KADI

Summary of travel reports and an overarching review of lessons learned

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KADI

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KADI

Executive Summary

This report details the knowledge exchange and training activities that were designed, developed, delivered and supported through the lifetime of the KADI project. These activities were centred around the work undertaken by the pilots in WP2 and resulted in 6 knowledge exchange and training events. Some of the training activities were directly embedded in the KADI project aims and objectives, for example the oceans training workshops associated with WP4 Task 4.3. Here, two ocean training workshops were organised. One in South Africa to develop hands-on skills and another in Morocco to work towards the development of a pan-African coastal observational network that could integrate with wider global initiatives.

Through Task 4.2 (Knowledge sharing for African scientists) the KADI project had the flexibility to adapt to key African stakeholder needs and to develop or facilitate training workshops as required. Through this, the KADI project supported African ocean scientists to travel to Belgium to attend an international/global meeting on surface pCO2 measurements, directly facilitating knowledge exchange between the African Union (AU) and the European Union (EU). This task also had the agility to respond to the needs of stakeholders for training in key areas, and the stakeholder workshops held as part of the pan-African and European knowledge and innovation exchange (Task 4.1), highlighted key training requirements identified by stakeholder engagement that the KADI project could facilitate. Through the pilot projects in WP2, training workshops were developed to explore, knowledge exchange and use on weather and climate information, training on data analysis platforms and coding languages to expand the climate services of key data sources further, and hands on training to assess heat stress and air pollution in urban environments.

This report details a summary of activities and outputs of these knowledge exchange events, details in the lessons learnt and take-home messages from the activities are detailed in each section. However, one of the main achievements of the KADI project and the knowledge exchange activities has been the development of stakeholder champions in thematic areas aligned to the project (oceans, urban environments, meteorological measurements). These stakeholder champions are committed to continuing and further developing the outputs of KADI through the creation of Communities of Practice (CoPs), managed online through tools/platforms such as WhatsApp to facilitate the continued discussion and development of knowledge exchange activities in these areas.

KADI

CONTENTS

Knowledge sharing for African Scientists

The KADI project had a direct focus on knowledge sharing and training through activities undertaken in Tasks 4.2 and 4.3. These were facilitated through project pilots in Work Package 2 (WP2) as opportunities and needs were identified. There were also targeted training courses that were organised as part of the Ocean Biogeochemistry pilot field training exercises (Task 4.3). The training courses were agile in nature, identifying additional training opportunities during the lifetime of the project to address training needs required by African scientists (e.g. the Python data training gym where the need was identified as part of the second stakeholder workshop) or the surface pCO_2 ocean workshop, that was organised independently of the KADI project but provided an opportunity for KADI to facilitate African scientists to travel to Europe to provide additional knowledge exchange activities. Each of the knowledge exchange or training opportunities were advertised broadly, through the project communication channels and international networks, and were open to all scientists from across Africa to engage with these activities. Over the course of the project the KADI knowledge exchange and training activities have engaged stakeholders from 18 African countries (Figure 1).

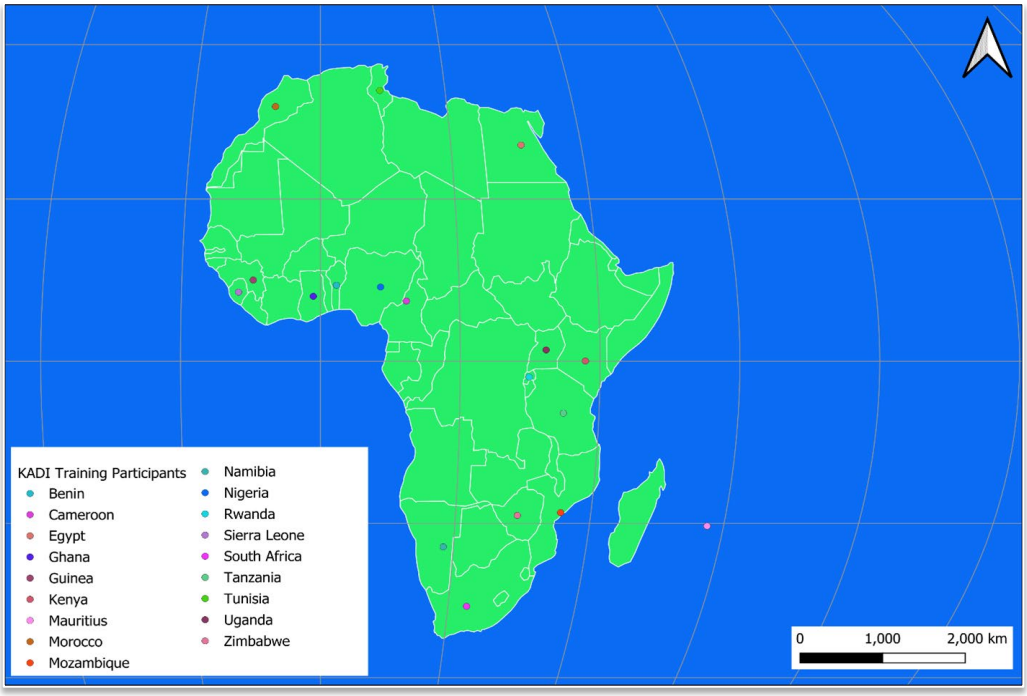

Figure 1 The location of participants involved with KADI Knowledge Exchange and training events across Africa. Map credit Omobola Eko.

