1. Excellence

Since the mid-20th century, consequences of **changes in the Earth's climate are more and more felt, including changes of the temperature and rainfall patterns, as well as alterations to the frequency, duration and spatial distribution of extreme weather events**. These changes are more **evident in the African** continent and the **impact of them is greater on the local societies due to the strong economic dependency on climate-related activities and products**. According to the IPCC's 5th assessment report **agricultural, water, energy, land use and health are the sectors which are expected to be impacted the most by climate change in the continent**.

In the agricultural sector the **increased risk of adverse weather phenomena** due to the climate change, especially in semi-arid regions and in areas with more frequent and prolonged drought, is posing a **direct threat to food-security**. In the water sector, climate change will impose additional pressure on **water availability, accessibility and demand** in Africa and is projected that most of the African countries will **exceed the limits of their economically usable, land-based water resources before 2025**. In regard to the health sector, the resulting risks of the climate change to human populations depend on where and how people live. The rise of global temperatures makes the population in urban areas and particularly those of tropical mega-cities **vulnerable to heat stresses, infectious diseases, and air pollution**, while the population in rural areas is vulnerable to **infection agents and their associated vector organisms**, because their reproduction and survival rates are strongly affected by temperature fluctuations. The **energy sector** is both a major contributor to climate change and a sector that climate change is **expected to disrupt significantly**. The increase in the energy demand globally especially in African mega-cities is primarily driven by the **economic growth and the rising population**. More so within this demand-driven environment, climate change presents increasing challenges for the sector, both in terms of energy production as well as in the energy transmission. In this highly impacted and dynamic environment, the source and infrastructure to produce and transport energy will be **adversely impacted by climate change: oil and gas industry as well as power plants are likely to suffer from increased disruption and production shutdowns due to extreme weather events; the ailing energy transport infrastructure including the electricity grids will be impacted by storms, and the rise in global temperature may affect electricity generation including thermal and hydroelectric stations**. Furthermore, climate change is also affecting the **bioenergy crops, disrupting several aspects in the cultivation period but also in terms of final yield**. For the land use sector climate change is expected to change the **suitability patterns of the land and to increase land vulnerability** to **landslides** and **soil erosion**. To this end, the adaptation to the new reality and where possible some amount of mitigation is the only way to overcome the challenges posed in Africa by climate change, and to achieve this goal there is the need for customised tools and services that will help one especially at the grassroots to take more informative and climate smart decisions.

The revolution of the observational systems especially in the earth observation sector, the better understanding of how the earth system works, the provision of a wealth of free and under an open license environmental data from many institutions are providing the most **needed components to develop the tools that will help make climate smart decisions for adaptation to this changing world**. In combination with new and innovative technologies for in-situ data gathering, configuring a blockchain to register data transactions and changes on a selection of repositories sustaining the delivery pipeline of scientific data processing, modelling, and artificial intelligence, climate services can be delivered to the **last mile user more effectively and efficiently to enhance food security, improve healthcare administration, provide renewable energy solutions and alleviate people from poverty** via living labs, multi-actor and digital platforms. This is what the **ANTS project aspires to deliver.** A suite of **sector specific climate services and climate smart decision tools for the food-security, water, energy, health and land use/planning sectors in Africa**, following a user-driven purely **multi-actor approach**, engaging the whole actors of each sector's value chain. **The ANTS project is a joint effort of African and European partners and builds on the experience and expertise of the AfriCultuReS, TWIGA, and KALRO projects**.

__ANTS__ is the acronym of the __A__frican-Europe __N__exus for __T__ransformative and Innovative Climate __S__ervices, and borrows the name of one of the most adaptive species in environmental changes; ants, by continuously utilizing the wisdom of the nest, the ant adapts through strategic thinking and logistics aptitude to prepare for the upcoming season, and throughout history, ants through these activities have paved the way as the only "climate service" to be offered to local communities to prepare themselves for the upcoming seasonal weather. ANTS climate services and climate smart decision tools aspire to replace ant's role as the only climate service for the local communities and to provide to the citizens of Africa and policy makers the services and tools that are needed for better planning of their adaptation strategies to the climate change, either short-term or long-term.

1.1 Objectives

The overall aim of the project is to co-design, co-create and co-validate a suite of user-driven climate services and climate smart decision support tools for the food-security, water, health, energy and land-use sectors in Africa, in order to help these sectors to achieve short, medium and long-term adaptation to climate change. To achieve the overall objective, ANTS is following an implementation strategy of 8 sub-objectives.

