KADI

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KADI

Executive Summary

This report provides an overview of the individual activities and synergies between each of the work packages (WPs) in the KADI project. The identification of key climate services is described, building on outputs and experience from previous projects, and these will then be used to inform the development of work undertaken in each of the climate service pilots (WP2). The engagement with stakeholders in WP1 and outputs of the climate services (WP2) will then inform the activities of WP3 to allow for the development of a proposed observational infrastructure that provides the climate services required for the diverse array of stakeholders across Africa. These collective outputs will then feed into WP5 to aid policy cooperation and provide greater impact through connections with funding agencies who could aid the implementation of the observational network proposed in KADI.

Table of Contents

Introduction

This report details discussions held within the wider project team as part of the first knowledge-exchange activity scheduled within the project. This meeting was held online in June 2023 and included project partners only, as activities within the project were at an initial stage with several staff still to join the project. This gave the project team an opportunity to present the planned activities in each work package and allow colleagues in other areas of the project to develop wider synergies with the planned work undertaken. The meeting focused on key aspects of the wider KADI objectives, and this workshop allowed the team to explore the knowledge gained and past experience of team members who had involvement in previous/related projects to identify

knowledge gaps. From this the team discussed how this knowledge could be used to shape activities in KADI and how will each of the proposed WP/pilot activities will address the knowledge gaps and key stakeholder requirements building impact through the WP and wider project outputs.

Work Package 1: Definition of required climate services

KADI WP1 aims to investigate the climate service needs of stakeholders across Africa. The findings will inform the design of the pilot case studies in WP2 and identify the necessary observational and modelling infrastructure for WP3. To understand the current state of knowledge on research infrastructures, WP1 conducted a preliminary literature review to examine how these concepts are currently defined and to identify their key components. Research infrastructures are the physical and digital tools that researchers use to conduct innovative research. They provide unique infrastructures such as laboratory equipment, data repositories, and knowledge-based resources (Regulation 1291/2013). According to the Global Framework for Climate Services, climate services are tools that provide information to aid people in making decisions. These services must be accessible and easy to use, and they should be tailored to the specific needs of the users (WMO, 2014). Both research infrastructures and climate services are well-defined but information on the application of research infrastructure for climate services is limited. In addition, research infrastructures and climate services struggle to articulate impact. The approach taken in WP1 will expand on the current definitions of research infrastructures and climate services. Research infrastructures are perceived to be driven by quantitative research. This approach includes qualitative methodology and user input throughout the entire development of our framework. Figure 1 shows the preliminary results of the WP1 team adding additional elements to a research infrastructure for climate services. For example, one key element in Figure 1 is impacts. WP1 will address how the proposed climate services impact stakeholders by using impact pathways. WP1 will continue to adjust these elements with input from the broader KADI team and analysis from the ongoing literature review. The activities of WP1 will be used to identify the needs, gaps, and stakeholder requirements of the KADI project.

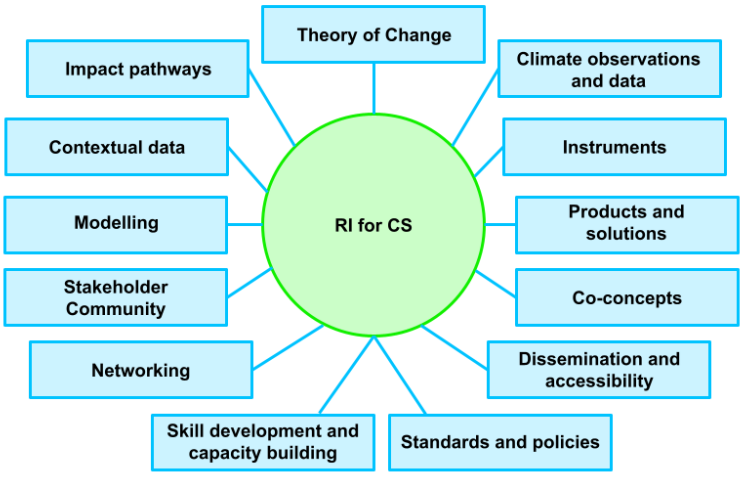

Figure 1: Preliminary ideas for key elements of a research infrastructure for climate services.