Knowledge sharing activities and training courses

The knowledge sharing activities associated with task 4.2 were developed with the pilot project leads in WP2, and were initiated through discussions held at the project kick-off meeting in October 2022 and key training or knowledge exchange needs were identified as the activities in the pilot projects evolved in collaboration with stakeholder engagement. Two training courses associated with the Ocean Biogeochemistry pilot were proposed as part of the KADI project, with the first focusing on hand-on field-based training and the second considering how an observational network for the surface and deep oceans could be developed for Africa and integrated into the global networks and initiatives. Over the course of the KADI project WP4 facilitated the mobility of African scientists to attend and engage with six workshops/training courses five of these were

based in Africa and one in Europe to further enhance AU-EU and wider global knowledge exchange. The six activities consisted of:

- A workshop on surface pCO_2 measurements held in Belgium
- The first oceans training course held in South Africa
- A second ocean training course and workshop held in Morrocco
- A training course on urban heat stress and air pollution held in Tanzania
- A knowledge exchange workshop for meteorological measurements held in Kenya
- A Python data training gym held in Kenya

Further details on these activities are outlined in the section below.

Ocean pilot

Surface ocean pCO_2 conference and training

The first event supported under the oceans pilot was not a planned activity within the project, however this opportunity was identified and the KADI project supported the participation of six African ocean carbon cycle scientists from Benin, Egypt, Ghana, Mozambique, Nigeria, and South Africa, to attend a workshop focussed on the Surface Ocean pCO_2 measurements in Ostend, Belgium held between the 6^{th}-9^{th} of October 2023 (Figure 2). Full details on this workshop can be found in D4.5.

The workshop was facilitated by multiple organisations and EU projects (Workshops on surface ocean pCO_2 observations | OTC Carbon Portal) and gathered more than 100 ocean experts and stakeholders representing Europe, Australia, Asia, North America, South America and Africa. The objectives of the workshop were (i) to assess the status of the wider community of measuring, storing, synthesising and mapping the surface ocean carbon dynamics, and (ii) to call for concerted international and intergovernmental efforts to create a robust, resilient and sustainable surface ocean carbon observing system. Both objectives were of direct relevance to the Oceans pilot in KADI.

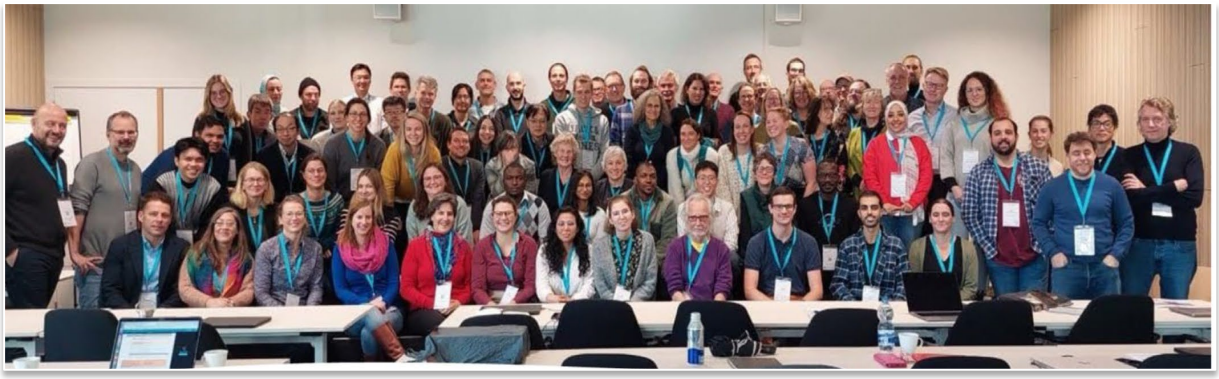

Figure 2 . Attendees at the 2023 Ostend Workshop including KADI project team members and selected participants

SOCONET design and pCO_2 products and 3) SOCAT strategy and quality control. It represented the first opportunity for the surface ocean pCO_2 community to come together since the COVID-19 pandemic and was

motivated by a widespread recognition of the value chain linking observations through to policy advice is too weak and required strengthening.

The most important outcome from the workshop was a declaration on the operationalisation of the value chain of the observing network SOCONET (the Surface Ocean CO_2 Observing Network) which was developed by a community of experts and stakeholders. It covered the societal challenge of climate change, the primary drivers, and the policy mechanisms designed to reach net zero by 2050. Furthermore, it identified the need to routinely monitor the ocean carbon uptake as essential for understanding the global impacts of climate change and its future projections in support of climate policy making. Finally, the declaration has drawn attention to the fact that the SOCONET, despite its success in delivering critical information, lacks formal integration into the organizations mandated by the United Nations Framework Convention on Climate Change (UNFCCC). Several recommendations were presented in the declaration on how to improve the current situation. The globally representative nature of the authors list and participants at the workshop lead to the influence that the declaration had: it was the key document that supported the application made to GOOS for SOCONET to become a recognized network. The advantage of this, is that all observing systems globally now have a 'home' which can unlock funding and further support, particularly within the G3W which has a strong capacity building element. These aspects were extremely useful for the KADI project and the participants and helped to further inform and develop the training activities as part of task 4.3.

