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D7.4 – Progress Report 2_v2

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HISTORY OF CHANGES

Date	Version	Author	Change Description
30.01.2025	0.1	Valerio Botteghelli	Initial version with ToC
28.02.2025	1.0	CENTAUR Consortium Board and Steering Committee	First version of the document
30.04.2025	2.0	CENTAUR Consortium Board and Steering Committee	Second version of the document

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1 INTRODUCTION

1.1 SCOPE OF THE DOCUMENT

The main objective of **D7.4 – Progress Report 2_v2** is to provide an overview of the activities performed and results achieved between M19 and M29, as well as the deliverables and milestones accomplished and planned for the CENTAUR project.

The activities conducted and progress made from M1 to M18 are outlined in the Mid Term Report ([RD29]).

In particular, this report offers an overview of the status of completed activities, ongoing tasks, and the next steps for each work package (including related tasks), along with the results achieved, during the abovementioned period.

1.2 DEFINITIONS, ABBREVIATIONS AND ACRONYMS

Abbreviation/acronym	Definition
AB	Advisory Board
AoI(s)	Area of Interest(s)
CCR	Casse Centrale de Réassurance
CB	Consortium Board
CEMS RM	Copernicus Emergency Management Service Rapid Mapping
CEMS RRM	Copernicus Emergency Management Service Risk & recovery Mapping
D	Deliverable
DRC	Danish Refugees Council
DDR	Demo Design Review
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EEAS	EU Situation Room
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
EFAS	European Flood Awareness System
EO	Earth Observation
ESS	Exploitation Strategy Seminar
EU	European Union

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FR	Final Review
GFFO	German Federal Foreign Office
HaDEA	European Health and Digital Executive Agency
HE	Horizon Europe
HRB	Horizon Results Booster
ICDPR	International Commission for the Protection of the Danube River International Commission for the Water Quality and Water Management
IPR	Intellectual Property Rights
IR	Interim Review
JRC	Joint Research Centre
KERs	Key Exploitable Results
KOM	Kick-Off Meeting
KPI	Key Performance Indicators
LULC	Land Use/Land Cover
ML	Machine Learning
NDA	Non-Disclosure Agreement
NLP	Natural Language Processing
OBJ	Objective
OSINT	Open-Source INTelligence
PC	Project Coordinator
PDR	Preliminary Design Review
PDRE	Preliminary Demo Results Evaluation
REDIAM	Red de Información Ambiental de Andalucía Environmental information
SAR	Synthetic Aperture Radar
SatCen	European Union Satellite Centre
SC	Steering Committee
SESA	Copernicus Service on Support to EU External and Security Actions
SMEs	Small and Medium-sized Enterprises
STP	SpaceTec Partners
UF	Urban Flood
UN	United Nations

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UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
URR	User Requirements Review
(V)HR	(Very) High Resolution
VITO	Vlaamse Instelling Voor Technologisch Onderzoek
WFS	Water & Food Security
WP	Work Packages
WPL	Work Package Leader
TL	Task Leader

1.3 APPLICABLE AND REFERENCE DOCUMENTS

ID	Document name
[RD01]	CENTAUR - 101082720 – Grant Agreement
[RD02]	HORIZON-CL4-2021-SPACE-01 - Strategic Autonomy in Developing, Deploying and Using Global Space-based Infrastructures, Services, Application and Data 2021, available at https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl4-2021-space-01-12
[RD03]	D1.1 - Report on Urban Flood and Water & Food security indicators
[RD04]	D2.1 - Catalogue of CENTAUR data and related specifications
[RD05]	D2.2 - Urban flood and Water & Food Insecurity Design
[RD06]	D2.3 - Urban Flood and Water&Food Insecurity service pipelines v1 (baseline set up)
[RD07]	D2.4 - Urban Flood and Water&Food Insecurity service pipelines v2 (tuning and adaptation)
[RD08]	D2.5 - CENTAUR multi-criteria indexes design
[RD09]	D2.6 - CENTAUR multi-criteria analysis and indexes generation pipelines v1 (using indicators from the baseline)
[RD10]	D3.1 - Platform design and development
[RD11]	D3.2 - Platform Design Document v2
[RD12]	D3.3 - CENTAUR integrated platform including Urban Flood and Water&Food Indexes v1 (baseline)
[RD13]	D3.5 - CENTAUR integrated platform test document v1 (baseline)
[RD14]	D4.1 - CENTAUR demonstration plan v1 (cold case)
[RD15]	D4.2 - CENTAUR demonstration plan v2 (hot case)
[RD16]	D4.3 - CENTAUR demonstration operational report and validation result - cold cases

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[RD17]	D4.4 - CENTAUR demonstration operational report and validation result v1 - hot cases (intermediate)
[RD18]	D5.2 - Plan for the dissemination and exploitation including communication activities
[RD19]	D5.3 - Plan for the dissemination and exploitation including communication activities v2 (interim)
[RD20]	D6.1 - Communication strategy and action plan
[RD21]	D6.2 - Interim communication report
[RD22]	D7.1 - Project Management Plan v1
[RD23]	D7.2 - Project Management Plan v2
[RD24]	D7.3 - Progress Report 1
[RD25]	D7.5 - IPR and innovation plan
[RD26]	D7.7 - Data management plan
[RD27]	D7.13 - Report on Steering and Advisory activities v1
[RD28]	Centaur Consortium Agreement – Version 1 – 21st June 2023
[RD29]	Periodic Report - Technical Part B v3
[RD30]	D4.5 - CENTAUR demonstration operational report and validation result v2 - hot cases (final)

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2 EXPLANATION OF THE WORK CARRIED OUT BY THE BENEFICIARIES

2.1 OBJECTIVES

OBJ1 - Enhance Copernicus SESA service portfolio to better respond to climate security risks and effects

Building on the initial findings from Work Package 1 (WP1), which identified key user needs within the Copernicus SESA community, the project has continued developing tools and datasets to better address climate-related security risks. Work Package 2 (WP2) has focused on the engineering of thematic products, particularly those related to Water and Food Security (WFS). During this period, significant progress has been made in defining and refining key indicators. These indicators are now integrated into the system, forming the basis for improved climate security monitoring. Work has also advanced on the development of multi-criteria indexes, which aim to provide a more structured and informative assessment of risks linked to climate change and environmental degradation. However, further validation and refinement of these indexes are still needed to ensure their effectiveness in supporting decision-making processes.

In Work Package 3 (WP3), efforts have been directed towards enhancing the CENTAUR platform, ensuring that users can efficiently access and interpret relevant data. A key development has been the implementation of an integrated catalogue, allowing for structured organization and retrieval of WFS-related datasets. Work is ongoing to improve the automation of data processing, ensuring that indicators are updated regularly and presented in a way that facilitates their use in crisis monitoring. Initial steps have also been taken to introduce user-configurable notifications and alerts, which will enable the system to notify stakeholders when specific risk thresholds are met. The ability of the platform to handle both real-time and long-term analysis is being tested, with further improvements required to ensure reliability and accuracy.

A key challenge, however, remains the integration of the CENTAUR platform within the Copernicus SESA operational environment. While the project has progressed in aligning products and services with Copernicus requirements, direct access to the system for testing and validation purposes is essential. The current standalone deployment limits the ability to thoroughly assess the system's usability, scalability, and operational applicability. Without this step, it will be difficult to fully demonstrate how CENTAUR enhances the Copernicus SESA service portfolio.

Validation activities under Work Package 4 (WP4) have played a crucial role in assessing the performance of the developed tools. The cold case demonstrations have provided an opportunity to compare historical data with past crisis events, offering valuable insights into the accuracy and applicability of the indicators. This process has also highlighted areas that require further refinement, particularly in relation to the consistency and reliability of data processing. Preparations for the hot case demonstrations are ongoing, with a focus on testing automated alert mechanisms and real-time monitoring capabilities. Ensuring that these alerts are both relevant and actionable remains a key challenge, and further adjustments will be necessary before they can be fully operational.

Work Package 5 (WP5) will focus on supporting the integration of CENTAUR products into Copernicus SESA. Preparatory discussions are already taking place to assess how best to align the newly developed indicators with existing workflows. Future efforts will also address interoperability, ensuring that the data produced within CENTAUR can be effectively incorporated into the broader Copernicus Security framework. Additionally, outreach activities will play a key role in engaging stakeholders, collecting user feedback, and raising awareness of the project's developments as WP5 progresses.

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While substantial progress has been made, further work is required to refine the tools, validate the indicators, and ensure the successful integration of CENTAUR products into Copernicus SESA.

KPI 1.1: Copernicus SESA portfolio integrates at least one product or service for monitoring, assessing, and detecting potential security risks in connection with climate change and environmental degradation.

At this stage, the full achievement of this objective is still pending, as it depends on the final outcomes of the project. However, progress has been made in defining and implementing relevant indicators for the Water and Food Security (WFS) domain. The cold case demonstrations have provided valuable insights into how these indicators can be utilized for crisis monitoring, and the platform now includes functionalities for visualizing and analyzing key climate security risks.

Discussions on integration strategies with Copernicus SESA have started, with formal activities under WP5. Future efforts will focus on ensuring interoperability and assessing technical requirements for aligning CENTAUR products with SESA workflows. Additionally, the results of the hot case and hot-cold demonstrations will provide critical input for refining the automated production pipelines and determining the best approach for meeting this KPI.

KPI 1.2: Copernicus SESA portfolio adapts at least one product or service to better address potential security risks in connection with climate change and environmental degradation.

Work continues on adapting existing products to improve their relevance to climate security applications. The development of automatic production pipelines for relevant WFS indicators is progressing, with initial tests conducted during the cold case demonstration phase. These pipelines aim to streamline the integration of key indicators, into the operational workflows of Copernicus SESA. Ongoing validation activities are helping to refine the methodologies used for data processing and alert generation.

KPI 1.3: Proactive intelligence analysis service running pre-operational over at least one area for the Food Security domain, selecting/defining proper monitoring and prediction of food/water indicators, based e.g. on precipitation, Crop temperature, evapotranspiration, root zone soil moisture.

The definition of advanced crisis indicators has progressed, with further work dedicated to refining predictive models. Initial implementations of the risk assessment framework have been tested through cold case demonstrations, with ongoing efforts to assess their effectiveness in real-world scenarios. The focus has now shifted towards the hot case demonstrations, where real-time monitoring and alert functionalities will be tested in operational conditions. User feedback collected from workshops and direct engagement with stakeholders has been important in guiding further improvements. However, additional validation is needed before the system can be considered pre-operational.

OBJ2 - Enhance and adapt CEMS Early Warning component by developing meteorological indicators in support of urban floods early detection at the pan-European scale

CENTAUR aims to improve the precision and accuracy of forecasts for intense, localized precipitation events at high resolution, crucial for identifying urban areas susceptible to disruption. Therefore, a novel forecast for extreme precipitation focuses on the prediction of the rarity of an event: how often did the predicted event intensity occur in the past? By doing so, the forecasts become much more reliable for extreme events as traditional numerical weather forecasts often underestimate the total precipitation during such events due to model biases. The identification of return periods further helps to pinpoint to urban areas susceptible to pluvial flooding and hence addresses a gap in existing warning systems. Building upon these novel, high-resolution precipitation forecasts, inundation models are expected to facilitate targeted interventions, enabling timely planning of Earth Observation (EO) data acquisition and leveraging open/social media data for improved flood detection and monitoring within Copernicus EFAS, ultimately enhancing the performance of the CEMS Early Warning component.

While the previous version, in which a machine-learning model was developed to predict these extremes, struggled to reliably predict the most affected areas and the intensities of historical events, a novel approach

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exploiting the information readily available and embedded in existing numerical ensemble forecasts and hindcasts shows promising results. Work to develop an integrated warning index in support of urban floods early detection has been carried out and refinements of this index will continue during the last year of the project.

KPI 2.1: Measure of success for the high-resolution precipitation forecast is to detect the occurrence of extreme intensity precipitation (return period higher than 10 years) at least 48h in advance when verified against local observations or the precipitation from the OPERA network with an error smaller than 20% and a spatial correlation for daily accumulations better than 60%.

This KPI is partly fulfilled. The novel return period forecasts reliably predicted extreme precipitation in at least 13 out of 20 CEMS rapid mapping activations in 2024 that led to flooding and were associated with mostly localised precipitation (~10 purely fluvial floods downstream of the precipitation event were excluded for a fair comparison). A qualitative validation indicates a high accuracy and reliability for predicting 10-, 20- and 50-year return period events up to 72 hours in advance when verified against gridded observation-based precipitation products. A quantitative verification against the same products and available in-situ observations from rain gauges is ongoing.

KPI 2.2: CEMS pre-tasking success (75%), in terms of number of pre-tasking alert, timeliness and improvement in the definition of the Areas of Interest for crisis-time satellite acquisitions.