KADI

Work Package 2: Climate Service Pilots

Ocean biogeochemistry

The carbon cycle is heavily under sampled in most of the African coastal areas, despite the important role coastal ocean plays in regulating global climate. This knowledge gap is addressed in the KADI project by organising a pilot which aims to quantify key elements of the coastal carbon cycle and to better understand how connections between the use of the ocean for the local environment and wider ecosystem services and the global climate. This will be achieved through training workshops where the focus is on capacity building with regards to ocean measurements, the sensors deployed in this field and how they should be used, data collection and quality control, evaluation and interpretation of data and how these measurements can be integrated into wider international networks. Particular focus will be given to the use of low-cost sensors to perform time series measurements and expand the observational network in coastal areas of Africa.

The workshops will be held in South Africa coordinated by research groups at SAEON who are at the international forefront of ocean research in Africa and globally. Their expertise as well as measurement locations in St Helena Bay and Algoa bay are of importance for this pilot. In addition, colleagues from NORCE in Norway, with expertise in this aera and experience from the former SEACRIFOG project and the ongoing ICOS project will take part.

From the ocean focused workshops in SEACRIFOG we experienced the importance of available and reasonable facilities and human and instrumental resources at the measurement sites of interest. This experience has resulted in inclusion of low-cost sensors in the KADI project, which will make it possible to perform valuable measurements in spite of limited resources.

Cities

Abidjan

Work carried out as part of the “Aerosols and Pollution” team's various projects has clearly demonstrated the importance of particulate pollution in Côte d'Ivoire and Sub-Saharan Africa in general. This work has shown PM2.5 concentration levels generally higher than WHO standards. Thus, these results justify the objective of this climate service, which is to design a particulate pollution warning system in Abidjan by developing a PM2.5 measurement network and an effective communication network to reach the end users in case of exceeding WHO thresholds. UFHB intends to draw on its experience and network of partners to set up and monitor this climate service.

To achieve this objective, the climate service must first set up a particulate pollution observation network. This network will provide real-time, continuous PM2.5 concentrations, as already done by the "Aerosols and Pollution" team at different sites in Abidjan. The number of sites will be increased through collaboration with partners. The meteorological parameters (air temperature, relative humidity, precipitation, wind direction and speed) needed to monitor the dispersion of this pollutant will be provided through a partnership with the Société d'exploitation et de développement aéroportuaire, aéronautique et météorologique (SODEXAM). PM2.5 concentrations will be presented on maps in graphic form for the general public.

The "Aerosols and Pollution" team has a network of atmospheric pollutants measurements (gases and particles), available for almost ten years, which will be made available to this climate service. These measurements, carried out as part of several scientific projects, have enabled us to identify the main sources of these pollutants.

Abidjan's pilot climate service will implement an effective communication system using all media (radio, TV, social networks) to provide real-time information on particulate pollution to Abidjan's population. This system will ensure the protection and prevention of the population. Containment measures will be taken to limit outside movement (particularly for sensitive individuals). Similarly, hospital emergency services will be alerted to take care of the most vulnerable populations. In addition, recommendations including action plans to mitigate air pollution will be proposed to political leaders. The latter need information on pollutant sources and air pollution levels to make the right decisions to improve air quality. Evaluation of a mitigation strategy requires emission inventories (emission registers, actual consumption data) regularly updated with information produced by stakeholders.

Our climate service will need an awareness-raising policy. To achieve this, information and awareness campaigns on PM2.5 sources will be conducted via community events, social networks, posters, information brochures and educational programs in schools. This awareness-raising will enable the population to better approve the reduction measures and modify their behaviour to better adapt to them. All awareness-raising actions will be carried out in synergy with all stakeholders, including politicians, NGOs, environmental agencies and the general public.