The African participants reported that the workshop was very useful both at technical and institutional levels. They gained essential knowledge about the protocols, methods, and standards required to conduct ocean carbon and ocean acidification research. They also gained valuable insights that observing systems are often implemented with regional inputs and their home institutions can make important data contributions. Points such as this were further developed by the KADI team through the identification and support of regional stakeholder champions and communities of practice (CoPs). After the workshop the participants looked forward to (i) engaging in collaborative efforts, such as co-authoring research papers, with the scientists they connected with during the workshop, (ii) look for opportunities to partake in relevant regional cruises to extend training opportunities and data acquisition, (iii) attend workshops and conferences to showcase their regional studies and research, (iv) advocate the involvement of their home institutions in international research activities focusing on oceanic greenhouse gas observations such as the SOCONET.

The workshop provided a valuable platform for ocean carbon scientists to address the requirements of the Global Greenhouse Gas Watch (G3W) initiative and discuss advancements in the Surface Ocean Carbon Value Chain. The discussions and outcomes of the workshop will have a significant impact on the improvement of the uncertainties associated with the Global Carbon Budget (GCB) and facilitating the routine provision of crucial information to policymakers. Moreover, the workshop fostered international collaboration and facilitated the sharing of knowledge among experts in the field.

Supporting African researchers' participation in international technical workshops, like the Ostend workshop, was an important activity to build capacity in potential contributors of African observation network while fostering global network for observational data to advance fundamental knowledge, improve forecasts, and provide longer-term projections of climate, weather, and ocean ecosystems.

First Ocean Workshop

The first KADI ocean workshop was held from the 12th-15th March 2024 in Ocean Sciences Campus, Nelson Mandela University, Gqeberha, South Africa. Full details on this workshop can be found in D4.5.

The main objective of the course was to support the establishment of an African network of Greenhouse Gas (GHG) measurements by giving early career scientists/professionals an overview of available sensors, hands-on training, fieldwork, data collection, data analysis, data processing and management, and international

networking. Fifteen participants from 11 different countries on the African continent from Morocco, Nigeria, Guinea, Egypt, Namibia, Benin, Kenya, Tunisia, Mauritius, Cameroon and Benin (Figure 3) were invited to join a four-day training course on coastal oceanographic and carbon data collection, analysis and sharing.

Specifically, the participants learnt about how coastal carbon observations can be made with sufficient funding and what can be done with limited resources. The course was structured around three main components that included:

1. Lectures: topics covered broad coastal biogeochemistry with a focus on some specific aspects such as the ICOS marine stations, blue carbon (estuaries and salt marshes), coastal oceans, and the open ocean.

2. Field work and measurements: students were divided into two groups which alternated between the following activities:

- Blue carbon measurements in a tidal estuary, including the use of a GHG analyser and the collection of water and sediment samples.
- Coastal biogeochemistry off a small research vessel to collect marine samples (using the GOA-ON in a box kit https://www.goa-on.org/resources/kits.php).
- Deployment/recovery of pCO_2 and pH instrumentation.
- Analysis of sediment and water samples in the Carbon Laboratory.

3. Data analyses: training on the analyses and interpretation of the results was followed by each group writing reports and presenting their results.