Objectives	WP
Objective 1 – To develop a state-of-the-art and a detailed requirement analysis for the Climate Services in Africa. To understand the links between food-security, water, health, energy and land-use sectors with climate information and variability. To identify the vulnerabilities of these sectors due to climate change and review the current state of weather and climate risk management (climate profile) in each sector.	**WP1**
Objective 2 - To shape the user communities for food security, water, health, energy and land-use sectors and establish Living Labs for user engagement. To empower the community to support Public Private Partnership through the co-design and co-creation of climate services following the multi-actor approach. To establish a knowledge-exchange network on regional climate risks for each sector and microclimate management following the Living Labs method.	**WP2**
Objective 3 – To develop a climatic data management framework and the underlying models for the representation of the different and heterogenous data elements in a unified integrated layer. To conduct an analysis on existing datasets and available data-streams on regional, national and global level and data collection mechanisms that could be integrated into the ANTS climate data framework. To define the data collection protocol. To introduce ways for heterogeneous data harmonization, geospatial fusion, integration, preparation, and sharing on the backbone of blockchain and the internet of things.	**WP3**
Objective 4 – To develop and provide sector specific climate services and climate smart tools. To provide and support the operational production of, weather and climate data for different spatial and temporal scales, addressing the specific needs of each sector down to the grassroots. To develop sectorial climate indicators.	**WP4**
Objective 5 – To develop methods and tools for climate smart decision making. To develop innovative user-friendly tools and climate information products and services that will support (last mile) users to take climate smart decisions either on their everyday activities or in the long-term strategic planning for their adaptation to climate change.	**WP5**
Objective 6 – To pilot test the ANTS services and climate smart decision tools in a real operational environment. To pilot test the ANTS services and climate smart decision tools through at least two National Meteorological Agencies. To support the capacity building (including research) related to climate services in African countries by building on existing capacity to increase knowledge in the context of climate change.	**WP6**
Objective 7 – To develop an outreach plan to maximize the society impact of ANTS project. To communicate and raise awareness about project activities and disseminate ANTS results.	**WP7**
Objective 8 – To develop an exploitation plan to maximize the business potential of ANTS services, climate smart decision tools and gender-neutral disruptive technologies. To build the strategy for the long-term sustainability of the ANTS services and climate smart decision tools. To establish the links between the project and the current and future global policies for sustainable development while enhancing gender equity in the use of disruptive technologies and tools.	**WP8**

1.2 Relation to the work programme

Relation with the topic LC-CLA-05-2019: Climate Services for Africa	
Challenge specified in the CALL:	
As climatic changes increasingly place populations under pressure, human beings are already adapting. However, less developed countries – particularly in Africa – are often less resilient to climate change and require the deployment of appropriate support to adaptation, including in the form of bespoke climate services to user's needs.	
What the CALL requires	**What ANTS will deliver**
Actions should exploit new, relevant climate data made available by Copernicus and other relevant sources (such as GEOSS).	**ANTS** services and climate smart decision tools will be built upon the wealth of free and open data offered by international initiatives and institutions, such us **Copernicus, EUMETSAT, NASA, NOAA, WMO, GEOSS, FAO**, etc. At the proposal phase sufficient some of the data sources that will be used by **ANTS** climate services and climate smart decision tools which have identified includes: 1) **Earth observation** data from **Copernicus** and **NASA** missions, 2) **Numerical weather predictions** from **NCEP/ NOAA, IBM,** 3) **Seasonal climate forecasts** from **Copernicus climate change service** and the **NCEP/ Climate prediction centre**, 4) **Satellite derived climate observations** from the **EUMETSAT Satellite Application Facilities**, 5) **Land/use change data** from the **Copernicus Land Monitoring Service**, 6) **Drought monitoring** from the **Copernicus Emergency Service**, 7) **Reanalysis data (ERA5)** from the **Copernicus**