However, to be realistic, financial resources are a challenge we need to meet if this climate service is to be sustainable. Indeed, this climate service will require the coverage of the city with measuring equipment, the purchase and storage of geospatial and pollution data, as well as operating costs.

Dar es Salaam

The KADI climate service pilot in Dar es Salaam is based on previous work done in World Bank funded Tanzanian Resilience Academy (RA) project (2019-2023), which now continues as an institutionalized program in four Tanzanian universities in collaboration with University of Turku. Resilience Academy has an approach where university students conduct community mapping with low-cost digital and mobile tools to collect critically needed geospatial data of climate hazards and the lived environment to enhance informed climate risk management, decision-making, and climate actions. In addition to geospatial data collection, RA provides also online learning materials of geospatial data management, open data sharing, participatory mapping, flood modelling, climate change, and remote sensing, which support the students conducting the data collection. All collected datasets are shared openly available via Climate Risk Database, and they are used in other World Bank projects and official initiatives that aim to improve climate resilience across Tanzania.

In urban settings, climate services operate in socio-ecological, economic and cultural systems, where improved management of climate risks is not detached from the management of multitude of other risks in a rapidly changing environment. It is necessary to tie other stressors and characteristics of urban living environments to local contexts and co-create knowledge and action, which is need-driven and impactful for the local communities and actors in the cities. Thus, geospatial data to support decision-making of officials and citizens must also cover other aspects of the lived environment than climate information, such as drainage infrastructures, river morphologies, soil sediments, buildings, land use change, and more (Figure 2). The RA

geospatial data collection campaigns have validated existing data and collected missing information of these themes to provide a solid base for climate services that informs improved management of pluvial floods in Dar es Salaam. The importance of this holistic view on climate risks in urban settings is also acknowledged in the KADI Dar es Salaam city pilot.

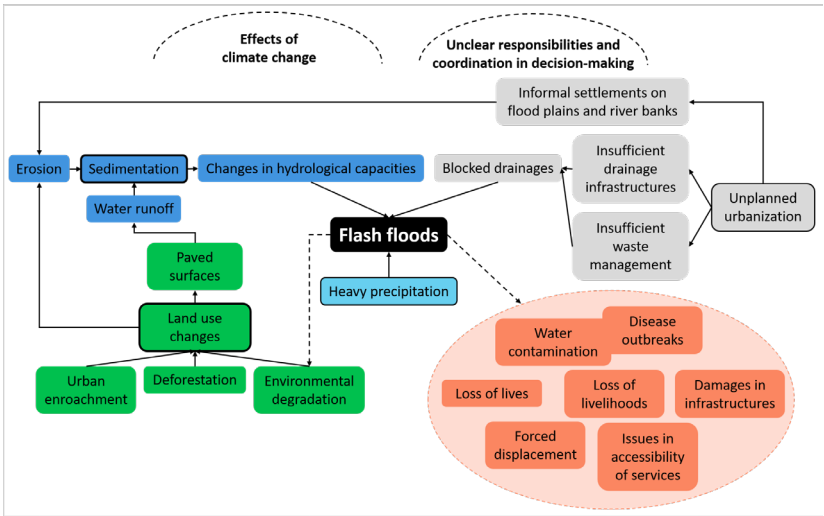

Figure 2. Dar es Salaam suffers from regular flooding of the Msimbazi river that flows through the city. The floods are caused by heavy precipitation, but there are numerous other reasons that create the circumstances for the river overflow. When managing the floods, information of all these other factors must be available for decision-making.

At this stage, the most important knowledge gaps identified that would be beneficial to be addressed in the KADI Dar es Salaam city pilot, but also broader in all of the (city) pilots are related to 1) ensuring and measuring impact of climate services, 2) conducting effective and ethical citizen engagement, 3) shared understanding of the definition of climate service research infrastructure, and 4) suggestions for low-cost tools or methods for air temperature monitoring that could be used in citizen science-based data collection campaigns. Training needs in the Dar es Salaam city pilot relate to training students for conducting participatory mapping, and exchanging knowledge, experiences and best practices between the city pilots.