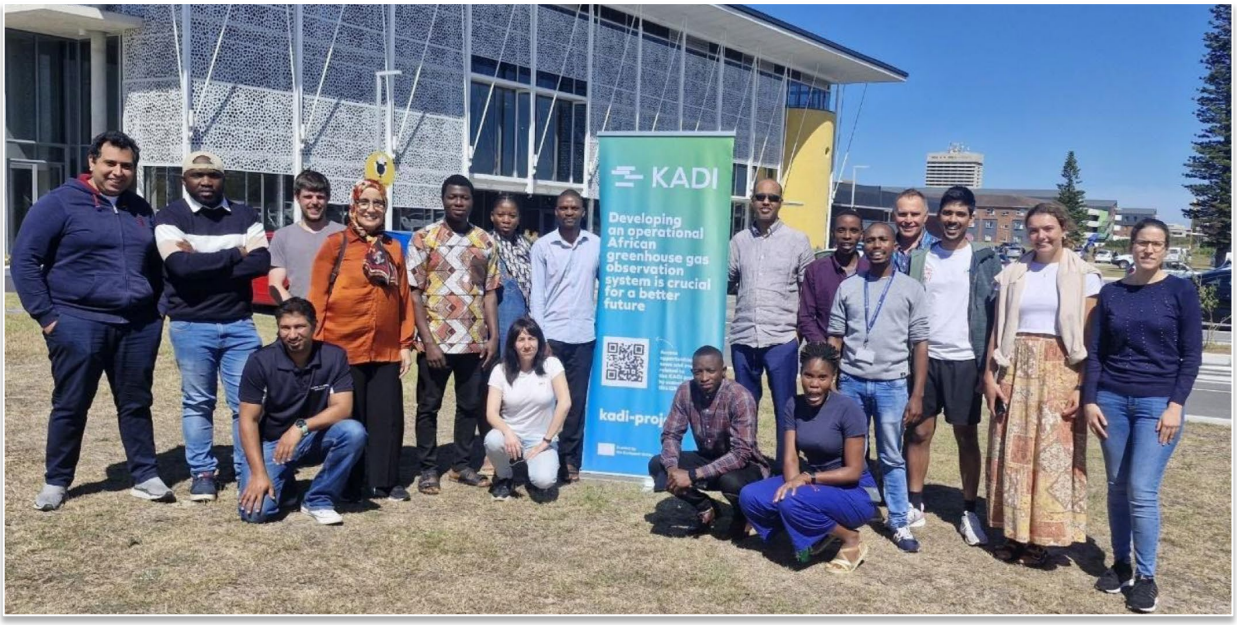

Figure 3 Selected participants and KADI teams members at the first oceans workshop in Gqeberha, South Africa

During this workshop, a significant amount of time was spent on discussions in addition to the hands-on training to elucidate the current needs, resources and limitation for building a community of operators, funders and end-users in ocean carbon cycle science in Africa. These discussions were structured around three topic areas of regional needs, network design and resource limitation and the key aspects and take home messages are summarised below.

Regional needs

A discussion on regional needs to establish a basic African network of coastal biogeochemistry sites resulted in the following key statements:

- A list needs to be drawn up of what equipment, resources and capacity is available in each of the countries.
- It will be important to harmonise methodology (SOP & Ocean Best Practises manuals) between the different countries in Africa. To this end, the workshop identified the following:
    - Establish a Task Team for Ocean Best Practises in coastal carbon observations in under-resourced countries
    - Link this task team to best practices for real-time moorings
    - Link this task team to the Task Team for Ocean Best Practices in coastal Observations in under resourced countries (already established)
- Establish calibration centres, either in Africa or in the Mediterranean region that will be easily accessible for the calibration of in situ sensors
- Conduct inter-laboratory comparisons
    - CRMs being developed in other countries (for easier access). CRM development in Europe is still under discussion.
- Biggest need is for basic carbon analyses instruments, especially for those countries with no national funding available. Some suggestions provided during the workshop include:
    - Apply for small grants to some of the agencies. Important to show that there is capacity (and ambition) before applying for a grant.
    - Countries can also ask for partial assistance, e.g. some equipment needed to conduct observations or to fund analyses of samples in other countries.
    - Dedicated large grant for Africa on this topic would be ideal, i.e. EU-Horizon type funding or similar.
- Specialist training on the use of equipment, analyses of samples and data was also highlighted as critical. To this end, the proposed network should consider:
    - Mentorship programmes within Africa and with other international experts/entities. This could be managed by a community if practice in Africa.
- Collaboration between countries and more developed countries (e.g. project grants, mobility grants, exchange programmes, etc.) will be very important in the establishment of an African network.

Designing an African Carbon Observation network

To design an African network, the discussions highlighted that the following topics should be considered:

- An initial high-level approach is required to ensure buy-in from countries into the establishment of an African Carbon Observation network.
- Establishment of regional hubs across Africa with capacity and expertise to analyses samples and produce guidance and advice will be required

    - Regional hubs can test and calibrate lower-cost sensors.
- Funding: External funding will be easier to obtain than National funding in most of Africa
    - Rotation of key equipment is also an option, but this will need regional hubs, community of practice, or countries that are near each other.
    - Important to start small with small grants and build capacity, thereafter it will become easier to apply for larger grants and grow the collaboration.
    - Show proof of concept first and use that as a platform to apply for funding and collaboration
- Conducting the mapping exercise on the capability of countries and availability of equipment will be critical to start the process.
- A Pan-African network should consider the following:
    - Link marine and terrestrial hotspots, i.e. catchment to the coast
    - Consider sustainability, i.e. what other activities are being conducted (and links to terrestrial) in the area
    - Identify existing research and research Infrastructure activities that carbon/GHG observations can be combined with to save on effort and use existing long-term datasets.
    - Align activities with government priorities
    - Connect data being collected for other research initiatives (IPCC, IPBES, etc.)
    - Stakeholder mapping exercise to identify needs and abilities in all the African countries
    - Have a coordinator (e.g. secretariat / etc) and establish a community of practice. Establish a committee of network members to start the process and once funding is secured can establish a secretariat.
    - Possible name: African Carbon Observation Network (AfriCON)
    - Need to create Ocean Best Practice/Standard Operating Procedures for key GHG/carbon observations

Resources and limitations

The workshop participants identified the following technical requirements and funding/resource limitations to achieving the immediate establishment of an African network of coastal biogeochemistry sites:

- Carbonate chemistry
    - Spectrophotometer for pH
    - Titrometer – alkalinity (ideal = auto titrator)
    - Samples fixed with mercury-chloride
    - CRMs only come from the USA (box of 24 = 4500 Euros – or only for 5 depending on customs); Quasimeme – internal standard (available from Europe – Netherlands for alkalinity and DIC)
    - Human resources: Dedicated person to conduct analyses. Also need other specialists to analyse other variables.