	Climate Change Service, 8) **Air Quality reanalysis and forecast** data from the **Copernicus Atmosphere Monitoring Service**, 9) **Point observational data** from the **WMO, NHMS and the 500+ TAHMO stations network across 21 countries in Sub-Saharan Africa**. During the co-designing phase of the **ANTS climate services and climate smart decision tools**, the data sources mentioned above will be revised and adapted according to the specific user and services requirements.
Actions should lead to the creation of dedicated climate services for Africa for at least two of the following sectors: water, energy, food security, land use, health and infrastructure.	**ANTS** will create a suite of **user-driven climate services** and **climate smart decision tools** for the **food-security, water, health, energy and land-use sectors.** Project implementation will follow a purely **multi-actor approach** that will lead to the **co-design and co-development of the ANTS services and climate smart decision tools**, we have **already identified potential services** for each sector that will be used **as starting point for user engagement**. The identified services for each sector are presented below: **Food Security:** 1) Irrigation scheduling, 2) Tillage scheduling, 3) Fertilization scheduling, 4) Crop type and crop variety selection taking into account the seasonal climate forecasts, 5) Sowing and crop planning using seasonal climate forecasts, 6) Alerts for extreme weather events that impacts the agricultural sector, 7) Agrometeorological prognostic system for pest and crop diseases, 8) Seasonal crop yield forecasting, 9) Long-term investment planning for tree crops using decadal climate forecasts and climate change projections, 10) Agricultural drought monitoring and seasonal forecasting to support agricultural insurance. **Water:** 1) Early warning system for floods, 2) Drought monitoring and seasonal drought prediction, 3) Crop water requirements monitoring and seasonal forecasting, 4) Soil moisture monitoring and seasonal forecasting, 5) Long-term strategic water resources management and planning using seasonal climate forecasts and climate change projection, 6) Monitoring of drainage congestion and water logging **Energy:** 1) Strategic investment planning of renewable energy facilities, 2) Optimization of the energy production and energy pricing using short-range weather and seasonal climate forecasts, 3) Energy-grid monitoring and stabilization using real-time weather conditions and short-range weather forecasts 4) Streamflow forecast for hydropower optimisation. **Health:** 1) Early warning system for epidemics, meningitis and respiratory diseases, 2) Air quality monitoring and forecasting, 3) Early warning system for high level of pollutants in the atmosphere, 4) Monitoring and forecasting the aflatoxins in cereals 5) Stagnant water monitoring to reduce breeding grounds for mosquitoes **Land Use:** 1) Strategic land use planning using climate projections, 2) Land suitability analysis using climate seasonal forecasts and climate change projections, 3) Erosion monitoring and forecasting.
Activities should develop and deliver tools/applications which demonstrate clear end-user engagement, consultation and participation, and which enhance planning and implementation of climate adaptation strategies in Africa.	**ANTS climate services** and **climate smart decision tools** will be **co-designed, co-developed and co-validated by the users** from the food-security, water, health, energy and land use sectors. **More than 50% of ANTS partners are** either **end-users** or they will be **used as intermediates to reach a broader audience of users** in each of the sectors of interest. **ANTS** will establish a **knowledge-exchange network** on regional climate risks for each sector and microclimate management following the **Living Labs method** to **enhance planning and implementation** of **climate adaptation strategies** in Africa.
Actions should consider activities addressed by other initiatives such as the Global Framework for Climate Services, Copernicus and development cooperation activities and provide added value.	**ANTS** will **recapitalise** on the **experience and expertise** gained in the **AfriCultuReS and TWIGA** H2020 projects and KALRO in the **field of targeted and localised climate services**. **ANTS** during the implementation phase will **incorporate** all the **outcomes and recommendations** of **other initiatives in the climate services sector**, while at the same time will establish the appropriate channels to **share the produced knowledge and data** with them. Many of the services developed by the AfriCultuReS and TWIGA projects are made possible by the Copernicus programme and the opportunities it provides. **ANTS** provide tools and technologies such as blockchain, living labs that will revolutionise the implementation of the Global Framework for Climate Services with Public Private Partnerships models that enhances data sharing and enhances targeted services delivery. For example, downscaling of global models requires access to local data that is often missing. This is a gap that ANTS will bridge to support the implementation of the GFCS. ANTS will also provide in situ data, living Labs and tools

	that will help with the continuously calibration and validation of satellite products for use in Africa and Europe.
Actions should consider the EU-Africa Research and Innovation Partnership on Climate Change and Sustainable Energy.	**ANTS** will reach out to **relevant existing projects** and run **knowledge sharing round tables, webinars and events** (in Africa, Europe and beyond) to ensure new findings are **shared through appropriate channels ensuring wider use of its research findings.** The roadmap for the development of the AU-EU R&I Partnership on CCSE relies on three pillars; 1. Climate Action for adaptation and mitigation; 2. Sustainable Energy and 3. Capacity Building and Open Access to relevant data. ANTS will heavily rely on TWIGA and AfriCultuReS projects, which jointly address the most relevant components of these pillars, namely: Promotion of monitoring tools, delivered by space-based earth observation technologies; use of in situ observations which complement space-borne observations and enhance monitoring and forecasting of climatic changes; implementation of easy-to-use/low-maintenance technology to measure in situ parameters; and, setting up of proper communication between space and in situ observation stations to ensure the resilience and permanency of data generation; support capacity building and involvement of local users and stakeholders in the co-design and co-development of solutions that fit for purpose in a real environment.

1.3 Concept and approach

1.3.1 Overall concept

ANTS overall concept is **to reuse existing ICT tools, infrastructure, knowledge, in situ climate and earth observation data, and build bespoke climate services and climate smart decision tools for the food-security, water, energy, health and land-use sectors.** ANTS methodology to deliver the climate services and the climate smart decision tools is described below.

Understanding of the user-requirements for the Climate Services in Africa

The first step in the implementation of the **ANTS project** is to understand the **user-requirements for the climate services in Africa.** That means, 1) to know which type of climate services and data are available in Africa addressing the climate adaptation problems of the food-security, water, energy, health and land-use sectors, 2) to understand the current weather and climate risk management in each sector, 3) to identify if there are any legislative barriers in order to incorporate innovative and disruptive climate services and tools in each sector business flow and 4) to evaluate the weather and climate services by means of the extent to which users are able to access and use services and to estimate the potential impact and value of these services.