Based on literature and past experiences, ensuring and measuring impact seems to be a challenge for projects working in the axes of disaster risk management, climate adaptation and climate services. Either the project proposal has not contained strategies for ensuring and monitoring impact, or the realized impact has been difficult to showcase and articulate. Recently, impact monitoring and articulating impact pathways has become more mainstream in such projects. However, concrete impacts might materialize after a significant period of time, which is often out of scope of the project duration. Thus, innovative and practical methods for impact monitoring should be adopted in projects with shorter duration. Also, best practices for ensuring impact should be available and actively discussed already in project planning.

Effective and ethical citizen engagement is not a new concept, and there is plenty of expertise available within KADI project. Thus, it is not a knowledge gap as such. However, its nature is very context-specific, complex, and resource-intensive. Pilot teams conducting citizen engagement activities must have knowledge of best practices, and ethical guidelines to carry out these activities in a sustainable manner. Similarly, definitions of climate services and research infrastructures are well known within the discipline. Combining these two and taking a broader

look at their elements than traditionally might be the case brings up the need for discussions between project partners to ensure common understanding, and sharing of expertise when defining the elements (work of WP1).

Specifically for the Dar es Salaam pilot, there is a need for sharing experiences on using low-cost tools or methods for air temperature monitoring in urban context. Should funding allow, the team will pilot air temperature monitoring in selected neighbourhoods, with integrated citizen science and community-based data collection approaches. The team has already encountered some interesting solutions (e.g. Kuras et al. 2015 and Wolff et al. 2021), but would benefit greatly from experiences from KADI partners or other stakeholders with such expertise.

The Dar es Salaam city pilot will conduct participatory community mapping activities to scope the citizens' climate service needs when adapting to cascading effects of floods, heat stress and poor air quality. The participatory community mapping is conducted by 5-10 university students or alumni. The team will train the students to use the mapping tools, and to conduct the surveying with proper methods. This training is done by the team members with extensive previous expertise. However, additional training needs would stem from exchanging knowledge between the city pilots. The city pilots share many aspects in their city pilot plans, and would benefit from knowledge exchange activities between each other, either online, or in-person. Also, training in the pilot cities of citizen science approaches and community-based mapping for higher-education level students might be beneficial. In addition to these pilot-specific training needs, the possibility for a wider-scale leadership training for city- or even national-level officials across the KADI pilot countries could be explored. The leadership training could touch themes of seeking funding for climate adaptation related projects, creating MoUs and other official agreements with partner organisations, and managing collaboration consortiums, and more.

Kenya – Lessons learned

Sustainable (atmospheric) observations require long-term commitment of the operating institution at various hierarchical levels, i.e., from the on-site operators, to the operators' supervisors, and up to the higher management level. Twinning programmes and personnel exchange among new and established stations or laboratories are usually effective approaches to advance the development of new monitoring capabilities to full operational status. This also requires long-term commitments of the expert twinning partners as experience has shown for the Mount Kenya atmospheric monitoring station (MKN) in Kenya. MKN was established in the mid-1990ies under the WMO/UNDOP/GEF programme GLO/91/G32. It was soon recognized that continuous support is key to maintaining high-precision observations in line with the data quality objective requirements after the end of the initial programme.

The Swiss experts from Empa and MeteoSwiss started to support the Kenyan Meteorological Department (KMD) in their operation of the MKN observations in the early 2000s through their mandate of supporting the data quality of World Meteorological Observation's (WMO) Global Atmosphere Watch (GAW) programme. Similarly, MeteoSwiss has supported and accompanied the ozone monitoring program at the KMD headquarters in Nairobi for over 25 years. This site has successfully functioned in support of the WMO/GAW and the Nasa SHADOZ programs ever since. Experience from MKN and other monitoring stations in developing countries has shown that the process of station support and capacity building is a long-lasting process: when starting from a general willingness to perform high-precision air quality observations but only basic equipment, infrastructure and expertise is available, it usually takes about 10-years of close

collaboration until the state of a fully autonomous monitoring station, with high-quality data, and good visibility in the scientific community and beyond is reached.