    - Countries with capabilities: Morocco, Sudan, Namibia, South Africa, Egypt, Mauritius, Mozambique, Nigeria, Kenya, Benin (limited), Tunisia (limited).
    - Import duties are prohibitive in many African countries.
- Blue carbon and sediments
    - Easy, relatively low-cost methods and most labs in African countries have the instruments
    - Drying oven, Ashing oven, balances
    - Corer (for offshore samples a multicorer is required, as well as a winch to retrieve the corer)
    - Mechanical Grinder
    - Samples for dating and elemental analyses must be sent overseas as there are currently no facilities in Africa. Consider establishing regional hubs
    - Human resources: Most research facilities in Africa do not have staff capacity to dedicate to coastal sample collection and analyses.
    - Countries with capabilities: Tunisia, Mauritius, South Africa, Mauritius, Kenya, Egypt, Morocco, Mozambique, Seychelles, Tanzania, Ghana, Mauritania (starting) Cot d'voire, Togo (starting), Nigeria,
    - Need additional capacity to get research operational but there is enough interest from several countries to drive this.
        - Infrastructure there, but held across various institutions
- GHG Flux measurements
    - Static chambers
    - Glass vials sent for GC analyses (samples can be sent overseas for analyses)
    - Flux towers – very expensive
    - LI-COR flux analyser – very expensive but techniques that utilise LI-COR such as eddy covariance and dynamic chambers provide excellent spatiotemporal coverage.
    - Water samples fixed with mercury-chloride sent overseas for analyses
    - Countries in Africa with capability: South Africa and Egypt
    - This research was identified as a big gap currently in Africa
- Near real-time data
    - Countries of capability: South Africa busy developing.
    - Moorings have numerous benefits and one way to grow the network is for industry to procure and use the platform to add their own sensors. An important partner could be the oil and gas industry.
    - Biogeochemistry Argo float data freely available, but data is limited to when a float passes a particular country. Another limitation is that these floats are often far offshore, not coastal.
- Research cruise carbon data
    - Countries that collect samples for carbonate chemistry (Morocco and Namibia, Nigeria, South Africa, Mauritius, Kenya, Guinea (mostly fisheries)

- South Africa has pCO_2 underway sensor on SA Agulhas (Southern Ocean research)
- For coastal areas additional capacity could be developed using smaller vessel

A major limitation highlighted by all the countries was the humas resource capacity and dedicated technical staff capable of maintaining and operating the specialist instruments. It will be important to source funding for permanent posts for key researchers and technicians.

Second Ocean Workshop

The second ocean workshop was designed and delivered as a two-day workshop entitles “Opportunities for Integrating African Coastal Carbon Measurements into Global Observational Networks”, this was run as a hybrid event both in-person and online from the 15th-16th July 2025. The in-person meeting hosted by the National Institute of Fisheries, in Casablanca, Morocco, and allowed for online participation through the Microsoft Teams platform. The focus of the workshop was to:

- Explore opportunities for integrating African coastal carbon measurements into global observation networks.
- Identify knowledge, infrastructure, and human capacity gaps.
- Discuss the creation of an African network dedicated to coastal carbon science and monitoring.
- Develop a roadmap to address the continent’s observation needs.
- Produce a summary report with key recommendations and next steps.

The workshop was used to build the concept of stakeholder champions and communities of practice which is a key outcome and achievement of the KADI project (D4.3). At this workshop the project brought together regional stakeholders from Kenya, Gambia, South Africa and Morocco (the KADI stakeholder champion from Morrocco facilitated the hosting of the workshop Figure 4). These stakeholders had been identified through the wider KADI knowledge exchange workshops and wider oceans training and knowledge exchange events facilitated in WP2 and were joined at the workshop by online participants from the wider KADI team and international scientific community.