Shaping the user-community – Establish Living Labs for User Engagement

The second step is to **empower the community** to support Public Private Partnership (PPP**) to co-design and co-develop the climate services, the climate smart decision tools and to establish knowledge-exchange networks following the Living Labs methodologies**. Living Labs methodologies consider local community building as a basis for user groups engagement, getting key territorial stakeholders involved and agreeing with them about the methods to be stated and implemented, establishing short experimentation, monitoring and evaluation cycles of solutions, and gradually building the Climate Services and Climate smart decision tools to develop strategies for achieving impact at local, national and international levels. The cornerstone of living lab methodology is the **continuous development, prototyping, user experimentation and evaluation of innovative collaboration** systems and the new ways of collaborative working. Our aim is to **link and integrate** the innovative technical work and user-driven innovation process, embedded in local innovation and rural development contexts. We will follow **a two-level approach**: (1) organizing the development and experimentation, and (2) within Living Lab cycles apply an action research approach at the "micro-level" of interactions between designers, users, researchers and other stakeholders. From the early beginning and grounded in the local community building, we will build a series of experimentations and evaluations, monitored over time. Therefore, an important challenge in developing living lab ecosystems is to create the conditions and frameworks for such "action research" interactions, e.g. by establishing a local user–stakeholder community and arranging agreements among all actors to participate in the PPP development process, and given such frameworks to arrange and manage the concrete innovation project as a process of user-influenced experimentation and evaluation covering the complex, cyclic and interacting processes of conceptualizing, designing, developing, testing, using and validating a PPP. The practices to apply Living Labs approach in the participative development of a PPP include (1) cyclic development, (2) action research style experimenting, (3) user engagement, (4) agile development, and 5) monitoring and assessment.

Filling the gap in climate information in Africa – ANTS climatic data framework

The third step in the implementation of the ANTS project is to **establish a unified climatic data framework** that will enable 1) the collection of weather and climate information, 2) to filling the observational gap in remote areas using advance data assimilation and fusion techniques, 3) harnessing the wisdom of the crowd by collecting crowdsourced data (citizen science) and 4) ensuring the transparency of the collected data and processing methods using blockchain technology.

An extensive amount of climate and meteorological data will be collected and processed in order to **produce and provide hyper-local meteorological information**. The provided meteorological information will refer to **different**

temporal scales from historical data and near real-time information to **medium range, seasonal and decadal forecasts.** This information will be the cornerstone of the project, since all the climate smart decision tools and climate services will be built and run using this information. Point observational data from surface weather stations and IoT sensors from the WMO, TWIGA project and partners (TAHMO, KALRO) network will be collected and fused with satellite meteorological products (reference evapotranspiration, land surface temperature, downward solar radiation, precipitation) from the EUMETSAT Satellite Application Facilities, Copernicus land use/cover data and thermal data from the Copernicus Sentinel-3 mission, in order to produce near real-time observational hourly gridded meteorological data with 100m spatial resolution.

Within **ANTS** we will introduce the **user as a sensor** concept taking advantage of the capabilities of mobile smartphones on acquiring measurements through crowdsourcing, mainly referring to the current weather conditions, pest, disease and crop yield reporting. Through crowdsourcing an increasing amount of data can now be obtained from a huge variety of non-traditional sources – from smartphone sensors to amateur weather stations to canvassing members of the public. Although a very powerful "engine" of data, the Crowdsourcing do showcases some vulnerabilities, such as such as lack of: anonymity, security, transparency, ethics, data manipulation cases etc. With those being some of the emerging dangers of utilising "crowdsourcing", new approaches of implementation are needed. **ANTS** will deliver a **Blockchain infused crowdsourcing initiative** that will convene and support a network of partners/stakeholders and users to more efficiently gather data on how climate change is impacting people and nature, support on-the-ground projects that help rural communities adapt while reducing pressure on biodiversity, and provide essential and most accurate information to policy actors to better design their strategies and mitigation actions in all climate affected sectors.

Finally, a key challenge related to this objective is **the harmonisation**, (spatial) fusion and integration of the different datasets. Datasets are available through different systems, are accessible via different methods, in different formats, can use different naming conventions and may be represented based on different (data) models. Hence, **ANTS** aim at providing, to the **greatest extent** possible, a unified view over such **heterogeneous data sources**, and to make it accessible through a **single-entry point**. This will facilitate the ingestion and processing of the datasets by the different climate services and climate smart decision tools. To achieve this goal, the idea is to use Linked Data as a federated layer, which in addition to enabling data integration, allows the discovery of new knowledge through the links created (automatically) between the different datasets, and via the potential application of logical inference. Such layer will include access control mechanisms enabling the compliance with any required data privacy constraint.

Climate services and climate smart decision tools

The next step in the implementation of the project is to deliver the sector specific user-driven services. At the proposal stage we have identified the following services that might be of interest of the users of the food-security, water, energy, health and land use sectors. These initial services will be used as a starting point for user engagement and user interaction. **Food Security:** 1) Irrigation scheduling, 2) Tillage scheduling, 3) Fertilization scheduling, 4) Crop type and crop variety selection taking into account the seasonal climate forecasts, 5) Sowing and crop planning using seasonal climate forecasts, 6) Alerts for extreme weather events that impacts the agricultural sector, 7) Agrometeorological prognostic system for pest and crop diseases, 8) Seasonal crop yield forecasting, 9) Long-term investment planning for tree crops using decadal climate forecasts and climate change projections, 10) Agricultural drought monitoring and seasonal forecasting. **Water:** 1) Early warning system for floods, 2) Drought monitoring and seasonal drought prediction, 3) Crop water requirements monitoring and seasonal forecasting, 4) Soil moisture monitoring and seasonal forecasting, 5) Long-term strategic water resources management and planning using seasonal climate forecasts and climate change projection, 6) Monitoring of drainage congestion and water clogging. **Energy:** 1) Strategic investment planning of renewable energy facilities, 2) Optimization of the energy production and energy pricing using short-range weather and seasonal climate forecasts, 3) Energy-grid monitoring and stabilization using real-time weather conditions and short-range weather forecasts. 4) Hydropower optimisation using streamflow forecasts. **Health:** 1) Early warning system for epidemics, meningitis and respiratory diseases, 2) Air quality monitoring and forecasting, 3) Early warning system for high level of pollutants in the atmosphere, 4) Monitoring and forecasting the aflatoxins in cereals. **Land Use:** 1) Strategic land use planning using climate projections, 2) Land suitability analysis using climate seasonal forecasts and climate change projections, 3) Erosion monitoring and forecasting.