This KPI is partly fulfilled. A qualitative comparison against flood-related CEMS activations in 2024 indicates a high success rate in predicting extreme precipitation events up to 72 hours in advance. The use of return periods of extreme precipitation and the development of an integrated warning index that calculates the potential risk for urban areas facilitate the timely definition of areas of interest for crisis-time satellite acquisitions. A quantitative evaluation of the success rate is ongoing but is expected to find that this KPI is fulfilled.

OBJ3 - Improve CEMS Mapping component by generating thematic products related to floods in urban areas with enhanced accuracy through combined improved detection and crisis temporal analysis by modelling

The gap analysis conducted for CEMS RM highlighted critical deficiencies in current SAR and optical data processing, leading to limitations in urban flood mapping. Additionally, the irregular acquisition of SAR and optical data, coupled with the lack of automated extraction techniques, poses challenges in capturing flood peaks and producing accurate flood maps. Addressing these gaps aligns with the project's priorities, focusing on automated urban flood mapping using all-weather InSAR imagery and hydro-geomorphological urban flood modelling utilizing EO inputs and ancillary data.

To overcome these challenges, we have devised a set of indicators aimed at revolutionizing urban flood mapping and emergency response:

- UF-ID-2: Forecasts of return period-based precipitation events over urban areas (early warning phase) for proactive preparedness and timely alerts. Gaps addressed: Improve the prediction of very intense and localised precipitation event and facilitate a timely definition of AOIs in anticipation of the event.
- UF-ID-3: Urban inundation probability maps and water depth for scenarios defined by return period at a spatial resolution in the order of <10 meters, enhancing accuracy in predicting flood extents. Gaps addressed: Improved spatial resolution (<10m); scalability and Use of DTM High Resolution than ongoing applications.
- UF-ID-4: Inferred InSAR urban flood extent utilizing advanced processing AI techniques to map flooded areas with higher precision, even in adverse weather conditions. Gaps addressed: Mapping of urban flooding using SAR satellite images with a water-extraction workflow not yet exploited in the CEMS RM - RRM.
- UF-ID-5: Urban flood map combining geomorphological and InSAR approaches and comprehensive damage assessment of buildings, facilities and roads for effective emergency planning. Gaps

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addressed: Improve urban flood mapping and accelerate post-event damage analysis by assessing the vulnerability of urban areas.

- UF-ID-6: Incorporating social/traditional media indicators for Urban Flooding Maps to gather real-time information and community insights, aiding in better understanding and response to urban flood events. Gaps addressed: Enhance the post-event damage analysis: assess urban areas vulnerability.
- UF-ID-7: Hazard web sources indicator to collect and analyse data from diverse web sources, enhancing the depth and accuracy of information available for flood mapping.

These indicators represent a significant leap forward in urban flood mapping, utilizing innovative techniques and integrating diverse data sources to fill the existing gaps identified in the CEMS RM analysis. By implementing these indicators, we aim to revolutionize urban flood mapping, provide timely and accurate information, and significantly enhance emergency response capabilities in urban flooding scenarios. Thanks to the proposed indicators in CENTAUR, it is possible to achieve the expected goal of significantly improving resolution, detection capabilities, timely data access, and information delivery to Authorized Users of the Copernicus EMS RM.

KPI 3.1: Increase in urban flood mapping (>75%) using SAR and InSAR processing combined with urban flood modelling.

KPI remains highly relevant as preliminary outputs—especially from UF-ID-4—demonstrate the system's ability to detect urban floods using freely available Sentinel-1 data, which is routinely leveraged during CEMS RM activations. A current limitation is the bimonthly availability of Sentinel-1 data following the deorbiting of S1B; the upcoming S1C launch is expected to resolve this.

Developed indicators—UF-ID-3, UF-ID-4, and UF-ID-5—combine SAR/InSAR techniques with geomorphological models to detect flooding, already outperforming existing CEMS products. Although UF-ID-4 provides valuable detection, greater emphasis is now placed on UF-ID-3 and UF-ID-5 for their enhanced performance.

To meet the >75% mapping goal, the GoFlood model has been improved, replacing the previous SpeedyFlood tool for flood extent production. Current, and already encouraging, flood depth validation results are based on SpeedyFlood; however, while the INFLOS algorithm is being used temporarily (and is already implemented in CEMS products), a new flood depth tool—completing the GoFlood model—is scheduled for release soon to further enhance accuracy.

KPI 3.2: User recognize improvement in the pertinence of the current delineation/grading products as regards urban flood impacts (>75%, user survey).

As of February 2025, a total of 5 end-users have contributed the feedback collection after the cold case workshop. With a turnout rate of less than 50 % out of all the users that have participated to the workshop, this KPI is not met at the moment. In any case, during this first round of feedback collection, the ***general rating for UF-ID-4*** *(InSAR-based urban flood delineation)* ***and UF-ID-5*** *(coupling of modelling and InSAR) have reached mean values of* ***56 %*** *and* ***68 %*** *based on the available interviewees. The validation efforts have highlighted several avenues for improvement, which are likely to further improve pertinence by the execution of the hot phase workshop.*

OBJ4 - Test new early response tools through end-to-end demonstration in real scenarios from the past (Cold Cases) and future crisis (Hot Cases)

- In total, 7 main use cases have been defined, located in Europe and Africa to deploy the system on.
- For the UF track specifically, the so-called "cold-hot" use cases have been developed. They correspond to optional demonstrators that have been identified to test the system in case the main ones cannot be assessed during the hot phase. They are past events that have occurred recently, as far back as 20 October 2024, part of the CEMS RM portfolio.

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- The approach with “cold-hot cases” differs from the initial plan, as a way for the consortium to ensure that the system is being tested one more than just the cold phase. To minimise overhead, “cold-hot” cases are located in the same original countries, over different AOIs.
- 4 use cases (Spain, Italy, Germany, and France) are specifically tailored for assessing the system’s performance on urban floods in the context of Copernicus EMS RM.
- 2 use cases (Somalia and Mali) are specifically tailored for assessing the system’s performance on water and food security in the context of Copernicus SESA.
- 1 use case (Mozambique) has been developed to perform a cross-cutting analysis. It integrates both urban floods and water & food security concerns, in the context of both targeted Copernicus services.
- Apart from a use case in Germany, all other use cases possess both a cold and hot mode.
- As of February 2025, the identified “cold-hot cases” correspond to Spain (Valencia), Italy (Emilia-Romagna) and Mozambique (Storm Chido). The Valencia case was the first to be executed, carried out between the end of March and the beginning of April 2025 and is now completed. Italy and Mozambique might come at a later date, depending on the occurrence of events in real time.
- The cold mode served for calibrating the tools and systems developed within CENTAUR, while the hot and “cold-hot” modes serve as a pre-operational assessment in actual activation conditions.
- To test the new tools, workshops and questionnaires have been developed to collect feedback from end-users and service providers. The workshop for cold cases was held in November 2024. It has yet to be organised for the hot phase. Findings from the cold phase workshop are available in deliverable D4.3.
- As part of the innovative indicator design in the domain of Water & Food Insecurity (WFS) we are currently developing early warning indicators related to meteorological and agricultural drought events. In contrast to most of the existing drought early warning systems available today, which mainly focus on delivering information about currently ongoing drought events in near-real time, our indicators explicitly aim to predict these events well in advance (up to 6 months). As such, with these innovative developments we aim to push the current state of the art in the domain of drought early warning and forecasting. The new indicators are currently still in development, as part of Task 2.6.
  Furthermore, as part of T2.6, indices were developed to correlate the potential impacts of drought on food security, livelihoods of affected populations, displacement and conflict.
- The indicators were tested, validated and quality checked during the cold phase as part of WP4, with results available in D4.3 (CENTAUR demonstration operational report and validation result - cold cases). Quality checks and validation will not be systematic during the hot phase, being up to the responsibility of technical partners, or upon request to the relevant teams to perform these operations.
- Corresponding to the (hot, cold and “cold-hot”) use-cases, the portfolio of traditional and social media channels has been extended and adjusted in a principled manner. Media-processing models have been updated (e.g. concepts/entities) and processing has been running continuously to collect current data for hot-cases. The same system also served as a data-backend for the cold-cases. Queries have been devised, based on models developed in WP2 to extract information from this system which is used to feed media-based indicators (5 for UF and 12 for WFS yielding a total of 61 datasets).
- The execution of cold case scenarios, initially scheduled for mid-April 2024, was delayed and held in November 2024 due to multiple factors. These included cross-dependencies with WP2 and WP3, the expansion of the indicator catalogue, product regeneration based on user feedback, and the development of a more user-friendly platform. Key issues involved adjustments to the production timeline, the need to generate consistent metadata files across all products, and their integration into the CENTAUR platform. Additionally, the strategy for disseminating CENTAUR products was revised to simplify access for end users.
- The hot phase will conclude in June 2025 to reach out to the users, compile the results, and perform potential validation and quality checks. Results will be disseminated in D4.5 ([RD30]) and a subsequent workshop, organise before the end of the project, between September and December 2025.

KPI 4.1: Validate and demonstrate the suitability of the early warning system and foresight tools over the proposed Hot Cases demonstrators in over 50% of demonstrators.

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This KPI cannot be validated presently, as hot case demonstrators were launched in December 2024.

KPI 4.2: Obtain at least 85% of user acceptance during the collection of feedback through questionnaires to the engaged end-users' participation to the demonstrator events (100% users remain in demonstrators, 85% positive feedback).

*As of February 2025, a total of **5 end-users have contributed the feedback collection** after the cold case workshop. With a turnout rate of **less than 50 % out of all the users that have participated to the workshop**, this KPI is not met at the moment. However, these 5 users cover both UF and WFS tracks, including UF Spain, UF Italy, UF France, UF Mozambique and WFS Mozambique. The results, available in D4.3, highlight rather positive feedback on the delivered products and CENTAUR platform, with a **mean general rating of 60 % for UF**. With only **one interviewee for WFS**, across 1 use case and only 8 of the 25 available portfolio items, drawing any conclusions yet would not provide any significant insights. In any case, key findings highlighting room for improvement, especially in terms of data discoverability and platform functionalities. Moreover, the users have indicated that the proposed system was a pleasant surprise, with several novel products and a wide range of indicators and indexes to help bolster emergency forecasting and monitoring. Despite several rounds of reminders towards end-users and the team's availability for one-on-one meetings during the cold phase, additional efforts will be put into place for hot case demonstrators, to ensure a better turnout.*

KPI 4.3: CENTAUR's demonstrator service and product validation according to the planned criteria and quality standards (>80% flood extent accuracy in urban areas).

The validation results for the different cold cases showed promising outcomes. While the KPI of >80% flood extent accuracy in urban areas (a very challenging target) was not reached, the German case achieved 75%, and the other cases showed results around 60%.

An exception is the Mozambique use case, where the low accuracy (16.62%) is strongly linked to a six-day gap between the information used to generate the indicator and that used for validation. To further improve results, refinements have already been implemented in the production workflow, which will benefit the generation of such indicators during the hot-cold cases.

KPI 4.4: Products within CEMS & SESA delivery-times according to the Service Level Agreements as witnessed by Entrusted Entities (80% products fit to be assigned SL1 or SL2 mode timeliness).

This KPI cannot be validated presently, as this can only be tested during hot and "cold-hot" demonstrators, launched in December 2024. This is explained by the required pre-operational processing mode, which was not enabled for the cold phase.

KPI 4.5: Feedback by the Entrusted Entities about the relevance and value adding of incorporating CENTAUR services into CEMS and SESA portfolios (100% if all Entrusted Entities are agreed).

Bare 2 end-users, all the others have contributed to the collection of feedback following the cold phase workshop. Integration into CEMS-RM and SESA workflows has yet to be fully assessed, as part of WP5 and the hot phase workshop in late 2025. Findings will be shared in subsequent deliverables.

KPI 4.6: Feasibility of integrating CENTAUR products within the SESA and EMS operations by 2021-2027 time-horizon. (100% if at least partial agreement on Copernicus integration in both domains).

This KPI cannot be validated presently as the feasibility of integrating the new products within the SESA and CEMS portfolios has just started (M28) and will continue during the last year of the project.

KPI 4.7: At least one of the CENTAUR pre-operational solutions for the detection and analysis of climatic and environmental risks products (e.g. continuous monitoring system, crisis risk index, web simulator) are adopted by security analysts and other security sector stakeholders in the EU and third countries.

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This KPI cannot be validated presently, as the feasibility of integrating the new products within the SESA and CEMS portfolios has just started (M28) and will continue during the last year of the project. The integration depends on the outcome of this step.