Specific steps during this time are (i) advice for instrument selection, (ii) technical support / advice to set up measurement capabilities, (iii) regular on-site training, (iv) remote support / trouble shooting, (v) facilitating the provision of spare parts, (vi) support for data processing / data submission, (vii) support for (research) proposal writing, and (viii) support for scientific data analysis and publication. While the training and support for the hands-on operation and maintenance of instrumentation is often successful, issues were often particularly faced with respect to robust data chains, (automated) data processing and quality control. This may be unexpected since partners among the GAW umbrella are usually the national weather services (like in Kenya) that are expected to be familiar with the handling of continuous data and large datasets, However, data treatment of atmospheric composition data is more demanding than the recording for standard meteorological variables: atmospheric composition sensors usually require very regular calibration, (automatic) distinction of the calibration data from the ambient air records, analysis of the calibrations, and application of calibration functions and other corrections (e.g. in the case of cross-sensitivity of the instrument to other species) to the instruments' raw data.

Overall, there is a series of obstacles that operators in developing countries along with their twinning partners face when performing 24/7 air quality operations: examples are (i) lack of adequate consumables, (ii) lack of spare parts, (iii) lack of budget, lack of financial authority with the operators, (iv) hierarchy issues within the organisation, (v) (long-term) commitment of the partner, (vi) insufficient know-how, (vii) distance to the headquarters (in case of field measurements in remote locations), (viii) unclear responsibilities within an institution and among the partners, (ix) fluctuation of staff, and (x) language barriers. Of these, financial constraints and rotating-off of trained staff are perhaps the most difficult ones to address.

Work Package 3: Strategic Infrastructure Design

Work package three focuses on the development of a conceptual Infrastructure design to support the required climate services in Africa as identified in WP1. This a WP dependent on the outcomes of WP1 in conjunction with the lessons learned from the pilots (WP2) relating to the Development of an African Earth System Model, the Ocean Biogeochemistry, Cities and the Lessons Learned in Kenya. In addition, the Stakeholders identified in WP 5 (Deliverable 5.1) will form the basis for engagement. Due to the requirement that the other work packages develop their concepts and approach before the topic of Infrastructure design is approached, the majority of the work for WP3 will be developed during years 2 and 3 of the project. However, in order to unify approaches with WP1 a review of climate services in Africa is being developed, this has a strong focus on the climate services that can be provided by research infrastructures. Both a top down (looking at the models of existing research infrastructures and observation platforms) and a bottom up, (based on the Pilot studies in WP2 and coordinated stakeholder engagement in parallel with WP1) approach is being taken. Areas of particular focus include reviewing the outcomes of the SEACRIFOG project, understanding the landscape of RIs with a climate services contribution both globally and in Africa, understanding their operations and the operational space for observational infrastructure across the continent

Interviews with the pilot project teams will be undertaken with a goal of understanding the existing observation infrastructure, the existing data infrastructure, an understanding of how the

infrastructures or observation platforms interact with the scientific and modelling community in the provision of services.

Work Package 5: Policy Cooperation

Lessons, past experiences, knowledge gained and gaps

Policy cooperation and climate services in Africa are essential for building resilience and effectively addressing the challenges posed by climate change across Africa. Policy cooperation in climate observations is a critical aspect in addressing climate change. Climate observations refer to the collection, analysis, and monitoring of various environmental data, such as temperature, precipitation, sea levels, greenhouse gas concentrations, and more. These are essential for understanding the Earth's climate system, detecting trends and changes, and developing effective climate policies.