The **ANTS climate services and the climate smart decision tools** will be developed following a **decentralized modular architecture**, consisting of several **micro-services** with the capability to be offered either through a **Restful API** or through a **white-label fully customizable web and mobile application.** The service architecture is supported also by a **Software Development Kit (SDK)** that will allow the **adaptability of the services to fit the exact user-needs** and **easy development of new services**, as a combination of the microservices or **the evolution of them following the latest scientific advancements**.

Pilot testing and capacity building

The validation process will evaluate, and Pilot test the **ANTS climate services and climate smart decision tools** in real operational conditions. The assessment will be based on the economic, environmental and societal values of the **ANTS** concept at commercial scale across African regions with a special focus on East Africa (Kenya, Uganda, Ethiopia, Rwanda, Tanzania, Madagascar and Mozambique) and West Africa (Ghana, Cote d'Ivoire, Burkina Faso,

Togo, Benin, Mali, Liberia and Sierra Leone) by deploying, case-implementing and validating multiple ANTS climate services and climate smart decision tools **under a joint venture with local multi-actor communities**. The Pilot case studies will be adapted to the **specific character of each pilot area and the stakeholder component will be fine-tuned according to the specific regional climate challenges**. The Pilots will make the full use of the entire **ANTS** services and climate smart decision tools in each case study area and will be run by a team of ANTS partners (Core Validation Team (CVT)) and the local users per pilot case study. The Core Validation Team will oversee the monitoring and validation process and will have access to a rich source of data from the trials and Pilots across Africa. Dissemination (objective 7) will take place in accordance with and building on the dissemination strategies of the AfriCultuReS, TWIGA and ASAL APRP projects, which already cover a large part of the topics and the target groups. A business strategy in the form of an exploitation plan (objective 8) will be developed to ensure sustainability of results and operations after the end of the project.

1.3.2 Positioning of the project

While the individual components of ANTS are based on technologies already or close to the market (TRL 8-9) or proven in lab or real environments, the integrated ANTS concept is a research and innovative concept. Therefore, **ANTS advance's the TRL from level 3-4** (Technology validated in relevant environment) **to level 7** (System prototype demonstration in operational environment).

1.3.3 National and International Activities linked to the project

The **ANTS** EU-Africa partnership is truly international with vast experience of leading and participating in national and international research and innovation projects (particularly FP and H2020). The **ANTS** strategy is to '**build on the shoulders of our predecessors**' in so far as possible, taking outputs (or ideas) from previous and ongoing research projects to expedite the advancement of **ANTS** – we do not intend to 'reinvent the wheel'! The consortium's experience and ongoing collaboration network give **ANTS** a 'head start' in bringing 'background' to **ANTS** thus ensuring efficient use of resources and rapid progress. **ANTS** will further develop the most promising concepts and elements identified through its partnership network, delivering efficiency and relevance (value addition).

Partners of the **ANTS** consortium are or have been involved in EU-funded projects or commercial innovation activities related to the project objectives. The Table below summarises these projects and activities and explains how **ANTS** links to them (Table 2).

Table 2: Relation with international projects

Project / activity	Description	Potential uptake by ANTS	Partner(s)
TWIGA H2020	TWIGA aims to provide currently unavailable geo-information on weather, water and climate for sub-Saharan Africa by enhancing satellite-based geo-data with innovative in situ sensors and developing related information services that answer needs of African stakeholders and the GEOSS community.	ANTS will benefit by the TWIGA observational network and by the use of GPS and SAR data to estimate atmospheric water vapor to improve weather forecasts.	TU Delft, TAHMO-Kenya, HCP, Farmerline, SU
AfriCultuReS H2020	AfriCultuReS aims to design, implement and demonstrate an integrated agricultural monitoring and early warning system that will support decision making in the field of food security.	ANTS will benefit by the modular architecture of the AfriCultuReS climate and EO services for the food-security in Africa.	GMV, AUTH, HCP
SMEETH ESA	SMEETH is a standardized information system, based on Web-based GIS technology, containing satellite based geo-referenced information of air quality and clinical data to be used for analysis by the Health sector.	ANTS will benefit from the knowledge gained in the implementation of climate related EO derived services for the health sector	GMV
WEkEO DIAS EU EUMETSAT-ECMWF-Mercator Ocean	WEkEO is the EU Copernicus DIAS (Data and Information Access Services) reference service for environmental data, virtual processing environments and skilled user support.	ANTS will benefit from the experience gained through the development of the processing and data access tools and software to be deployed within the production grade platform of WEkEO DIAS	GMV
Ground Truth 2.0 H2020	GT2.0 aims to implement "sustainable Citizen Observatories that allow authorities and citizens to share collective intelligence about their environment, water, and their usage; empower citizens in planning, decision making and governance processes; and build on the citizens' current use, interactions with, and knowledge of their environment for better decision making linked to land and water resources management"	ANTS will benefit from the GT2.0 lessons in sustaining the collection of data through Citizen Observatories - especially the incentives and barriers for the collection of such data to support climate services.	TAHMO-Kenya