OBJ5 - Improve temporal and spatial resolution of Copernicus EO-based downstream services (e.g. agriculture monitoring, inland water surface area)

The enhancement of temporal and spatial resolution within CENTAUR for Copernicus EO-based downstream services, specifically focused on flood management, is achieved by leveraging significantly improved datasets and innovative methodologies compared to current ones. These datasets and methodologies enable the delivery of novel products for emergency response scenarios. For instance, a novel prediction of return periods of precipitation facilitates the detection of localised extremes and circumvents the bias embedded in traditional numerical weather prediction forecasts of precipitation (UF-ID-2), while still enabling an association with precipitation volumes (UF-ID-1), further supporting high-resolution DTM as input of an innovative geomorphological model named Go Flood in UF-ID-3 and UF-ID-5, InSAR technique and AI-based algorithms in UF-ID-4 contribute to spatial and temporal resolution enhancement of existing products within CEMS. Particularly, UF-ID-7, an index integrating various data sources including Copernicus (i.e., EFFIS information, the observed event currently extracted by satellite in the delineation and grading Rapid Mapping products, the consequence tables and additional information deriving from Copernicus Risk & Recovery products), provides additional insights crucial for characterizing extreme events and their impacts on specific areas of interest. Furthermore, the obtaining of social and traditional media, allows to enhance the CEMS products giving supplements information where satellite data coverage might be insufficient.

According to the original proposal some effort was devoted towards enhancing the spatial resolution of existing indicators. However, the added value of a statistical downscaling of meteorological observations and forecasts to urban scales showed no significant added value. While further work on improving this downscaling is ongoing, the gap between coarse-scale weather forecasts and high-resolution urban scales and satellite data for agricultural drought monitoring is tackled through the incorporation of uncertainties that embed the subgrid scales.

For the agricultural drought indicators, we shifted the focus towards the temporal domain (forecasting) rather than the spatial domain. We are convinced that by focusing on forecasting of agricultural droughts, we will be better able to serve the goals of the project overall and the identified composite crisis indexes defined in Task 1.3 in particular. Agricultural droughts typically occur over larger areas, thereby justifying the use of lower resolution data (1 km). Producing low spatial resolution indicators also drastically improves the practical feasibility of upscaling the developed indicators to country and continental scales. By focusing instead on forecasting in the temporal domain we hope to contribute to increasing preparedness and resilience of communities to drought events- something we identified as more urgently needed given the availability of high-resolution monitoring products.

KPI 5.1: Reduce the temporal or spatial resolution of at least two of the current datasets, products or services delivered by a Copernicus operational service by 50% by using drone data or other available data sources for Flood.

Several indicators and indexes are currently being developed by leveraging national data sets that provide a finer depiction of features and processes. Indicator UF-ID-3 leverages high-resolution DTMs (<10 m) to significantly enhance JRC flood hazard maps, which currently use 90 m resolution data. Although quantitative validation of UF-ID-3 for flood extent and water depth has shown mixed metrics, visual analysis in use cases in Spain, Germany, and Italy (Ceva) suggests the products are "Highly Developed" and outperform the existing coarse-resolution datasets.

KPI 5.2: Implement and serve at least one new downstream service using input data or information coming from a Copernicus Service.

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Several indicators and indexes directly leverage Copernicus data. UF-ID-4 takes Sentinel-1 imagery as an input. UF-ID-3 uses as calibration datasets the JRC Flood Hazard Maps that are part of the Copernicus Emergency Management Service. UF-ID-5 uses flood masks derived from Sentinel-1 imagery or those provided by CEMS RM activations to enhance flood extent delineation - specifically by addressing gaps in urban area mapping. UF-ID-7 uses as input the GHSL - Global Human Settlement Layer and the GDACS Hazard indicator. Also, the composite indicators, as the FII (Flood Impact Index), uses many indicators derived from input data or information coming from a Copernicus Service.

KPI 5.3: Engage at least 5 stakeholders from downstream market. *At the moment, at least one stakeholder was identified to partake in the demonstration phase for each demonstrator. This includes the Joint Research Centre, the European External Action Service, the United Nations Support Office in Somalia, the Spanish Directorate General of Civil Protection and Emergencies, German Federal Foreign Office - Data Science Division, Danish Refugee Council, Caisse Centrale de Réassurance, International Commission for the Protection of the Danube River, Red de Información Ambiental de Andalucía, WAV-e and Helpcode. Engagement in the actual execution and validation process will only be assessed starting in late June 2024. ECMWF has applied for a testing phase for innovative solutions for emergency management solutions from the Joint Research Centre and the Emergency Response Coordination Centre to promote the novel extreme precipitation products and engage with these stakeholders. e-GEOS also joined the same initiative with the presentation of the following products: Enhanced Flood Delineation and Damage Assessment in Urban Areas for Real Flood Scenarios and High-Resolution urban flood maps for various return period.*

KPI 5.4: Receive at least 70% of positive feedback about potential application of the CENTAUR indicators in the respective field.

*As of February 2025, a total of **5 end-users have contributed the feedback collection** after the cold case workshop. With a turnout rate of **less than 50 % out of all the users that have participated to the workshop**, this KPI is not entirely met at the moment. However, these 5 users cover both UF and WFS tracks, including UF Spain, UF Italy, UF France, UF Mozambique and WFS Mozambique. The results, available in D4.3, highlight that only **1 user has answered on whether they could integrate CENTAUR products into their workflow**, indicating that some **changes would be necessary to do so**. The envisioned application would pertain to a **higher quality monitoring of events**. Out of the 5 participants, **80 % have indicated that CENTAUR products would be beneficial to their workflow** during operations, the last 20 % corresponding to the absence of an answer. Additional feedback collection during hot case workshops will help further explore this KPI.*

OBJ6: Explore the extent to which data driven approach based on AI/ML techniques can be used to extract information and indicators from heterogeneous datasets and to predict the occurrence of crisis and describe their impact and evolution

Machine learning models were tested to address the limitations of numerical weather prediction models for extreme precipitation but showed weaknesses due to limited training data. An alternative approach, using existing NWP outputs, proved more reliable in predicting extreme events up to three days ahead. While further refinement of the ML model could improve results, the novel NWP-based approach is currently the preferred solution.

Deep learning techniques are used within CENTAUR to analyse InSAR satellite data and to interpret flood delineations from previous crises, with the goal of identifying flooded urban areas (UF-ID-4). The methodology proposed by UNISTRA involves a convolutional neural network, which is designed for semantic segmentation. This process is a common and powerful tool in computer vision that focuses on recognizing and locating specific objects within an image.

The analysis of social and traditional media is based on large volumes of data that leverages both natural language processing and visual media analysis. To increase the efficiency and quality of the production process various AI/ML automatisation steps were evaluated. In terms of media markers generation (geo-located visual media), the selection and filtering of relevant images/videos for a specific use case and area of interest is now

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supported by AI/ML models notably improving the handling of the vast amounts of data and increasing the variety of selected media. In terms of situational reports, preliminary experiments with Large Language Models (LLMs) for the automated generation of such reports show promising results for the summarization or large volumes of textual data (potentially provided in various languages). Further experiments are required to increase the focus of such reports and evaluate their quality and reliability in comparison to the manually generated situational reports.

The breadth of CENTAUR's indicators has also been exploited by Cherrydata, in collaboration with Adelphi and e-GEOS, to design prediction models of security related indicators, namely conflicts and IDPs. These models are based on the hypothesis that extreme natural events, particularly continued droughts made more severe by climate change, can significantly contribute to the socio-political instability of territories. The ability of CENTAUR indicators to anticipate change, with more precise prediction of weather together with a variety of other vulnerability variables, has enabled effective model design and training. The models have been trained at subnational (regional) level with monthly time frequency in CENTAUR's drought-related case studies.

KPI 6.1: Addition of multiple innovative forecasted crisis maps (food & water security, political stability, short-term flood risk, risk of damage in case of flood, social impact map of different types of risk, etc.).

Regarding urban floods, two weather forecast indicators are being developed. The novelty here lies in their high resolution over urban areas, that marks an improvement over the ~10km information available from global forecasts. The corresponding indicators and subsequent indexes have been drafted in WP1, will be fully fleshed out by the end of WP2, with an iterative refinement process based on operational experience from demonstrators in WP4. Contribution of a set of 17 innovative indicators (of socio-economic nature) for both UF and WFS. These more precise urban flood prediction indicators and related maps have been combined into an index called MHVZ (medium-high vulnerability zones) that shows the areas that are predicted to be flooded and at the same time are most vulnerable according to OSINT information, requiring greater attention and effort during crisis management. Regarding droughts, a broad number of CENTAUR indicators has been used to build two indexes, called DCPI (Drought Conflict Prediction Index) and DDPI (Drought Displacements Prediction Index) that provide a prediction of the number of conflicts and the number of IDPs, respectively (with region-month granularity).

KPI 6.2: Ability to generate maps with individual sources/types of information and their integration (separate vs. integrated layers where integration is not at the representation level but is embedded in the model of different synthetic indicators).

The platform is being developed to provide end users with a complete information package, from input data to high-level indicators and indexes. Progress on this KPI is being made, particularly in WP3. A dedicated section of the "Dashboard" allows the visualization of time series data over several years, making it effective for visualizing indicators like media keyword mentions.

KPI 6.3: Improvement of other more traditional map quality indicators owing to a more integrated and accurate input information and to more effective AI/ML modelling (thematic accuracy, speed of delivery, resolution, etc.).

This KPI is being worked on as part of WP1 and WP2 especially for example, thematic accuracy on flood delineation is expected to improve tenfold, due to the integration of urban settlements that were usually excluded from crisis products delivered during CEMS activations. This will be the result of AI modelling, using established computer vision models. Preliminary results already indicate promising results for some indicators, while it's still a work in progress for others. In addition, localized media-markers (derived from social media) contributes to the estimation/indicators' calibration. Contribution of localized media-markers for estimation calibration.

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OBJ7: Improve understanding on the cause-effect relation between climate change indicators with, water and food insecurity, population displacements and crisis

Building on the work conducted during the first phase, further progress has been made in deepening the understanding of how climate change indicators correlate with water and food insecurity, population displacements, and crisis situations. The initial gap analysis carried out in WP1 provided a structured assessment of the tools, products, and services required to address these challenges. Since then, efforts in WP2 and WP3 have translated theoretical insights into tangible datasets, indicators, and tools that can be applied in operational contexts.

During this period, advancements were made in refining the conceptual model and operationalizing key indicators for monitoring climate security risks. The primary achievements contributing to this objective include:

- **Enhanced development of risk monitoring and situation monitoring tools**, with a focus on automating the integration and processing of key indicators.
- **Expanded dataset collection and integration**, incorporating additional socio-economic variables and conflict-related data to provide a more comprehensive view of climate-related crises.
- **Cross-cutting analysis between urban flood risks and food & water insecurity**, highlighting shared vulnerabilities and potential cascading effects of climate change on security risks.
- **Progress in the operational testing of multi-criteria indexes**, with preliminary validation exercises conducted during the cold case demonstrations. Further adjustments are underway based on user feedback and real-world testing scenarios.
- **Increased interoperability efforts**, ensuring CENTAUR data and toolkits can be linked with existing Copernicus Emergency Management Service (CEMS) and Copernicus SESA workflows. This paves the way for future integrations that enhance situational awareness and decision support.
- **Initial evaluation of media markers and socio-political indicators**, providing additional context to climate-induced crisis situations by incorporating information from non-traditional data sources.

KPI 7.1: Publish at least 7 technical and scientific publications covering innovative methodological approaches to studying the climate-food-water-security nexus, as well as to key empirical results produced by the project.

In this regard, as of April 2025, a first scientific paper was presented at the XX Congress of the Spanish Remote Sensing Association (Cadiz, June 2024), while another one has been presented at JIIDE, in November 2024. In addition, one scientific publication about the meteorological drought monitoring dataset has been published:

- *Keune, J., Di Giuseppe, F., Barnard, C. et al. ERA5–Drought: Global drought indices based on ECMWF reanalyses. Scientific Data 12, 616 (2025). https://doi.org/10.1038/s41597-025-04896-y.*

The paper accompanies the following dataset:

- *Keune, J., Di Giuseppe, F., Barnard, C., Damasio Da Costa, E. & Wetterhall, F. Monthly drought indices from 1940 to present derived from ERA5 reanalysis. https://doi.org/10.24381/9bea5e16 (2025).*

More publications are being planned to further contribute to the scientific discourse in the project's fields. In particular, two papers on the forecasts of extreme precipitation developed within CENTAUR, i.e. UF-ID-2 and a corresponding extreme precipitation warning index are under preparation.

Furthermore, consortium members are working on two additional publications focused on the role of droughts in political and humanitarian crises. This way, the consortium aims to meet the KPI of publishing seven scientific papers.

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KPI 7.2: Exchange with at least 5 projects, initiatives or programmes dealing with climate security and its associated risks.