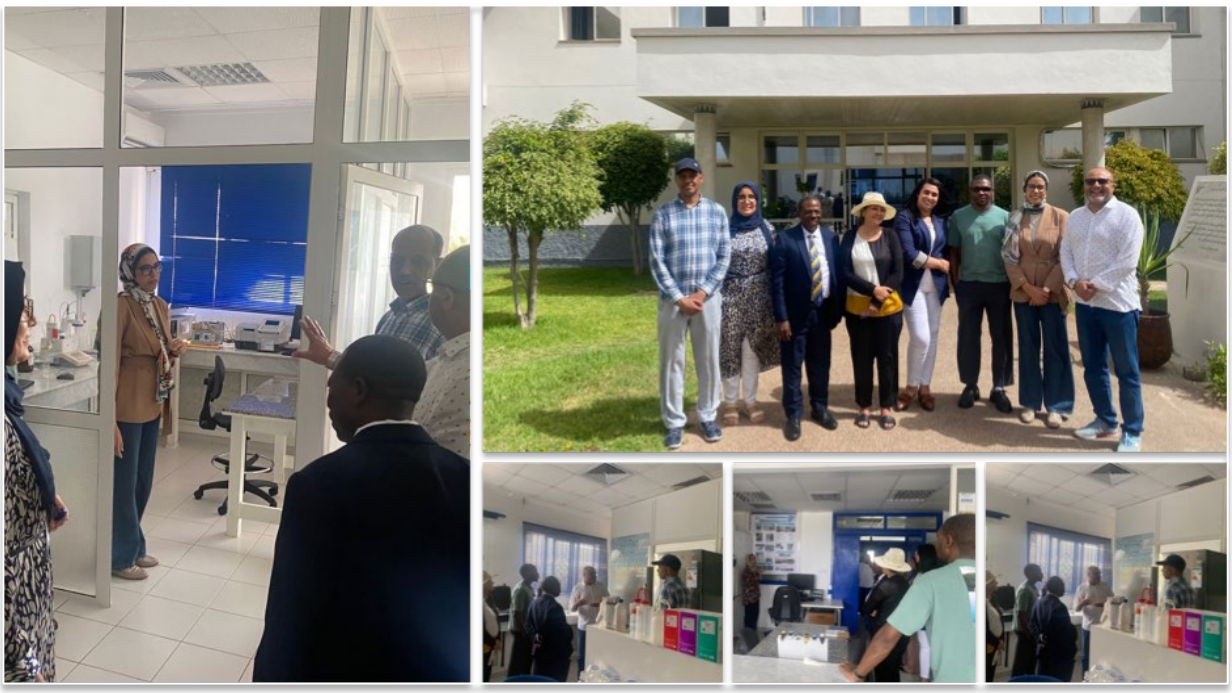

Figure 4 The local organising and KADI team at the INRH headquarters who hosted the second oceans training workshop (photo credit Abdirahman Omar)

The workshop focused on the KADI ocean biogeochemistry pilots and how this work can be used to further develop national and regional expertise, global networks and observational strategies and technologies, and how an African network for these carbon observations should be designed – directly informing WP3 of the project. Further discussions centred on the opportunities for integrating African coastal carbon measurements into global observational networks. The recommendations and future steps included:

- The development of four regional laboratories to regional Centres of Excellence. Primary tasks for the centres include sustaining current measurements according to common Standard Operating Procedures (SOPs) (made Africa specific if necessary), sensor calibration, training placements, data dissemination, further development of infrastructure, human capacity and expertise.
- The creation of an African Carbon Science Committee (ACSC) with the mandate to:
    - Map what is available in expertise and infrastructure; promote collaboration both south-to-south and with the international community; develop SOPs specific to Africa
    - Produce, disseminate, and oversee data quality requirements
    - Identify and submit applications of common projects to key funding agencies
    - Involve user-stakeholders and raise interest of coastal observations through the CoP
    - Implement mechanisms to enhance gender balance
    - Engage with policymakers and advocate for policy supporting carbon science advancement (e.g. through funding, easier visa and customs etc.).

The outputs of these discussions can be found in the detailed workshop report by Omar et al., (2025).

Cities pilot

City training workshop – urban heat stress and air pollution

The KADI city pilot teams (WP2) organised a training workshop "Open geospatial data, low-cost tools and participatory approaches for urban climate services in Africa" in Dar es Salaam, Tanzania on 12th to 15th of August 2025. The workshop was facilitated as part of WP4, Task 4.2. The event gathered 31 participants, including 17 early-career researchers and practitioners and 14 KADI experts, from 10 African and 2 European countries. It was held in conjunction with the KADI Final Stakeholder event (D4.3). The workshop was organised by the KADI City Pilots WP2 team (University of Turku (UTU), Université Félix Houphouët-Boigny (UFHB), Kenya Meteorological Department (KMD), Ardhi University (ARU) and Tanzania Resilience Academy.

The training workshop combined lectures, a field visit, and hands-on exercises to strengthen capacities in urban climate services. Participants acquired skills in co-creating climate services, applying participatory approaches, and using open geospatial data and low-cost tools for climate risk making and analysis.

Key insights underlined the importance of community engagement, inclusive co-creation processes, and the integration of local and scientific knowledge in climate services. Participants highlighted challenges such as logistical arrangements and the desire for more practical sessions, but overall confirmed that the learning objectives were well met.

The workshop contributed to building a diverse network of early-career experts across Africa and led to the establishment of a CoP on urban climate services in Africa to ensure continued collaboration, peer-learning, and capacity development beyond the KADI project.

The learning objectives of the training workshop were set as follows. After the completion of the training, the participants should:

- Be able to identify and understand natural hazards and climate risks and their contextual complexities in urban Africa
- Be familiar with the state of the art and practical examples in mapping and monitoring heat and pollution risks in cities with digital geospatial data sets (incl. EO), low-cost tools and community-based approaches
- Have obtained hands-on skills in climate data collection and community engagement using low-cost tools
- Have skills in integrated geospatial data analysis, combining local and global scale digital data products for the identification of climate risks and their spatio-temporal variation in the cities
- Be able to understand the prerequisites (needs, holistic approaches, engagement etc) and good practices for the co-creation of climate services with adaptation impacts

The main activities undertaken through the training workshop included:

- Field visits to Tandale and Kigogo wards**:**
    - Participants visited the same wards featured in the KADI Dar es Salaam climate service pilot (Figure 5). The visit focused on observing local environments through the lens of climate risks and urban infrastructure challenges, engaging in discussions with community members, and testing a low-cost participatory mapping solution.
- Climate service co-creation simulation:

- In group exercises, participants simulated the process of climate service co-creation. The activity highlighted key elements of the process, including mapping and understanding the roles of different actors, identifying desired impacts, and defining the requirements needed for services to achieve those impacts.