EO4SD Climate Cluster ESA	The ESA EO4SD - Climate Resilience Cluster project - aims to provide insight about the potential of EO to support climate-resilient decision making at the regional and national scale.	ANTS will benefit from the approach followed for the implementation of climate services.	GMV
AXIOM Copernicus Climate Change Service - Use Case	AXIOM is a climate service for the Agricultural Insurance sector, through which insurance companies will have access to crop-specific climate analytics in order to design more accurate and climate "smart" insurance contracts.	ANTS will benefit from the crop-specific analytics and will use this knowledge to develop the climate analytics for the sectors of water, energy, health and land-use.	AgroApps
MyWater FP7	Merging EO and weather prediction with hydrological modelling for advanced water services at watershed level, for including irrigation and water management	ANTS will benefit from the advances of MyWater on methods for remotely sensed estimations of soil moisture, evapotranspiration, land cover and other water related parameters.	GMV, AUTH
FarmFuse ERA-NET	Fusion of multi-source and multi-sensor information on soil and crop for optimised crop production systems.	ANTS will benefit from the data fusion methodology used in FarmFuse ERA-NET	AUTH
BEACON H2020	BEACON is providing Insurance companies with a robust and cost-effective toolbox of functions and services-BEACON toolbox-: allowing them to alleviate the effect of weather uncertainty when estimating risk of Agricultural Insurance products, reduce the number of on-site visits for claim verification, reduce operational and administrative costs for monitoring of insured indexes and contract handling, and design more accurate and personalized contracts.	ANTS will benefit from the disruptive BEACON climate services for the agricultural insurance sector and will use them to expand their capabilities to cover the water, energy, health and land-use sectors.	AgroApps
H2020_Insurance	H2020_Insurance intends to operationalize the Oasis Loss Modelling Framework, that combines climate services with damage and loss information and provides a standardised risk assessment process that can assess potential losses, areas at most risk and quantify financial losses of modelled scenarios.	ANTS will benefit from the Oasis Loss Modelling Framework for the agricultural insurance sector and will use them to expand their capabilities to cover the water, energy, health and land-use sectors.	TU Delft
NextSpace EC-DG-GROW	Framework contract for the collection of the requirements driving the operations and evolution of the Copernicus Space Component (CSC) infrastructure. NEXTSPACE will gather and analyse User Requirements, Service Specifications, Service Data Requirements and High-level tech. requirements on the CSC	ANTS will benefit of the experience GMV gained in NextSpace on requirements collection, recording and analysis and summarizing. Till the date more than 3.000 single records have been recorded and analysed, covering user, data and services requirements for the six Copernicus domains as well as requirements for the space component.	GMV
ESA Climate Change Initiative	The European Space Agency (ESA) Climate Change Initiative (CCI) is part of the European contribution to the Global Climate Observing System (GCOS) program. Fire disturbance is one of the Essential Climate Variables (ECV) included in the ESA CCI program	ANTS will benefit of the processing approach developed by GMV for the generation of climate variables based on the exploitation of large EO datasets	GMV
Meteorological Early Warning System to Build Resilience to Climate-Induced Shocks - GRP	The project aims at empowering local communities and vulnerable agriculturists across Uganda with an innovative early warning weather system for severe weather across the drought prone Cattle Corridor, the accident-prone areas of Lake Victoria, Kyoga, and Wamala, and Uganda's flash flood prone highlands. Leveraging the prevalence of cell phones across the country and in partnership Airtel Uganda, the Uganda National Meteorological Authority to	ANTS will benefit from the decision support and data dissemination systems using mobile web platforms architecture developed within the GRP project led by TAHMO	TAHMO-Kenya

	provide low cost, on-demand access to weather alerts to more than 16 million Ugandan cell phone users and free access to all 8 million Airtel subscribers.		

1.3.4 Overall approach and methodology

ANTS is organised into **six Work Packages** (WPs) designed to address the **ANTS objectives**, plus WP8 (ANTS Management) and WP7 (Dissemination and Communications, Exploitation). A Living Lab bases '**collaborative networking' approach** is taken, in order to **quickly produce demonstrable results** and innovations, utilising the rich knowledge base and network of the consortium as outlined previously but also local stakeholders' group and cooperatives. Development and experimentation will run in **2 cycles** to guarantee user community feedback to research and development.