Progress towards this KPI is ongoing, with multiple collaborations and interactions already established. The CENTAUR consortium is actively engaging with the NASA Harvest Consortium, particularly in relation to food security. Notably, NASA Harvest representatives participated as speakers in one of the panels during the first CENTAUR online workshop on 21 November 2024, where they presented their work and shared insights. Additionally, CENTAUR representatives are in discussion with the ThinkingEarth and SEED-FD consortia to explore scientific synergies and potential joint communication activities. Under WP6, engagement with fellow Horizon Europe projects has been regular, with a peak in interactions ahead of the November workshop, where the team reached out to 16 projects via social media to foster collaboration. Furthermore, CENTAUR has already been presented at 15 major international events, the latest one being the 4th Global Flood Forecasting and Monitoring Meeting in April 2025. Participation has also been confirmed or planned for at least five additional high-profile events, including the EGU Conference 2025, ESA Living Planet Symposium 2025, the Copernicus EMS Annual Conference, the annual conference of the European Meteorological Society, as well as for the World Water Week 2025.

KPI 7.3: Organise at least two stakeholders' workshops.

The first End-User Workshop took place on 22 November 2024, successfully bringing together the Advisory Board members and gathering precious feedback on project's developments. In addition, on 21 November a half-day open event has been organised to engage with other key stakeholders from the disaster management, food security, and climate security communities as well as the general public. The event, which featured expert discussions on urban flooding and food and water security, attracted nearly 100 participants and provided a valuable platform for knowledge exchange and engagement – including with other Horizon Europe projects. This workshop significantly boosted CENTAUR's outreach, contributing to the growth of the project's newsletter subscribers and LinkedIn followers. The second and final workshop is planned for the end of the year and will be focused on the dissemination of CENTAUR's findings.

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2.2 EXPLANATION OF THE WORK CARRIED OUT PER WP

In the following chapter, an overview of the status of the ongoing activities for the reporting period M19-M29 is reported for each Work Package (WP) and related Tasks. Particularly, for each WP the following contents are provided:

1. Overview of WP objectives.
2. WP time planning (tasks duration and deliverables).
3. Tasks description and CENTAUR team in charge of specific actions.
4. Deliverables description, due date and, type, dissemination level and lead beneficiary.
5. Milestones related to each WP.
6. Status of the activities and results achieved.
7. Next steps foreseen.

2.2.1 WP1 – ANALYSIS OF REQUIREMENTS AND USE CASES DEFINITION

The activities foreseen for WP1 were completed at M12, as scheduled, and a detailed description of these activities can be found in ([RD29]).

2.2.2 WP2 – THEMATIC PRODUCT ENGINEERING

Following the assessment of user requirements in WP1, this work package puts in place workflows for collecting necessary data for the development of risk indicators and crisis indexes, as well as for their implementation. The final output of this package shall consist in several service pipelines that will combine earth observation meteorological and hydrological data; open intelligence data from traditional and social media, socioeconomic and political indicators; other types of geospatial data, using geospatial and temporal information as common homogenising feature to merge these data into synthetic indexes.

Particularly, WP2 is organized in the following tasks with related objectives:

- Tasks 2.1, 2.2 and 2.3 harvested and pre-processed data collected from several repositories.
- In Tasks 2.4, 2.5 and 2.6 pre-processed data are used to design and implement the service pipelines for the generation of complex Urban Flood, Food/Water Insecurity, and socio-political-economic indicators, properly combining and integrating dataset for supporting monitoring services, crisis conditions, and impact assessment.
- In Task 2.7 indicators generated above are combined to produce enhanced integrated crisis indexes and prediction models improving information related to crises in connection with Urban Flood and Food/Water Insecurity.

WP2 will last 25 months, whose start/end dates of the different tasks are distributed as per the following schedule (Figure 1).

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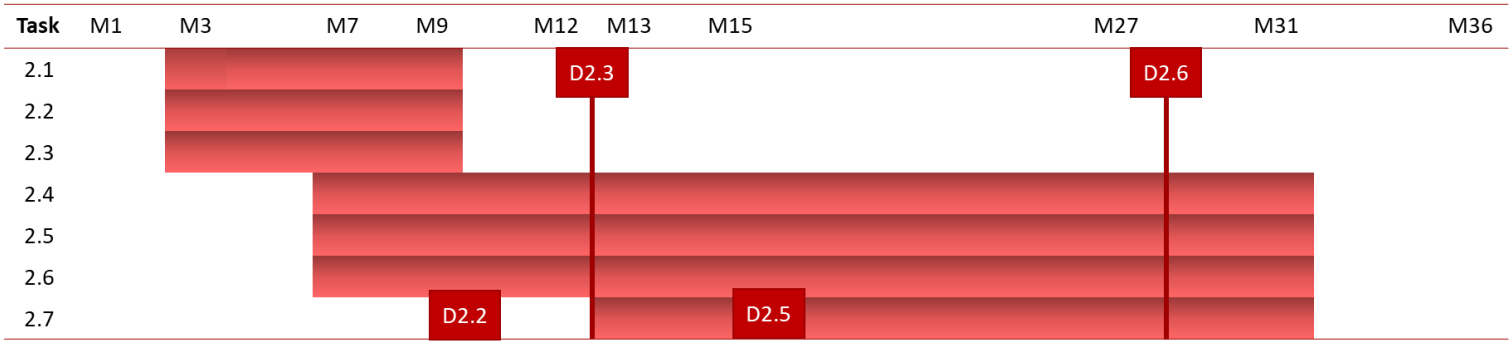

Figure 1: WP2 timeline of the activities and related deliverables

Work Package n.	2
Work Package Leader	EG
Work Package Title	Thematic Product Engineering
Participants	EG, ECM, UNI, CLS, ITH, CHE, ADE, VIT, DLR, SAT, TRA, GMV, HEN

Active Tasks for M19-M29 period	Duration
T2.4 – Social, economic & political indicators – design and implementation	[M10-M30]
T2.5 – Urban Flood indicators – design and implementation	[M10-M30]
T2.6 – Water & Food security indicators – design and implementation	[M10-M30]
T2.7 – Integrated multi criteria analysis and synthetic indexes design and implementation	[M13-M31]

Work Package Summary of Progress Towards Objectives
The development of indicators and indices within the CENTAUR project aims to achieve multifaceted objectives. Particularly within meteorologically linked indicators, the focus lies on forecasting the return period of impending extreme events, enabling advanced insights up to 72 hours before their occurrence. This pivotal information serves not only emergency responsiveness but also significantly aids in pre-tasking satellite services in CEMS, thereby facilitating the acquisition of a larger number of satellite images to cover extreme events, especially in case of flash floods, and to provide a wealth of information beyond current capabilities. On the flood-related indicators front, the integration of Artificial Intelligence techniques, InSAR methodologies, DEM-based geomorphological algorithm (such as INFLOS at the moment, to be replaced with GoFlood in the future), and Machine Learning algorithms facilitates the creation of highly detailed maps. These maps effectively cover areas that were previously invisible to satellite technology (i.e. urban, forest, shadows, etc.).

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The integration of these techniques enhances the accuracy of current CEMS delineation and grading products, offering far more precise information than currently available through operational services.

Through these integrations, not only the accuracy of products but also delivery timelines within current operational Copernicus services are significantly enhanced. The utilization of social media data and drones, exemplified by ID-6, allows for swift acquisition of crucial information identifying areas most affected by flooding. This indicator, unlike current CEMS practices, has the potential to provide initial, highly accurate products for limited areas based on available information. These initial products could offer precise, timely insights to local civil protection authorities, preceding more comprehensive products covering the entire area of interest.

Moreover, socioeconomic indicators allow to more precisely map vulnerable areas within urban settlements, enabling more accurate estimates of flood impacts on urban populations and assets.

On the Water & Food Security-related indicators, the integration of meteorological forecasts with near-real time observations of vegetation, soil moisture and other environmental conditions into a machine learning algorithm allows to identify regions with high risk of meteorological and agricultural drought. This identification could play an important role in taking proactive measures and effective risk reduction management. Particularly the inclusion of forecasts, instead of near-real time observations is innovative in agricultural drought monitoring.

A further step undertaken by the WP2 team is the creation of indexes that assess the multi-dimensional nature of flood/drought risk and impact, evaluating how factors like preparedness and weather conditions influence the overall severity. As part of the Urban Floods (UF) track in CENTAUR two composite indices are produced: a Flood Early Warning Index (FEWI) and a Flood Impact Index (FII). The two indices mainly differ with regard to their scope (the former focussing on simpler measures of flood likelihood and impact and the latter incorporating more complex measures of impact based on likely flood exposure and vulnerability), as well as with regard to their production (the former being continuously produced at global scale whereas the latter is punctually produced for specific AOI following an activation of CENTAUR's event-driven mode). Similarly, in the Water and Food Security (WFS) track of CENTAUR two indexes have been developed: DCPI (Drought Conflict Prediction Index) and DDPI (Drought Displacements Prediction Index), which are capable to predict the effects of the droughts and their possible impacts on conflict and displacement at a regional level one month in advance.

CENTAUR, with its proposed indicators and indices, aims to provide comprehensive coverage of an event from multiple perspectives. This includes forecasting, event occurrence, flood viewpoint, social vulnerability and impact, and various risk categories.

Task 2.1 – Geospatial data harvesting and adaptation

This task was completed at M9 and the description of the activities can be found in ([RD29]).

Task 2.2 - Open and socio-economic data mining and adaptation

This task was completed at M9 and the description of the activities can be found in ([RD29]).

Task 2.3 - Meteorological data access and modelling

This task was completed at M9 and the description of the activities can be found in ([RD29]).

Task 2.4 - Social, economic & political indicators - design and implementation

Activities Performed

In the current reporting period, Task 2.4 pursued its activities around the generation of relevant socio-economic (SE) indicators. SE indicators were produced for outstanding cold cases. In the UF track, SE indicators were produced for Turin, Italy and Beira, Mozambique. In the WFS track, time series for SE indicators were produced

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for Mozambique and updated for Mali and Somalia. Style files and metadata were created to allow for seamless visualisation on the platform developed in WP3. This includes the creation of indicators for: the number of people affected by water insecurity (WFS-ID-9), food insecurity and people affected by food insecurity (WFS-ID-8 & 11), economic insecurity (WFS-ID-12), displacement intensity (WFS-ID-13) conflict intensity and people affected by conflict (WFS-ID-10 & 14), radicalisation & polarisation (WFS-ID-15), humanitarian aid (WFS-ID-17), encroachment on pastoral land (WFS-ID-18), irrigation capacities (WFS-ID-19), access to infrastructures & services (WFS-ID-21), censorship & corruption (WFS-ID-23), legal issue (WFS-ID-24), and social cohesion (WFS-ID-25) in the WFS track; as well as very granular indicators for average incomes (UF-ID-9), access to essential services (UF-ID-10), and challenges to evacuation in urban contexts (UF-ID-13) for the UF track.

Data collection for the WFS-ID-7 IDP camp status in Bandiagara, Mali is ongoing. The location information was sourced from IOM. The indicator is expected to be finalized by June. Monitoring for emerging critical situations in other countries is also ongoing.

Work on implementing SE indicators for the hot cases is almost completed with the technical implementation of data pipelines to automate data retrieval, processing, and analysis for the SE indicators. This includes coordination with Task 3.2. and 3.3 to ensure effective data transfer between partners.

For some indicators, improved versions have been created for the hot case phase: GMV provided in March 2025 an updated of the *Livestock heat stress* dataset use by Adelphi as input data. It included the values for 2023 and 2024 for SOM, MLI, MOZ. DLR produced a new version of the World Settlement Footprint population dataset with improved population estimations per pixel. This updated dataset will serve as an input for multiple SE indicators during the hot case phase.

Furthermore, SE indicators for the “cold-hot case” of Valencia have been produced.

The team further supported Task 2.7, offering guidance and sharing data and a code template for a ML algorithm to predict the impact of drought on food security to be further developed and refined in T2.7. As part of this effort, it also contributed to discussion about appropriate metrics to use for complex indices from the perspective of social and economic research. It also liaised with Task 4.3. and 4.4 to support data validation and coordinate contributions for a review workshop with platform users in November 2024.

Achievements

The partners involved in T2.4 have been able to:

- Produce SE indicators for all cold cases (including metadata and style files) and Valencia cold-hot case
- Contribute to the validation of these indicators and of the functioning of the centaur platform
- Support the development of algorithms and complex indices in Task 2.7
- Support the choice of appropriate metrics for complex Risk indices involving SE indicators

Challenges

Data availability remains a challenge for the hot case phase, where up to date information and opportunities to automate data pipelines are of the essence. Data can only be considered if they are recent enough (last week or month) and available through an API. This already complicates the use of **IOM-DTM** data for WFS-ID-13, as these data are only available through the API until the end of 2023 for Mali, Somalia, and Mozambique. More dramatically, the task is impacted by the current restructuring of the US government: the API for **FEWSNET** data (supported by USAID), which are an essential source for WFS-ID-8 and WFS-ID-11, is not reachable anymore and it is unclear if/when the production of these data will resume. The team is currently looking for an alternative data source.