Many African countries face capacity constraints in climate-related research and services. Policy cooperation should involve identifying and exploiting opportunities for capacity-building initiatives to train African experts, scientists, and policy-makers in climate science, data analysis, interpretation and establishing climate research infrastructure. Climate services should be integrated into national and regional policies, development plans, and strategies. This will ensure that climate information is considered in the different but complementary sectors, such as agriculture, water management, health, and infrastructure development. Establishing and improving early warning systems is critical for disaster preparedness and response. Policy cooperation can help in developing effective early warning mechanisms. Climate observations need to be integrated into policy-making at various levels, from local to international. Decision-makers need access to reliable data to develop evidence-based adaptation and mitigation policies and strategies. The general need for systematic observations and knowledge sharing in Africa is part of the global climate discussions and negotiations. These negotiations are not disconnected from the current geopolitical issues.

From a previous related project, SEACRIFOG there is a sufficient knowledge on the policy spaces where the KADI project needs to be active. These include the Group on Earth Observations (GEO), UNFCCC, African Union-European Union cooperation, WMO and GGGW. KADI partners are already well-positioned in these spaces. Some instances for KADI participation and interaction include:

- KADI partners have a good representation at the World Climate Research Programme (WCRP)’s Open Science Conference 2023.
- An application has been submitted for a COP side event at the COP28.
- KADI will co-host a side event at the GEO Week 2023 ministerial summit.
- KADI will be presented at the African Group on Earth Observations (AfriGEO) 2023 symposium.
- The next AU-EU summit may be held when KADI is at a more advanced stage with significant results for the benefit of the intercontinental cooperation policies and initiatives. There is a need for a common research and innovation funding within AU-EU cooperation.

- KADI will attend the LEAP-RE Stakeholder Forum, an event aiming to create and expand an international multi-stakeholder community dealing with renewable energy, science-based policy-making, funding and research, innovation, monitoring, evaluation and learning, in Africa and Europe.

- From WP1, information on the existing climate services and what kinds of climate services can be developed and tried will be useful in the discussions with the policy actors.

KADI needs to explore the initiatives and activities at the science and policy nexus of climate services. This is being done by identifying the related networks where the KADI participants are already active. Some have already been identified through the stakeholder mapping in WP2 and WP5. We will also reactivate contacts from previous projects. For instance, the African Academy of Science and the National Young Academies of Science in Africa.

In SEACRIFOG, there was a wide identification of funders but no real connections or engagements were made. It is intended that the expertise of KADI partners who are more connected to these spaces will help with innovative funding solutions that can include both small- and large-scale funders. Policy cooperation in climate observations is vital for creating a holistic approach climate change. There are different complementary but unconnected funding and policy initiatives. Sometimes the actors involved operate within the same or similar territories but do not know about each other or collaborate. By linking these initiatives, we can improve data quality, enhance research, and develop effective policies to address the common climate service needs on the continent.

- There is also the need to explore the possibilities for resource-sensitive observation capacity. This should include non-technical and inexpensive measurement approaches, inter-calibrating them with more resource-intensive approaches.

- There is a need for policy awareness where policy-makers know about existing research and science solutions that support policy. Researchers and scientists should also be able to identify the potential policy, social and other forms of impact resulting from their research. Knowledge sharing opportunities in KADI can also be seen as helping in communication and bringing African climate scientists into tighter networks for collaboration. The training workshops in the knowledge exchange work package will contribute to these.

Summary

The first knowledge exchange meeting provided a concise overview of the wider activities and synergies between each of the WPs in KADI. The project builds from the outputs of previous work (e.g., SEACRIFOG) to engage stakeholders at local level across Africa to develop the climate services needed. This information is then being used to develop the activities in the climate pilots which will address key knowledge gaps and both will then aid the development of a proposed observational network for Africa. These outputs can then be used to engage with relevant sectors in policy development and infrastructural support to provide greater impact in the implementation of a sustained pan-African observational network that will provide the climate services for current and future generations.