1.3.5 Gender balance

ANTS will address the needs of **both female and male actors** and will take into account **gender-specific ways** to deal with technological tools, knowledge and information products in the development of these. Firstly, the project will be implemented in a **co-creation process** involving the presence and needs of end users. Great care will be taken so that ANTS`s specificities **will serve both male and female end users**, also assuring that ANTS services, tools and technologies **are equally accessible to all end users, regardless of gender**. This philosophy will also be reflected in the selection of end users for pilot cases, where efforts will be made to ensure an equal representation of men and women. Secondly, WP1 will include an initial **gender analysis and subsequent regular monitoring** and analysis of gender participation, gender disaggregation of data, and gender-sensitive aspects through a small working group. There are several **gender specialists with international experience in the consortium**. The methodology will be based on the gender mainstreaming approach and guidelines of, e.g., the World Bank and the UN Development Programme. Special care will also be taken to the use of gendered language. Taking into consideration that women are present at all levels in the food-security, water, energy, health and land-use sectors, the consortium organisation and structure of its internal management bodies (General Assembly, Executive Board, Working Groups etc.) will enhance and support equal participation of women at all management levels. The deliverables of the ANTS project will be implemented on a basis of gender-neutrality: the design, the management, the implementation, and the methods of delivery and communication of results will be chosen taking into account the gender dimension in order to be considered unbiased.

1.4 Ambition

1.4.1. Advance beyond the state of the art

ANTS has the ambition to lead the EU and Africa in the next generation of climate services. The project is focusing **on enhancing operational efficiency in local, regional and continental climate change adaptation** through the development of bespoke climate services and climate smart decision tools to assist users in the food-security, water, energy, health and land-use sectors to optimize their business workflows and to better manage the risk from extreme weather events, In the Table below the main advantages of ANTS beyond the state-of-the-art are summarized:

ANTS in relation to existing and emerging technologies	
State-of-the-art current technologies	**ANTS future technologies**
Blockchain technology for digital currency	Blockchain for climate services through enhanced data sharing to improve local, national, regional and global weather forecast that has eluded the globe for decades.
Multi-stakeholder platform and citizen science	Living Labs to continuously engage citizens in data collection, co-development of products and services while fully complying with the GDPR.
Data Fusion and Disruptive Technologies	Loopback (API connection to rich & transparent data sources) and Artificial intelligence to support climate services using data-driven evidence from citizens, EO and innovative in-situ sensors network, drones and Internet of Things (IoT) to convince both industry leaders and policymakers to help shape new regulations and adaptation practice.
Mobile platforms for climate service delivery	Digital platforms for climate Information services with automated scalable language transcription using Interactive Voice Response (IVR), SMS and other technologies for geolocated last mile users.

1.4.2. Innovation potential

ANTS innovation potential arises from: (i) the use of new sensors and networks to acquire data from remote areas; (ii) the capitalization of the large penetration of smart devices with citizens, the project team will design specialized apps, in order to crowdsource agronomic, hydrologic and climate information; (iii) the use of Big Data mining using machine learning algorithms that will be employed to analyse the collected geospatial information and provide improved microclimatic management; (iv) the use of blockchain technology to ensure the anonymity, security, transparency and ethics of crowdsourced data and in situ data for climate services provisioning; (v) the development of high resolution observational gridded datasets using advanced data assimilation and fusion techniques; (vi) the development of land suitability tools that will take into account seasonal and decadal climate forecasts; (vii) A multiscale approach to reporting information (Continent, Regional, National, local levels) will reach the appropriate decision maker in a cleaner manner, conveying the key messages. (viii) Use Living labs and multi-actor platforms to promote the co-design and co-creation of sustainable targeted climate services for Africa.

2. Impact

2.1 Expected impacts

Expected impact will be achieved and measured using the following outcome indicators: (i) **the number of direct project beneficiaries whose livelihood has positive change;** (ii) **Productivity Indicator - Increase in agricultural productivity levels arising from effective utilization of climate information services;** and (iii) **Resilience Indicator - Direct project beneficiaries whose adoption and coping decision-making processes and strategies towards climate change have increased.** Through these approaches the projects will enable diverse groups to mitigate risks related to climate change as well as transform communities to recover, cope, and experience positive change in the face of adversity. **ANTS** project is designed to bring transformation through inclusive decision-making and to provide contextual analysis of resilience processes as a reflection on learning. A theory of change approach will enable the project to achieve notable impact. The analysis will focus on linking interventions to areas of transformation specific to project development objectives. **ANTS inclusiveness, multi-sectoral and multidisciplinary approach will lead to sustainability of benefits, ideas broadening and resilience building among the member countries.**

Better policy making for climate adaptation in partner countries and Europe

Appropriate policy-making addresses challenges, defines objectives (e.g. adapt to climate change, reducing GHG emissions) and designs relevant instruments to efficiently meet these particular objectives. Climate Services (CS) are providing the needed information to improve decisions concerning the adaptation to climate change. It has a strong potential to help EU and partner countries policies meeting its objectives, to enhance competitiveness and improve sustainability and effectiveness (i.e. reducing its impact on the environment and using natural resources in a sustainable manner and at high efficiency). Under this framework ANTS contributes in high priority issues in the EU Environmental Agenda and EU international treaties as reflected in various legislative documents such as:

✓ **The Common Agricultural Policy (CAP)** and more specifically the cross-compliance scheme that couples' subsidies to farmers with environmental criteria. Under the new CAP, specific objectives have been set, several of them could be relevant for CS, amongst which: 'enhancing farm income', 'improving agricultural competitiveness', 'fostering innovation', 'providing environmental public goods', and 'pursuing climate change mitigation and adaptation' could be achieved by ANTS. Two broad types of environmental objectives are evident: **1. Reduce the negative pressures of farming on the environment, in particular on water, air quality, soil and bio-diversity. 2. Preservation of natural resources and energy.**

✓ **The EU Water Framework Directive** (Directive 2000/60/EC), that contains water directives focusing on the bathing water quality (76/160/EEC) and drinking water quality (80/778/EEC), (98/83/EC). An essential function of the ANTS system is the short- and long-term water resources management through a thorough data analysis and assessment that includes among others meteorological, soil and cultivation-related data. ANTS services are expected to bring substantial environmental benefits in terms of reduction on water consumption and consequently in improvements in water and soil quality.