Further challenges arise from the limited access to **media data** that span back before 2018. As seen during the cold case phase, these data greatly improve the accuracy of prediction algorithms. The accuracy could be

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improved even more, if longer times series were available. A possibility would be to search for alternative sources of media data that stretch further back in time.

The Copernicus Land cover classification gridded maps from 1992 to present derived from satellite observations product used by GMV for the dataset "*Rangeland cover change*" unfortunately not been updated since 2022, even if the title says "to present". Therefore, this product cannot be updated.

T2.5 - Urban Flood indicators - design and implementation

Activities Performed

Task 2.5 involves the conceptual and technical design of the Urban Flood (UF) indicators. The development of most of the indicators was completed during the cold case phase, with some requiring only adjustments to the algorithms used to produce two of the indicators (UF-ID-3: High Resolution Urban Flood Risk Maps and UF-ID-5: Enhanced Urban Flood Damage Assessment) and minor adjustments to the social media markers. For the UF-ID-3 and UF-ID-5 indicators, the Speedy Flood tool has been replaced with the GoFlood model to produce an improved flood extent mask, which also includes information on urbanised areas. As GoFlood is nearing completion and will soon be able to accurately calculate flood depths as well, the INFLOS algorithms are currently used as an interim solution for estimating depth values within the flooded areas. Once fully implemented, GoFlood will offer a more accurate and integrated approach for both flood extent and depth in urban areas. Regarding the production of media markers representing geo-localized images/videos from social and traditional media depicting a specific flood event of interest, the activities in the reporting period focused primarily on development of an automated pipeline for the selection and filtering of relevant visual data and the identification of mentions of potential locations of interest in the accompanying textual content in order to minimize the effort of the required manual process of image and video geo-localization.

In addition, and in synergy with Task 2.7 the development of combined indices for urban flood warnings have progressed in the current reporting period. In particular, the development of a Flood Early Warning Index (FEWI) progressed and now consists of two components targeting the prediction of extreme precipitation (based on UF-ID-2) and the prediction of inundated areas (based on the former index and UF-ID-3). The former exploits the return period forecasts for extreme precipitation to construct an extreme precipitation index that converges into three risk or warning levels and targets actionable information. This index estimates the potential risk of extreme precipitation through the estimation of the likelihood for an urban area as a function of the return period (i.e., 10-, 20-, and 50-years), which mimics the potential impact. A fuzzy neighbourhood approach has been incorporated in the calculation of this index to account for the increasing uncertainty of the forecast with lead time. The resulting risk or warning index then indicates levels of action, i.e. 0 – no warning, 1 – watch, 2 – prepare, and 3 – act, and the risk/warning level are currently being calibrated using reforecasts and observations. To provide further actionable information at the urban scale, the resulting risk level is associated with a corresponding high-resolution flood inundation map derived with Go Flood (UF-ID-3). This map provides high-resolution information on potential risk zones based on flood events with associated return periods. Together, these indices build the FEWI, which ultimately helps to define a potential AOI up to three days ahead of an event.

Achievements

The team has developed a comprehensive understanding of the data requirements and interdependencies among the various UF indicators. The development phase is complete for nearly all indicators, and the integration of cold-phase products into the CENTAUR platform has been successfully demonstrated during the demo execution.

In addition, a combined workflow is put in place for the index FEWI aimed at forecasting. Urban areas to be monitored during the hot phase have been defined and are already monitored using UF-ID-2. In addition, an internal automated email notification system between ECMWF and e-GEOS has been set up and includes daily text summaries of extreme precipitation predictions by country and risk/warning level for the hot phase. For

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further information, a PDF document is attached to the email and shows the spatial patterns of the extreme precipitation index. This information then enables e-GEOS to evaluate the situation and produce UF-ID-3 and the resulting FEWI index upon demand.

UF-ID-3: High-Resolution Urban Flood Risk Maps. This indicator uses the Go Flood Model (DTM – based model), calibrated on JRC flood hazard maps (10, 20, 50-year return periods), to generate high-resolution flood scenarios. By leveraging detailed DEMs, it enhances urban flood delineation and risk assessment. Its key advancement is the unmatched spatial resolution, enabling more precise flood mapping than existing products.

UF-ID-4: Inferred INSAR Urban Flood Extent. Even through preliminary results are encouraging, validation efforts of the cold phase and described in D4.3 have highlighted the necessity of incorporating additional post-processing steps, aimed at reducing false positives in urban areas. Different tests are currently being performed before integration into the UF-ID-4 pipeline. Changes to the methodology can be expected during the hot and "cold-hot" phase.

UF-ID-5: Enhanced Urban Flood Damage Assessment. It combines the GoFlood model (DEM-based), results from UF-ID-4, and the INFLOS algorithm to provide flood delineation (covering both urban and non-urban areas and flood depth) and assess urban flood damages. It categorizes damage by flooding depth, replacing labor-intensive photointerpretation in existing CEMS products, thus streamlining damage assessment while maintaining precision.

UF-ID-6: Social/Traditional Media Indicators for Urban Flooding Map. This indicator utilizes traditional and social media markers related to specific flood events, offering a rapid understanding of the situation within urban areas. It generates a set of geo-tagged markers, providing details such as date, time, and links to relevant news during and after extreme events. This indicator is absent in current operational modes and services but stands out for its effectiveness in information generation, aiding timely intervention and response measures during emergencies.

UF-ID-7: Hazard Web Sources Indicator. This indicator assesses flood hazards using web data, identifying intensity, magnitude, and vulnerable areas by integrating meteorological and demographic factors.

Challenges

- Efforts are underway to fully automate the GoFlood model integrating also the new fully automated depth calculation module.
- Difficulties have arisen in finding high-resolution DTMs that are hydro-enforced correctly to represent river connectivity in the studied areas
- A key challenge is determining the appropriate trigger for the UF workflow after a UF alert. Currently, the decision to initiate the workflow relies on human judgment. Establishing critical thresholds is essential, but calibrating the indices to set these thresholds is challenging due to the rarity of such events.

T2.6 – Water & Food Insecurity - design and implementation

Activities performed

Task 2.6 involves the conceptual and technical design of the Water & Food Insecurity (WFS) indicators and has officially started in September 2023.

The team began by analyzing the data requirements and identifying the inter-dependencies between different indicators, which allowed for a structured approach to their development. Significant work was carried out in the design and integration of the indicators into the CENTAUR platform, ensuring compatibility with both historical and near-real-time data. During this process, new methodologies were developed, including probabilistic approaches for assessing drought risk, and the creation of a system for continuous drought monitoring. Additionally, the integration of machine learning techniques enabled more accurate predictions, while the automation of data pipelines streamlined the process of collecting and processing relevant data.

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To ensure the correct display of indicators on the platform, the team worked closely with the WP3 team on their integration. This involved gathering the necessary visualization and analytical tools for each indicator. So, (cold phase) samples for all indicators have been provided to WP3 team for implementation into the platform through a dedicated AWS S3-bucket. Meetings between all partners involved were held for alignment. Bilateral meetings were also held between ECMWF-VITO to align on the development and workflow of forecasting indicators and using single ensemble members.

Achievements

We have gained a clear understanding of data requirements and inter-dependencies between the different WFS indicators. The development for nearly all indicators has finished and the integration of (cold phase) products in the CENTAUR platform has been performed. The results for the cold cases have been presented at the demo execution.

WFS-ID-1: A meteorological drought monitoring system was developed and historical droughts over Mozambique, Mali and Somalia were analysed. To that end, a large set of indicators was created, considering different accumulation periods that represent the different impacts of meteorological droughts. During the latest reporting period, the historical time series of the drought indices has been extended and a more drought events have been identified and compared.

WFS-ID-2: Forecasts of the probability of drought occurrence in the coming 6 months have been developed and further evaluate the severity of the meteorological drought. The prediction follows a probabilistic approach to better estimate the risk associated with the occurrence of the hazard. In the final cold case phase, forecasts for all use cases have been developed and uploaded to the platform. A new forecast is issued at the beginning of every month.

WFS-ID-3: This indicator has been revised during the latest reporting period and now focuses on a probabilistic evaluation of meteorological drought risk over administrative regions. Therefore, the area affected is juxtaposed to the probability of a drought, resulting in a four-level risk index from no risk, over low and medium risk to high risk.

WFS-ID-4: An operational system has been developed for Mali, Mozambique, and Somalia in which maps of Vegetation Index Crop Insurance (VICI) are produced for 01/01/1999 - NRT at 1000m resolution for every 10 days. Values range between 0 and 100, with 0 indicating no agricultural drought risk and 100 severe drought risk. The operational system automatically uploads NRT data once the required input data is available (CGLS NDVI).

WFS-ID-5: A machine-learning based indicator has been developed that is able to forecast agricultural drought risk for Mali, Mozambique, and Somalia at 1000m resolution 10 days, one month, and three months in advance. The methodology draws a lot of parallels from the VICI indicator (see WFS-ID-4) in a sense that it is based on anomalies in NDVI to the long-term average. A separate masking is performed for croplands and grasslands. The indicator has been validated for 2021-2022 (cold phase) and has been adapted to function using meteorological forecast members – and thereby provides uncertainty estimates on top of an estimated value of anticipated agricultural drought impact.

WFS-ID-6: Based on the products developed in WFS-ID-4 and WFS-ID-5, a zonal aggregation method has been developed. For each administrative region (ADM1/ADM2/ADM3), it identifies the forecasted number of pixels under agricultural drought risk (VICI > 0) or under severe agricultural drought risk (VICI = 100) compared to the total number of pixels under cultivation. For this, the growing season is explicitly considered – meaning that pixels outside of the growing season are not considered in the calculation. These products are currently operational for those using WFS-ID-4 (observations) and are being prepared for an operational phase for those using WFS-ID-5 (forecasts).

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Challenges

There are many dependencies between indicators mutually and to the composite crisis indices developed in Task 2.7- making the system vulnerable to cascading delays. The predictability of droughts over seasonal time scales is subject to improvements and remains constrained by the capabilities of current weather prediction models to forecast precipitation anomalies.

T2.7 – Integrated multi criteria analysis and synthetic indexes design and implementation

Activities performed

The following main activities have been performed in T2.7:

- Completed qualitative analysis, aimed at understanding cold cases setting a baseline for the risk prediction and impact assessment capabilities of T2.7 indexes.
- Design and implementation of AI/ML models applied to floods and, particularly MHVZ (medium-high vulnerability zones) combining multiple indicators to draw a map of the most vulnerable zones that are predicted to be flooded.
- Further progress on the development of the Flood Early Warning Index (FEWI) is ongoing, with two key components: extreme precipitation prediction (UF-ID-2) and flood inundation forecasting (UF-ID-3). The precipitation index, which evaluates risk levels based on return periods, is being refined using a fuzzy neighbourhood approach to address forecast uncertainty. These components, combined with high-resolution flood maps, aim to define potential risk zones and an Area of Interest (AOI) up to three days in advance.
- Design and implementation of AI/ML models applied to droughts and, particularly DCPI (Drought Conflict Prediction Index) and DDPI (Drought Displacements Prediction Index) combining multiple indicators to predict conflicts and displacements at region-month level of detail.
- Design of alerts associated with DCPI and DDPI (in connection with WP3).
- Design and implementation of an improved version of FII (Flood impact index) capable of making a distinction among different types of impact (Human - Assets (Roads and Buildings), thus fully exploiting the richness of information in CENTAUR.
- Deliverable D2.6 CENTAUR multi-criteria analysis and indexes generation pipelines v1 (using indicators from the baseline) was submitted, led by Cherrydata with contributions from e-GEOS, Adelphi, and ECMWF.

Achievements

The qualitative analysis of indicators has been completed. Insights have been documented and shared within the consortium. Based on the feedback received from partners, the approach to the design of MHVZ (for floods) and DDPI/DCPI (for droughts) has been fine-tuned and finalized.

MHVZ, DDPI, and DCPI have been designed, implemented, documented, and made available on the CENTAUR platform.

Significant progress has been made in the development of the Flood Early Warning Index (FEWI), with the identification of two key components: extreme precipitation prediction (UF-ID-2) and flood inundation forecasting (UF-ID-3). These components, along with high-resolution flood maps, now enable the identification of potential risk zones and an Area of Interest (AOI) up to three days in advance.

Alerts associated with DDPI and DCPI have been designed, and will be implemented in the next steps of the project. An improved version of FII has been already delivered for the Valencia cold-hot case and will be further refined in the next phases in T2.7.