- Technical practical for participatory mapping tools and data analysis:
  - Participants tested an open-source participatory mapping tool while discussing common pitfalls and good practices for digital participatory GIS surveys. They also analysed data from the KADI Dar es Salaam climate service pilot using appropriate methods and produced meaningful visualisations.

Figure 5 KADI city training workshop participants and KADI team members on field visits to Tandale and Kigogo wards in Dar es Salaam, Tanzania (photo credit Matthew Saunders).

After the training course the participants were asked to identify the three top skills they had acquired during the week. These are summarised in Table 1 below and categorised around four key topics/areas that included:

- Integration of co-concepts for designing and producing climate services with relevant urban actors.
- Building competences in participatory approaches, including designing and facilitating inclusive processes, engaging communities, effective stakeholder communication, and recognising the value of local site visits in planning.
- Understanding in the theoretical concepts of urban climate services, including identifying climate risks of different local contexts.
- Technical skills in applying low-cost geospatial tools, using open data, conducting analysis and creating participatory mapping surveys using open-source software, and applying innovative participatory data collection techniques.

Alongside these, participants also highlighted that the workshop triggered innovative and creative thinking when approaching climate adaptation challenges and solutions.

Table 1. The skills identified by participants of the training workshop. These skills are grouped and categorised to thematic entities.

Top skills acquired	
Co-concepts	Climate service co-design
	Co-production skills
Participatory approaches	Designing and facilitating participatory approaches
	Importance of community engagement
	Stakeholder communication
	Importance of site visit before planning
Concepts	Concepts of urban climate services
	Identification of climate risks and stakeholders
Technical skills	Applying low-cost geospatial tools
	Using open geospatial datasets
	Analysis of climate hazard experiences in QGIS
	Using PARTIMAP
	Data collection techniques
	Innovation-creativity

Lessons learnt pilot

Knowledge Exchange Event on weather and climate information

The KADI project organized a workshop to bring together stakeholders of weather and climate information provided by the Kenya Meteorological Department (KMD) to develop the discussion around how to better understand user of this information with the aim of co-producing better climate services.

Assessing weather and climate information for use in Kenya

This meeting highlighted the background need to consider the impacts of climate change in Kenya. Agriculture, a cornerstone of the economy, is particularly vulnerable with climate variability leading to reduced crop yields, food insecurity, and economic instability, especially in arid and semi-arid land (ASAL) regions. Water resources are also under threat as changing rainfall patterns affect the availability of freshwater resources. Rising temperatures contribute to the spread of vector-borne diseases like malaria, impacting public health. Additionally, frequent floods and landslides damage infrastructure, disrupt transportation networks, and affect energy production.

Because of these drivers and impacts, the Country's demand for climate services is increasing and becoming more sophisticated and requires improved technologies and approaches in addressing.

According to the Kenya National Bureau of Statistics Economic survey 2024, some key sectors contributing to the Kenyan economy are Agriculture, Construction, Energy, Environment and Natural resources, Health, ICT, Money, Banking and Finance, Transport, Education and training, Tourism, Governance and peace security, Social and Economic. These sectors are vulnerable to climate variance and providing climate information to support decision making will reduce the expected impact to these sectors and overall cushion the economy from adverse shocks. Representation from these sectors was viewed as being key to achieving the workshops objectives.

With a main mission to improve the uptake of national climate services, the workshop's intent was also to develop coordination between actors and stakeholders along the country's climate services value chain. The envisioned value chain includes observations networks & monitoring systems, user interface platforms, research, modelling and prediction, climate services information systems, and capacity building.

KADI in conjunction with KMD organized a workshop to bring together various users of climate information services. The workshop objectives were to:

- Assess weather and climate use through a key stakeholder/informant survey
- Identify gaps in weather and information use
- Document weather and climate services in Kenya

Workshop Participants

Participants at the workshop were drawn from a pool of frequent users of climate information (both forecast and ground data) from the National weather service, Kenya Meteorological Department. They are also organizations from key sectors in the country.

The feedback received formed a basis of evaluating the service provided, the gaps experienced and give recommendation/suggestion to improve the products and services provided by KMD.

Summary of Workshop findings:

- Mapping of weather and climate information used as a base for design of future observation capabilities.
    - All participants acknowledged the importance of climate information in their operations. In agriculture for example, weather forms a critical part of their planning from advising farmers on planting weeding to harvest and storage of food including crop insurance. For livestock farming weather assists in fodder availability, destock and input storage. Data as an input, is therefore crucial in the production of climate information.

