenditures or costs incurred to search for or obtain met/hydro information	– Uses observed data to conduct ex-post analyses – Tailored to specific policy case	– Measures use values only – Collecting adequate data is often expensive and time intensive
	Hedonic analysis	Uses observed housing, property, or labour market behaviour to infer values for quality changes	– Uses observed data to conduct ex-post analyses – Tailored to specific policy case	– Measures use values only – Requires extensive market data – Assumes that market prices capture the good's value

	Decision analysis	– Analyses decisions and resulting values when people have access to met/hydro services and when they do not – Typically paired with business or production models	– Useful to examine decisions and expected outcomes at household or firm level – Can be relatively simple to perform depending on model employed	– Can be time and data intensive, depending on model employed – Requires sector expertise (for example, agriculture, transport) – Often assumes perfect information as a simplifying measure
Economic modelling	Equilibrium modelling	– Examines changes in supply and demand, and price effects associated with use of met/hydro services – Measures resulting gains/losses for producers and consumers	– Partial equilibrium modelling useful to examine benefits of met/hydro services for a specific sector	– Time and data intensive – Expensive to implement – Requires significant expertise
	Econometric modelling	– Examines statistical relationships to determine specific outcomes associated with the use of met/ hydro services – Regression analysis is the most common form of econometric modelling	– Uses observed data to conduct ex-post and ex-ante analyses	– Can require significant amounts of data and expertise
Avoided-cost assessment		– Evaluates benefits based on avoided costs of weather and climate events due to better met/hydro information, including avoided asset losses, lives saved, and avoided morbidity impacts	– Can be applied in ex-post and ex-ante analyses – Relatively easy to implement	– Only represents partial value (for example, it does not take into account benefits of met/ hydro services associated with increased productivity and enjoyment)
Benefits transfer		– Applies results of existing valuation studies and transfers them to another context (for example, a different geographic area or policy context)	– Relatively simple and inexpensive – Accepted as a suitable method for estimating order-of-magnitude values for use and non-use benefits, in ex-post and ex-ante analyses	– Can generate potentially inaccurate and misleading results – Limited number of original studies