Challenges

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To understand indicators, harmonize their formats, understand their behavior/strengths and weaknesses, and define an approach to make the best use of each indicator. These challenges have required a lot of work to fully understand each individual cold case and obtain practical insights driving the design of the indexes.

Achievements and results

The CENTAUR project has made substantial progress in integrating diverse data sources and developing innovative indicators and indexes for urban flood mapping and water and food security.
In Task 2.1, a collaborative approach was used to collect geospatial data and define technical specifications for various datasets, resulting in the *Catalogue of CENTAUR Data and Related Specifications*. This catalogue outlines the Earth observation, meteorological, socio-economic, and social media datasets, forming the foundation for developing the project's key indicators.
Task 2.2 focused on the mining and adaptation of open and socio-economic data, with a specific emphasis on analyzing traditional and social media around the Cyclone Idai event in Mozambique. The team dedicated time and effort to organize, clean, and prepare the collected data for subsequent analysis. Thanks to this effort, a well-structured dataset was created, ready for further processing.
In Task 2.3, team developed two critical datasets to predict extreme precipitation events in urban areas and monitor drought severity, employing machine learning models for return period predictions and probabilistic drought assessments. These efforts are integral to the broader CENTAUR platform and contribute to water- and food-security indicators.
Task 2.4 focused on generating relevant socio-economic (SE) indicators for cold cases, producing time series and granular data for multiple regions for both domains (UF & WFS). It also supported the development of algorithms and metrics for complex risk indices, contributing to data validation and platform integration.
Task 2.5 focused on urban flood indicators, including the development of machine learning models to forecast extreme precipitation and high-resolution flood risk maps. This task also leveraged innovative InSAR techniques for mapping flood extent in urban areas. Key flood damage assessment and social media-based indicators were also integrated into the platform.
Meanwhile, Task 2.6 focused on water and food security indicators, with regular coordination to align the efforts across partners. Cold-phase products for these indicators were successfully integrated into the CENTAUR platform, facilitating smooth workflows for forecasting models.
Finally, Task 2.7 marked a turning point in our ability to combine indicators generated from previous phases, resulting in the design and implementation of comprehensive crisis indices, such as the Medium-High Vulnerability Zones (MHVZ), Flood Early Warning Index (FEWI) and Flood Impact Index (FII) for floods, as well as the Drought Conflict Prediction Index (DCPI) and Drought Displacement Prediction Index (DDPI) for droughts. The associated predictive AI/ML models have also been successfully designed and implemented. Ongoing work is focused on the development of the alert system, which will complement these indices. This further enhances the CENTAUR platform's ability to predict and assess the impacts of extreme events.

Next steps

With reference to the ongoing activities within Task 2.4, T2.5 and T2.6 the following activities are foreseen from M29 onwards:

1. **Pipeline Development and finalization:** the development activities on each pipeline will continue until M30, with the objective of develop and finalize Cold-hot and Hot cases.
2. **Consolidation of Indicators and Indexes for Early Response and Decision Support:** Building on the outputs of the pipelines, work will focus on developing the indicators and composite indexes that will support the generation of alerts and enable "what-if" scenario analysis. These analytical components will form the backbone of the early response and decision-support logic. The actual development of

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the tools and dashboards that will visualize and operationalize these features will be carried out under WP3.

In the coming months, Task 2.7 – Integrated multi-criteria analysis and synthetic indexes design and implementation will focus on finalizing the design and implementation of the alert logic, as well as an improved version of the Flood Impact Index (FII). Corresponding products will be made available on the CENTAUR platform.
All the indexes designed in T2.7 will be tested in the hot cases, with the goal of identifying possible weaknesses and limitations to be overcome in the next months of the project.
In T2.7 we will also continue to work in tight cooperation with WP3 to transfer algorithms to be integrated and deployed into the platform, and to refine implementations from design activities in T2.7.

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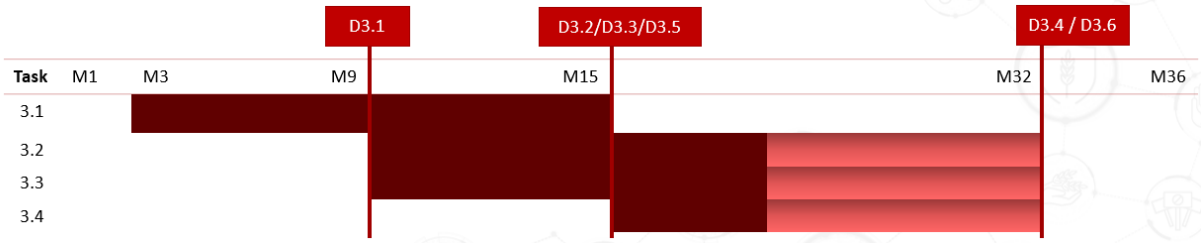
2.2.3 WP3 – SERVICE DEPLOYMENT

The objective of Service deployment work package (WP3) is to have the necessary tools to visualise/analyse the products generated in the services (the output of Thematic Product Engineering work package WP2). The platform will be designed to be scalable and agnostic to the IT resource tier.

The WP is split into several task to achieve the deployment of the services:

- Task 3.1 is related to design and the set-up of the platform where the different services will be integrated.
- Task 3.2 oversees the integration of the components related to Urban flood domain.
- Task 3.3 oversees the integration of the components related to Livelihood and food security.
- Task 3.4 is related to establishing the testing environment and developing the pipelines for automatization testing and guaranteeing the quality of the output. Each developer will create the test cases that will be run by a different team.



The WP will last 33 months, starting from M4 and activities are distributed as per the timeline below (Figure 3).

Figure 2: WP3 timeline of the activities and related deliverables

Work Package n.	3
Work Package Leader	GMV
Work Package Title	Service Deployment
Participants	GMV, EG, HEN, VIT, ECM, CHE, TRA

Active Tasks for M19-M29 period	Duration
T3.2 Urban flood - Service integration	[M10-M33]
T3.3 Water & Food Insecurity – Service integration	[M10-M33]
T3.4 Platform deployment and test	[M15-M33]

Work Package Summary of Progress Towards Objectives
The platform is designed based on standards and COTS. By integrating the first urban flood indicators, a guideline was published as a reference for the rest of the indicators. Furthermore, a development environment has been set to check the integration of the WP2 output with the WP3 platform. At this stage, the cold use case indicators have been successfully loaded and tested in the development environment. The deployment in a Kubernetes cluster of the core components of the v1 of the platform and the configuration of the cloud environment including the central repository based on S3 (Object Storage) service and all the needed services (Kubernetes managed service, Docker Registry, DNS) are currently underway.

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The integration of the two domains UF and WFS progressed significantly. The team also made considerable progress in refining the alerting system and integrating new components based on iterative feedback.

Task 3.1 - Platform design

Activities performed

The activities related to the design of the platform have been completed. However, as mentioned in D3.2 ([RD11]), discussions regarding the alert system component to be included in the CENTAUR platform are still ongoing. We are defining the system in an iterative process with input from WP2, ensuring continuous refinement based on feedback. The integration of the system alert will be addressed in Task 3.2 and Task 3.3.

Further details regarding task 3.1 can be found in please refer to ([RD10]).

Task 3.2 - Urban flood - Service integration

Activities performed

The activities involved in Task 3.2 Urban flood – Service integration, after the cold case experience, have been carried out to identify mature services and establish a common ground for the integration of automatic services while also include in the overall Urban flood services that requires human intervention as part of the service.

The integration of flood processors has been setup as described in the architecture with the definition of the automated pipelines that will integrate the different steps of the processing (e.g. flood footprint steps into flood modelling steps to extract better urban flood footprint estimate and flood depth).

The integration of this first alert has been started by defining the end-to-end of the workflow and in further details related to the parameters needed in the information to submit to the registered users.

Achievements

The implementation and deployment of the pipelines for Urban Flood has been carried out and is currently in testing phase.

Agreement on formats and styling of the indicators was during this period the key topic in the integration activities. Even though the platform will work with heterogeneous data, this has been simplified by using the same format when the subject of the data is similar.

Integration of the delivery into the central repository according to specific rules has already been carried out during cold case execution and will be further improved.

Common agreement on the structure of the message exchanged between the processing platform and the central node. Further iteration will might be needed.

Challenges

Finalize the integration of the pipelines, integrate the pipelines with the activation methodology using API and support the integration into the central node.

Task 3.3 - Water & Food Insecurity – Service integration

Activities performed

The activities involved in Task 3.3 Water & Food Insecurity – Service integration started once the definition and scope of all WFS indicators was clearly fixed. For each indicator, we determined whether it would be generated in a continuous way or would be generated on user request. The indicators will be processed on the local nodes and automatically uploaded to a centralized data repository (AWS S3), from where the central node of the system can easily fetch the products. Specific visualization requirements for each indicator have been collected. Integration of several WFS indicators has started and is still ongoing.

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For the purpose of integration, the WFS products are made available using the defined naming convention and specific cloud-native formats. After full integration all WFS products will be automatically uploaded to the S3 centralized repository to facilitate the access by the GeoNode platform.

The integration of this first alert has been started by defining the end-to-end of the workflow and in further details related to the parameters needed in the information to submit to the registered users.

Achievements

From a teamwork point of view, good communication between teams ensures the integration of the different indicators to be ingested in the platform for visualising according to the styling described in D2.2 deliverable.

From a technical point of view, the prototype has been further elaborated and will serve as input for the ongoing WFS service integration activities.

Agreement on formats and styling of the indicators was during this period the key topic in the integration activities. Even though the platform will work with heterogeneous data, this has been simplified by using the same format when the subject of the data is similar.

Agreement on the integration of the delivery of all WFS indicators into the central repository according to specific rules.

Detailed information was collected on status of automation, upload frequency, and expected upload moment (e.g., beginning of the month) for all WFS products to better understand interdependencies and set up a system to integrate WFS services into the platform.

Common agreement on the structure of the message exchanged between the processing platform and the central node. Further iteration will might be needed.

Challenges

Finalize the integration by elaborating on the different indicator pipelines and on the activation's methodology using API. Support the integration of the WFS indicators into the central node, finalize the integration into the future STAC catalogue.

Task 3.4 – Platform deployment and test

Activities performed

The activities involved in Task 3.4 consist in the deployment in a Kubernetes cluster of the core components of the v1 of the platform and the configuration of the cloud environment including the central repository based on S3 (Object Storage) service and all the needed services (Kubernetes managed service, Docker Registry, DNS). The activity included also the coordination with the development team of the core platform to align the methodology for the deployment and the coordination with WP4 to align the methodology for the delivery of the service.

The landing page has been fine-tuned to accommodate the initiation of cold-hot and hot cases, enabling the distinction between activations in the Urban Flood domain and between historical and current data in the WFS domain.

The identification and partial implementation of the new features that cover the hot case phase:

Manage AOI	Admin user will be able to create/update/delete AOI
Sending an email	Admin user will be able to send an email through the platform to the registered users
Manage on-demand services	Registration of services that are available in the system to request on-demand products

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Provide on-demand services to the registered users	The registered user will be able to request on-demand services
Manage alert catalogue	Provide a method to insert alert in the CENTAUR alert catalogue
Manage subscription	Provide the registered users the capability to subscribe to alerts
Alert ingestion	Provide a method to ingest alert produces by the processing platform
Alert Notification	Provide the registered users an email with the alert information

Regarding the testing task, testing of the platform has been successfully carried out in a dedicated testing environment, and a comprehensive report detailing the results has been created ([RD13]).

To streamline the testing process, some of the tests were automated using Cypress. This automation helped ensure the reliability and efficiency of the tests, allowing for quicker identification of potential issues and ensuring repeatability.

In addition to the initial tests performed in the testing environment, further testing is planned to be conducted directly on the production platform. To facilitate and organize the testing process, the necessary inputs and data for the additional tests have been identified and centrally documented in an Excel file.

Achievements

From a teamwork perspective, the task required significant collaboration and clear communication to ensure that everyone was aligned on the strategy. The goal was to establish a sustainable approach that would streamline future deployments and minimize risks. By effectively coordinating efforts, the team was able to tackle challenges and develop a solid foundation for ongoing success, ensuring that the platform remains adaptable to evolving needs.

The platform is now live and fully operational, with cold case products successfully loaded into the system. These products are now accessible to end-users, providing them with the necessary tools and information to engage with the platform. The deployment of the cold cases represents a major milestone, as it marks the platform's readiness for user interaction and highlights the completion of an important phase in the project

The rest of the tests will be implemented and execute them for new platform versions.

Challenges

Continue the support to the deployment of the platform as the core platform new version will be easily deployed from the Docker Registry as soon as they are released from the testing platform.

Achievements, results, and challenges

The foundational structure of the workflow has been established, focusing on the production, delivery, and presentation of the generated products. This framework is crucial in hot case scenarios, as it dictates the data flow for real-time events.