✓ **The Air Quality Framework Directive (2008/50/EC), KYOTO protocol for CO2 emission reduction and the COP21 Paris Agreement.** In the long-term, making farming practices climate smart via the ANTS solution will help reduce the GHGs emissions from the incomplete nutrients' absorption from the soil. Successively, the climate change will be mitigated, including all the adverse effects it is linked with.

✓ **The Habitats Directive** (Council Directive 92/43/EEC) on the Conservation on natural habitats and of wild fauna and flora. ANTS will have positive impact on diverse ecosystems and natural habitats, optimizing the environment - including air, water, soil and food- in which wild animals live. To this aspect, the ANTS project abides by the Directive.

✓ **The Integrated Pollution Prevention and Control (IPPC) Directive** (2008/1/EC) that aims to prevent or reduce pollution of the atmosphere, water and soil, as well as the quantities of waste arising from industrial and agricultural installations, to ensure a high level of environmental protection.

ANTS will contribute to all aspects of climate adaptation policy in African countries: Vulnerability assessment, adaptation options, adaptation planning and governance, implementation and review, monitoring and evaluation. Many National Adaptation Plans of African countries list priorities that will be impacted by ANTS:

✓ Sustainable agricultural value chain development;
✓ Promote the use of efficient irrigation systems, strengthen water resource monitoring and assessment for early warning and planning, and promote technologies that enhance water resource efficiency;
✓ Advice on coping with climate hazards and vulnerability, such as droughts and floods;
✓ Support to renewable energy development, including off-grid solar and wind energy;
✓ Integration of climate change scenarios into spatial planning (climate resilient spatial planning), and support to updating land-use plans with climate scenarios, including strengthening of rangeland management systems;
✓ Design appropriate measures for surveillance and monitoring of climate change related diseases in order to enhance early warning systems which includes enhancing existing databases on health sector indicators;
✓ Strengthen early warning and climate information services for all ANTS topics.

Supporting international scientific assessments

The wealth of data gathered, the involvement of target groups and data management (obj. 1-3) will provide material for scientific assessments, while the climate services and tools that form the basis for climate-smart decision making (obj. 4-6) will help translate the results of scientific assessments into practice and provide the background for further research. Although the project is directed at developing practical solutions, the following priorities indicated by African countries will be addressed:

✓Improvement of the climate observation and monitoring system, set up a database on issues, drawing on traditional knowledge and modern information technology to support forecasting and evidence-based decision-making;

✓Contribution to improved understanding, knowledge management and coordination in the form of promoting development of technology prototypes, promotion of development of locally available technologies in support of adaptation to climate change and scaling up of successful technologies.

Stronger adaptive capacities and climate resilience

All activities of the ANTS project are directed at strengthening adaptive capacity and increasing climate resilience, but the development of sector specific climate services and climate-smart tools (objective 4) and the methods and tools for climate-smart decision making (objective 5) will have specific impact in terms of increasing the capacity of African governments and other stakeholders to deal with the consequences of climate change. This will be followed-up by the implementation of the exploitation plan after the end of the project. The application of the climate-smart tools, developed by the ANTS project, contributes to the creation of alternative livelihoods in the region (corresponding with one of the aims of many national climate adaptation plans) and therefore can be instrumental in helping stem the migration flow from Africa to Europe. The impact is in line with priorities indicated by African countries and can be summarised as follows:

✓ Increased institutional capacity development for research and dissemination;

✓ Development and promotion of climate-resilient services;

✓ Creating awareness at all levels of relevant stakeholders on measures to address climate change and climate variability;

✓ Promote the use of information and communications technology (ICT) and information systems to enhance access to public information on climate change adaptation.

It should be noted also that the project contributes to the eight United Nations' Sustainable Development Goals and more specifically:

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
Goal 3: Ensure healthy lives and promote well-being for all at all ages.
Goal 5: Achieve gender equality and empower all women and girls.
Goal 6: Ensure availability and sustainable management of water and sanitation for all.
Goal 7: Ensure access to affordable, reliable and modern energy for all.
Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation.
Goal 12: Ensure sustainable consumption and production patterns.
Goal 13: Take urgent action to combat climate change and its impacts.

Capacity building is described in section 1.3.1 mainly using Living Labs and Multi-Actor platforms hence building on existing institutions instead of creating new ones. Dissemination (objective 7) will take place in accordance with and building on the dissemination strategies of the AfriCultuReS and TWIGA projects, which already cover a large part of the topics and the target groups. A business strategy in the form of an exploitation plan (objective 8) will be developed to ensure sustainability of results and operations after the end of the project.