- Review and recommendation for future expansions of the observation system
    - Sectors showed support in collaborating to improve and expand the national observation network and system. The energy sector confirmed hosting of automatic weather stations at their plants and sites. An expansive station network provides critical data that is useful for production of climate information. Most participants were agreeable to hosting of observing stations and collaborations in sharing of data.
- Requirements for environmental research infrastructure
    - All participants stressed that the changing climate was a primary concern in their operations. Most organisations are already developing climate units to improve the uptake/use of climate information provided by the national meteorological service. These units require openly available weather /climate data, capacity building, both soft and hardware support to enhance their sector specific research.
- Emerging frontiers in climate information
    - Investment into research on new technologies such as cloud seeding. What are the possibilities and impacts of such technology in the climate arena. There is also demand for accessible data and information on pollution and GHGs.
    - Climate projections and simulations into various sectors e.g. financial and health sectors. Such data should be available in a relatively ingestible format.
    - Conversion of weather data into sector specific implications and use, for example can rainfall data be incorporated into intensity. Sectors can support KMD in knowing what data they want and need.
    - Research Infrastructure involves both soft and hard infrastructure; appreciating social and cultural dimensions in the changing face of science.
- Lessons learnt:
    - Participants appreciated the hybrid format that the workshop had organized. Those unable to travel to the venue were still able to participate.
    - Kenya Meteorological Department was tasked with a coordinating a mechanism that supports the sharing of information and feedback mechanism.

Key insights and quotes from the workshop:

‘Finance sector is the overall bearer of all adverse effects of climate change as its performance is largely dependent on the success of the various sectors. It is therefore exposed to a higher risk with increased adverse effects of climate change. The needs of this sector have previously not been factored in the development of products that can inform its operations and decision making. This needs to change. Information on gaps, needs, availability of information, informed users and closer working relationship will help buffer the sector and improve resilience.’

‘There is no denying the Global shift towards space technology. Space weather is an untapped frontier in Kenya weather with the potential to improve forecasting capabilities. We should see more investment in the same’

‘There’s currently poor data linking climate to health. This is because there’s a glaring gap in the study of attribution and it’s the case in almost all sectors. Attribution can also be supported with availability and access to quality data.’

Data Training workshop

The KADI project has endeavoured to strengthen the foundations for climate and atmospheric services across Africa. These services typically consist of the dissemination of information in formats appropriate for the intended use. This may include summary statistics of data, visualizations of data, trends of time series data, maps of gridded data, etc. These data may originate from surface or space-based instrumental measurements or human observations, or they may be model output or even census-based. The modern approach to turn data into information and services, both repeatedly and consistently, involves data management, analysis and automation. Scripting languages like Python (and R) are the open-source tools of the trade. Their efficient use requires a basic understanding of the language itself, including important libraries and packages that are available, and of the setup of the computational environment. These competences are not normally part of the normal curriculum of meteorologists or technicians involved in operating measurement systems. These topics were highlighted and discussed at the second stakeholder workshop in Nairobi on October 2024, from these the KADI project decided to develop and deliver a training workshop to explore these issues with hands-on training and to develop a CoP to continue the exploration of the topic and development of this area of analysis (Figure 6). More information on the process and follow-ups is available on Github.

Figure 6 KADI data training gym participants and KADI team members at the Kapiti research station, Kenya (photo credit Jörg Klausen)

The training workshop uses the word ‘gym’ in its title and this is not by accident. A modern gym is full of machines that need instructions for proper use. To build up muscles, it then involves a lot of sweat and tears of the users, exercise and repetitions. This is best performed in a group, because individuals can assist and motivate each other and learn from each other. The same approach was applied in the workshop to build competences in climate service development and delivery.

Data training gym objectives

The workshop addressed basic technical requirements and build competences in modern application development of data analysis using Python. The workshop developed user skills to:

- Set up an integrated Python development environment
- Understand and set up virtual environments
- Understand and use git to version and share code
- Download data from remote locations (ftp, internet)
- Read various file formats and concatenate data files
- Work with data frames
- Filter and aggregate data, compute statistics
- Produce simple graphics, e.g., time series plots, scatter plots, box blots
- Understand the basics of visualization: good/bad data plots
- Develop and create simple maps
- Produce interactive graphs
- Use online AI tools such as ChatGPT to help write/revise code

As an outcome of the training, each participant was expected to design and implement a service that will be useful in their daily work and can serve as a starting point for other products. The participants also presented their work and climate service developed to the wider group as a group-led teaching exercise, and the group has formed a CoP around data exploration and analysis using these techniques.

Summary

The KADI project has facilitated several knowledge exchange and training workshops that have promoted knowledge networks and communities of practice over the project lifetime. KADI has also developed a legacy as these networks continue to foster collaboration among researchers, policymakers, and local actors to co-create climate services tuned to the societal needs in Africa. These networks have also empowered African stakeholders by fostering gender equity and inclusivity to ensure diverse voices contribute to and benefit from climate knowledge and the services that this knowledge underpins. By embedding training programs, mentorship and exchange platforms within the project, and by nurturing the stakeholder champion of CoP concepts, KADI has built a self-sustaining ecosystem of expertise and innovation across the continent.