Concerning the upgrade to the CENTAUR platform, currently, development is currently underway on capabilities that must be implemented on an ad-hoc basis for each specific domain. This process is iterative and involves close collaboration with the WP2 team Iterations between WP2 and WP3 are consolidated, with focal points clearly identified.

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The alert system is in the process of being defined, with each step meticulously detailed for each domain. In each domain, the initial phase involves identifying metadata that is relevant for users when receiving an alert notification. This step is under discussion with the WP2 team.

The definition of notification and alert should be agreed upon to avoid misunderstandings. While notification is an e-mail sent to the user as an announcement of an update in the CENTAUR platform, the alert is an event that the CENTAUR platform is capable of notifying.

Finally, user feedback collected during the cold case phase is being used to inform improvements to the CENTAUR platform, particularly with respect to the landing page. It has been optimized to support the commencement of cold-hot and hot cases, providing the ability to differentiate between activations in the Urban Flood domain and between historical and current data within the WFS domain.

Next steps

In the coming months, the platform will be extended with new capabilities to support the monitoring and analysis of Urban Flood (UF) and Water & Food Security (WFS) events, building on the innovative products developed in WP2.

These enhancements will be implemented through an iterative process that includes detailed design (in collaboration with WP2), development, testing, and integration into the platform.

To deliver these new functionalities in a structured and manageable way, **two additional platform releases are foreseen**. These releases will progressively introduce the new features, ensuring stability between versions.

The upcoming capabilities will support both administrative and end-user needs:

- From the point of view of an admin user: manage the services that can be requested on-demand, manage the email notification, and manage the alert system, manage the available AOI to request an on-demand product.
- From the point of view of a registered user: receiving emails to keep them updated about the generated products to enhance their analysis on the UF and WFS context, allowing the user to request on-demand products.

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2.2.4 WP4 – CLIMATE CHANGE CRISIS AND NATURAL DISASTER DEMONSTRATION

The present WP4 has the objective of testing the CENTAUR platform in a pre-operational context, as well as demonstrating its added value to current Copernicus EMS and SESA operations. Particularly, WP4 has the following goals:

- Organize demonstrations by running the CENTAUR system over selected use cases, on the basis of user needs and data availability.
- Execute demonstrators by ensuring proper platform and service runtime performance. The cold and hot uses cases for the two main thematic lines (Urban Flood and Water & Food Security) are executed for the scenario configuration that has been agreed with the user community.
- Analyse the demonstrator outcomes from a user perspective to ascertain user and stakeholder feedback, on the fit-to-purpose of platform user experience, continuous monitoring/indicators and products for both Urban Flood and Water & Food Security.

WP4 covers a large segment of the project, as illustrated in Figure 3.

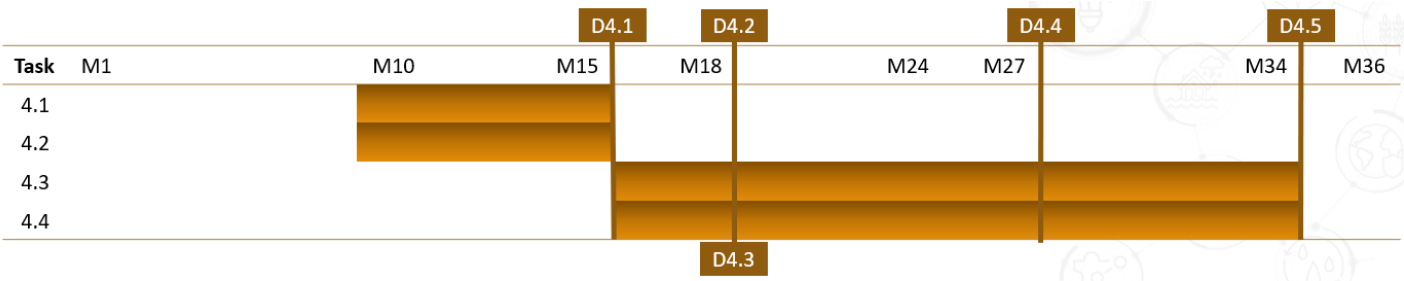

Figure 3: WP4 timeline of the activities and related deliverables

Work Package n.	4
Work Package Leader	UNISTRA
Work Package Title	Climate Change Crisis and Natural Disaster Demonstration
Participants	All

Active Tasks for M19-M29 period	Duration
T4.3 Demo execution	[M16-M34] Cold cases [M16-M27] Hot-Cold [M28-M29]
T4.4 Demo assessment	[M16-M34]

Work Package Summary of Progress Towards Objectives
The organization of WP4 has been initiated with the KOM of M10 in September 2023. Each task has been assigned to the responsible partner, and a schedule has been defined to prepare the expected WP4 contributions.

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The URR and PDR meetings in M6 and M9 respectively have helped validate and clarify use cases as per end-user feedback. In addition, the finalization of WP1 in November 2023 has laid the groundwork for WP4, with the collection of input data for all cold case demonstrators.

Steps that have been performed within WP4 towards the objectives:

- Kick-off meeting (2023-09-20): presentation of objectives and workshare.
- Tasks T4.1 and T4.2 were initially closed at the end of M15, following a 6-month development cycle. Their focus was on demonstrator design, performance identification and validation criteria, for urban flood and water & food security use cases. However, considering changes with the introduction of "cold-hot" cases to account for the potential lack of live crises during the hot phase, these tasks have been reopened in February 2025 to allow for adjustments in the workflow and partners' contributions.
- Cold and hot case demonstrator scenarios were created to organise data collection, production and delivery process. They were designed by UNISTRA with support from WP4 partners. With the introduction of "cold-hot" cases, no specific change in the scenario has been made so far in February 2025.
- E-mail templates were designed by UNISTRA, to standardize the information provided to end-users during each main step of the demonstrator cycle, including delivery and alert notifications, as well as feedback collection. They were not used during the cold phase, as the results were shared and presented during the cold phase workshop. Due to recent changes with the introduction of the cold-hot phase, they were entirely revamped by e-GEOS to better align with the updated workflow and communication needs.
- It was initially planned to deliver products through a temporary FTP site. This strategy was changed, directly leveraging the production S3 bucket made available by e-GEOS.
- Several quantitative and qualitative criteria were defined by Tracasa to assess the quality of delivered products. Demonstrators include a validation phase, performed by independent partners who were not involved in the design or computation process.
- A quality check of all products, in the delivery package and on the CENTAUR platform, was performed during the cold phase by GMV. This included metadata, stylesheets, rendering on the platform, naming convention, etc. Following this process, key guidelines were defined, to be followed by service providers. An additional check was performed in March and April during the first cold-hot case in Valencia (Spain), to ensure the compliance with all the specifications defined.
- The assessment also included end-user and service provider questionnaires, to collect feedback on delivered indicators and indexes. Their goal was to provide information on how to improve said products during the lifetime of the project. They were designed by Tracasa primarily, with support from CLS and SatCen. They have been analysed by SERTIT, their findings being available in D4.3 (CENTAUR demonstration operational report and validation result - cold cases).
- UNISTRA has delivered D4.2 (CENTAUR demonstration plan v2 (hot case)) as well as the initial version for D4.3 (CENTAUR demonstration operational report and validation result - cold cases) in M18. The final version was delivered in M27, due to delays in the timing and outputs from WP2 and WP3. An initial version for D4.4 (CENTAUR demonstration operational report and validation result v1 - hot cases (intermediate)) was also delivered in M27, providing insights into the updated plan for the hot and "cold-hot" phase. No result for the hot phase is available as of February 2025, due to the absence of live events over the original AOIs.
- T4.3 (led by GMV) started in M15 (March 2023) and it will continue until M34. The cold phase expanded from M15-M27, leaving M28-M34 for the hot and "cold-hot" phase demo execution. This demo execution of the Cold-Hot case of Valencia floods took place during end of March / early April 2025.

T4.1 Demo design, performance identification and validation criteria / EMS Urban Flood

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T4.2 Demo design, performance identification and validation criteria / EMS Water&Food Insecurity

Note: *As T4.1 and T4.2 are closely tied to one another, all activities, achievements and challenges were shared. Considering this point, details on both were merged in this report to provide a clearer overview.*

Activities performed

- Design of the cold case scenarios (urban floods, water & food security, cross-cutting use case).
- Design of the quantitative and qualitative validation criteria for assessing indicators and indexes.
- Design of end-user and service provider questionnaires, to collect feedback of the platform, indicators, indexes and various services.
- Definition of a timeline for the scenarios, depending on service provider availability and data collection or production requirements.
- Finalisation of input data collection for all cold cases, in close collaboration with WP2.
- Collection of additional data to support validation effort. Creation of mail notification templates, used by the consortium to mark different steps in the execution process, including the beginning and end of a demonstrator, the delivery of new products, alert triggers, and the solicitation to answer questionnaires.

Achievements

- Creation of the CENTAUR input and validation data catalogue, as well as notification mail templates.
- Finalisation of cold case scenarios and timelines across all use cases.
- Finalisation of questionnaires aimed at the end-user and service provider. Dissemination after the cold phase already performed, through D4.2.
- Delivery of D4.2 (CENTAUR demonstration plan v1 –hot cases), providing information the demo plan for the hot phase, including execution and validation.

Challenges

- Organise scenarios and timelines depending on progress across other work packages, WP2 and WP3.
- Get in touch with relevant stakeholders to collect missing key input data.
- Collect validation data for use cases where there is limited amount of available crisis information. This is particularly true for the WFS track, where several indicators are completely novel.
- Anticipate the hot case phase, by preparing reusable and compatible assets (e.g. scenarios, templates).

T4.3 Demo execution

Activities performed

- T4.3 (lead by GMV) kick-off in M15 (March 2023) as planned and it will continue until M34.
- UNISTRA initialised deliverable D4.3 (CENTAUR demonstration operational report and validation result - cold cases). The draft was shared with the relevant partners, with a first delivery at M18 and the complete deliverable finally provided at month 27.
- During April/Early May 2024, GMV, as Task 4.3 demo execution leader, has done multiple checks on data, metadata, ftp organisation, pre-production platform progress and prod platform plan as this are required before T4.3 Demo execution could start. The outputs of this preliminary checks found discrepancies as WP2, WP3 and WP4 run in parallel.
- The cold cases phase was originally planned to end at month 21 (August), however needed to be to adapt to the WP2-WP3 outputs timing as impacted the WP4 activities. As a recap, the definitive first round of products were not available on the platform until October 2024, and after, it required several loops of iterations (1) demo execution feedback, 2) amendments by data provider (WP2) or platform developers (WP3), 3) demo execution review), the task was finally closed in February 2025, with the submission of D4.3 (CENTAUR demonstration operational report and validation result - cold cases) v2.

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- UNISTRA initialised D4.5 (CENTAUR demonstration operational report and validation result v2 - hot cases (final)), with a section dedicated to demo execution. The draft was shared with partners.
- For each dataset, the demonstration execution included:
  - **Upload verification** of the final products to the CENTAUR platform.
  - **Visualisation and information accuracy:** following the upload verification, the team checks that the products are correctly visualized on the platform and that they are accompanied by the auxiliary information (title and metadata) as previously agreed upon.
- Additionally, the team working on the demo execution task finally also performed a review of the platform and its features (as an independent user) which provided useful feedback to WP3 developers.
- Collection of additional data to support production effort for cold-hot cases.
- Successful demo execution of the Cold-Hot Valencia which focused on the flood event that occurred in Valencia in October 2024:
  - Demo execution ran in parallel with the products provision. Findings provided by email to data providers.
  - Thanks to the work done during the cold phase, only fewer issues were detected during the cold-hot case:
    - Titles were accurate and properly handled.
    - Only a layer name inconsistency was identified and addressed
    - Only a few visualization issues related to product dates (publication and event simulation dates)
    - Only a few missing metadata items (such as the lineage field) were flagged for attention.
  - Pending changes from the cold phase were successfully incorporated for this cold-hot case
  - Notification emails sent to end-users were reviewed and comments provided.

Achievements

- The demo execution included the revision of a total of 14 indicators and indices for UF and 23 for WFS, which sum a total of 37 indicators, but when considering the several scenarios where these have been implemented, the total individual products reviewed account for **more than 300 datasets**.
- The demo execution checks have laid the foundations for the correct visualization of the considered products and the auxiliary information in a consistent and standardized manner, in a direct way, for the next phase.
- Update to unfinished items in D4.2, included in the preliminary version for D4.4. Delivery of the finalised version of D4.3 with the results and findings from the cold phase execution and its corresponding user workshop, held in November 2024.
- Successful demo execution in parallel of the Cold-Hot Valencia Oct 2024 flood event case.
- Preparation of the hot and “cold-hot” phase demonstration, performed until June 2025.

Challenges

- Progress on the demo execution plan (D4.1) had been delayed, as the final indicators (products), including all requirements such as metadata, needed to be displayed on the CENTAUR production platform before the demo execution could take place, as previously explained.
- The demo execution involved several iterations among the demo execution team, data producers and WP3 team to ensure that the correct upload of the data, appropriate visualization in the platform and consistency among products and scenarios. As such, resources consumed were larger than initially estimated.

T4.4 Demo assessment

Activities performed

- The validation of CENTAUR components has been performed across both UF and WFS tracks, for all cold cases and indicators where reference data was available and comparable.

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- The collection and analysis of end-users and service provider feedback, on both the CENTAUR platform and products, for the UF and WFS tracks, across all use cases (Spain, Italy, Germany, France, Mozambique, Somalia, and Mali).
- Preliminary work from T4.1 and T4.2 was put into production, including validation grids for CENTAUR components, as well as end-user and service provider questionnaires.
- UNISTRA has delivered D4.3 (CENTAUR demonstration operational report and validation result - cold cases). The document was completed by the relevant partners, with a consequent section dedicated to explaining the validation protocols, metrics and results.
- In the preliminary version of D4.4 (CENTAUR demonstration operational report and validation result v1 - hot cases (intermediate)) initialised by UNISTRA, a section dedicated to demo assessment was included, indicating that additional validation would be up to service providers, with support from Tracasa and CLS.
- UNISTRA initialised D4.5 (CENTAUR demonstration operational report and validation result v2 - hot cases (final)), with a section dedicated to demo assessment. The draft was shared with partners.
- User questionnaire prepared for the hot and cold-hot phases and shared with the end-users for the cold-hot case in Valencia (Spain) to collect feedback on the products, platform, and overall experience.

Achievements

- Validation during the cold phase was conducted by Tracasa and CLS under a tight timeframe following the validation criteria defined in T4.1 and T4.2, constrained by the availability of the indicators under a definitive form. Despite significant the volume, diversity and complexity of data to be validated, the task was successfully conducted by the partners.
- In total, 18 questionnaires were collected for analysis of feedback during the cold phase. 13 out of those were provided by service providers, accounting for a 93 % turnout. However, the last partner is not involved in the technical part, so this should be considered a 100 % turnout.
- All the findings were successfully compiled into D4.3 (CENTAUR demonstration operational report and validation result - cold cases) priori to delivery.

Challenges

- Perform validation across a large range of products in a timely manner.
- In total, 18 questionnaires were collected for analysis of feedback during the cold phase. 5 out of those were provided by end-users. However, 12 users participated to the cold phase workshop, resulting in a 42 % turnout, which is less than what would be appropriate for a proper analysis. Out of all the UF use cases, only Germany did not receive any feedback, equating to 20 %. Regarding WFS, the absence of feedback goes up to 67 %, as a return of experience was only provided for Mozambique.
- Collect feedback from end-users and service providers and maintain contact to ensure a continued improvement of CENTAUR components.
- Derive key statistics and meaningful feedback from a large range of products.
- Transpose said statistics and feedback into actionable information to help improve upon CENTAUR components as part of WP2 and WP3.

Achievements, results, and challenges

Achievements

- Creation of the CENTAUR input and validation data catalogue.
- Finalisation of cold case scenarios and timelines across all use cases.
- Creation of the corpus of criteria used for validating products from the CENTAUR portfolio.
- Finalisation of questionnaires aimed at the end-user and service provider.
- Finalisation of mail templates.

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- Finalisation of the execution timeline for the first cold cases (Spain, France, Germany, Italy, Somalia, Mali) as per the proposed scenarios, considering WP2 and 3 developments.
- Successful execution of the first end-user workshop in November 2024, marking a key milestone in the CENTAUR project. It provided an opportunity for the team to engage directly with the end-users, gaining valuable insights into how the platform and its datasets could be utilized in real-world scenarios. With the exception of 2 end-users, all the others have provided feedback on the workshop and available datasets, with positive feedback overall, indicating that they found the workshop informative and beneficial for understanding the project's outputs. This feedback will be crucial for refining the work done by the team.
- Successful validation and quality checks over all the products for the cold phase.
- Delivery of D4.1 ([RD14]), D4.2 ([RD15]), D4.3 ([RD16]), and the initial version of D4.4 ([RD17]).
- As hot and "cold-hot" case demonstrators have only recently started, there is no significant achievement as of February 2025.

Challenges

- Organise with WP2 and WP3 partners to align with availability and development of several CENTAUR components (storage, platform, indicators, indexes, services). To address this challenge, cross-WP meetings are organised.
- Anticipate delays in the delivery of one or more CENTAUR components, which could result in delayed demonstrator execution. Considering the fine relationship between all components, cross-WP meetings help identify potential bottlenecks, but general fall-back solutions have not been identified as they depend on the characteristics of each component.
- Anticipate the absence of hot cases, which are prospective, pertaining to events that may occur during the project's lifespan, and thus lack definitive data. To address this uncertainty, various optional use cases have been identified by end-users and CENTAUR partners, providing alternatives. However, considering the extensive efforts for collecting and preparing input data, this strategy is no longer relevant. Potential solutions will be explored in due time.

Next steps

WP4 is expected to span from M30 to M34.

For the M30 – M34 period, the following steps have been identified:

- Perform the hot and cold-hot cases demo execution until M34 (D4.5).
- On-demand validation of CENTAUR components, based on the defined criteria (Tracasa, CLS).
- Analysis of end-user and service provider feedback, collected through questionnaires (UNISTRA).
- Prepare end-user workshop scheduled for M35.

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2.2.5 WP5 – ANALYSIS OF THE INTEGRATION IN THE OPERATIONAL SETUP OF COPERNICUS EMS AND SEA, IMPACT AND FURTHER EXPLOITATION

The present WP5 has the objective of preparing a plan to move from a prototypal phase to an initial operational phase of CENTAUR into the Copernicus EMS and SESA Security operational service, based on lessons learnt from the demonstration phase. Particularly, WP5 has the following objectives:

- Performing an interoperability analysis and roadmap for the integration of the most relevant products and services developed in CENTAUR, into the Copernicus EMS and SESA service.
- Determine what can be integrated into the Copernicus EMS (RM & RRM) and SESA portfolios.
- Identifying the Key Exploitable Results (KERs) by all partners of CENTAUR by addressing existing gaps and market needs for emergency and security services.

WP5 will cover the entire duration of the project, following the start and end dates of the different tasks as per the following timeline (Figure 4).

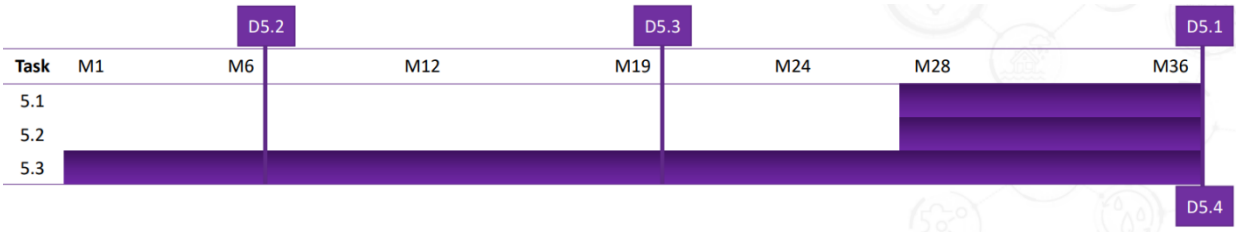

Figure 4: WP5 timeline of the activities and related deliverables

Work Package n.	5
Work Package Leader	EG
Work Package Title	Analysis of the integration in the operational setup of Copernicus EMS and SEA, impact and further exploitation
Participants	All

Active Tasks for M19-M29 period	Duration
T5.1 - EMS interoperability analysis and roadmap for integration	[M28-M36]
T5.2 - SEA interoperability analysis and roadmap for integration	[M28-M36]
T5.3 - Impact, exploitation and business model (including beyond Copernicus)	[M1-M36]

Work Package Summary of Progress Towards Objectives
The main objective of this work package is the preparation of a plan for the transition from a prototypal level to an initial operational level of CENTAUR into the Copernicus EMS and SESA Security operational service. Based on the impact analysis a feasible roadmap for the integration of CENTAUR in the existing initiatives will be drawn, also outside the Copernicus context. This WP also aims at identifying exploitable assets of CENTAUR and

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subsequently formulate individual exploitation strategies by creating specific business models tailored for the different stakeholders.

In this context, initial activities have focused on the assessment and selection of the most relevant CENTAUR products and services for integration into Copernicus EMS and SESA. Tasks 5.1 and 5.2 are addressing the technical and operational requirements for integration, and a roadmap is being developed to guide this process. CENTAUR partners ECM and EG have joined the initiative proposed by the EC, JRC, and ERCC to test innovative services, such as early detection of extreme precipitation based on return periods (ECM) and advanced flood delineation and urban damage assessment products (EG), aiming to expand the EU's emergency management capabilities.

In parallel, exploitation and business model development activities have progressed, including the identification and refinement of Key Exploitable Results (KERs), with the corresponding strategies presented in Deliverables D5.2 ([RD18]) and D5.3 ([RD19]). The HR Booster service has been re-activated, supporting the creation of tailored go-to-market strategies through a series of structured modules scheduled from March to July 2025, covering exploitation planning, business modelling, and access to further funding opportunities.

T5.1/T5.2 - EMS/SESA interoperability analysis and roadmap for integration

Tasks 5.1 and 5.2 have recently started (M28), focusing on the analysis and preparation required for the integration of selected CENTAUR products into Copernicus EMS and SESA. Initial steps have included aligning responsibilities among the involved partners and initiating a discussion on the most relevant indicators and indexes to be proposed for each service. Preliminary concepts have been presented to the JRC and are still under discussion. To anticipate integration challenges and demonstrate added value, CENTAUR partners have joined the initiative led by the EC, JRC, and ERCC to test innovative services. These include early detection of extreme precipitation based on return periods (by ECM) and advanced flood delineation and urban damage assessment products (by EG), contributing to the expansion of the EU's emergency management capabilities.

Activities performed

- For Urban Floods specifically, preliminary discussion with the JRC, initiated by UNISTRA, to assess CENTAUR components that could be integrated right off the bat within the CEMS RM portfolio, with little to no additional development. Topics initially discussed include asset grading based on flood depth, the resulting economic impact, as well as socio-economic indicators. Depending on feasibility, they could be included as part of CEMS RM's Year 3 Service Evolution, or during Year 4. Discussions to be continued with the JRC and the CENTAUR consortium as a whole.

T5.3 Impact, exploitation and business model (including beyond Copernicus)

Task 5.3 has been active since the beginning of the project, with substantial progress achieved by M29:

- The first two Key Exploitable Results (KERs), initially identified in Deliverable D5.2, have been revised to reflect the technical developments made to date.
- A third KER was identified, and the preliminary market analysis reported in D5.3 has been further elaborated and is nearly finalized. To this end, the activation of the new Horizon service will be beneficial.
- A potential fourth KER has also been identified; its qualification as a KER or categorization under "other results" is currently under evaluation.
- Description of the market analysis relevant for the exploitable results of CENTAUR, including a market segmentation, market dynamics and a competitive analysis on the technology and products relevant for the work conducted in CENTAUR.
- CENTAUR also took part in the 'Copernicus Security Service Evolution' initiative, contributing via an initial online questionnaire and a follow-up interview. Due to the relevance of CENTAUR's results,

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further details were shared with META service experts to support the possible publication of this study by HaDEA.

- To support the go-to-market strategy, the Horizon Results Booster (HRB) service was reactivated in January 2025. Following the service change, an introductory call took place on 24/01, where the service expert provided an overview of the services and outlined the objective of creating the Roadmap of Booster Services. Module A (Kick-off) has already been completed, including two meetings with service experts. Starting in May 2025, dedicated workshops for each of the three validated KERs will be held to fine-tune their exploitation strategies.

The full tentative roadmap of HRB modules is outlined below:

Module A (Kick-off): March 2025;
Module B (Unique Value Proposition & Key Exploitable Result(s)): April–May 2025;
Module C (Exploitation Strategy): May 2025;
Module D (Business Plan): June 2025;
Module E (Access to other funding & entrepreneurship support): July 2025.

Achievements, results, and challenges

Impact analysis, exploitation activities and business model creation started:

- Main KERs identified and analyzed, and initial market analysis carried out.
- Impact analysis a feasible roadmap for the integration of CENTAUR into the Copernicus EMS and SESA Security operational service partially drawn.
- Identification of potential additional "other results" among the new indices developed under Task 2.7, such as MHVZ and FII for the UF domain, and DCPI and DDPI for the WFS.
- Timely submission and approval of the Deliverables "D5.2 - Plan for the dissemination and exploitation including communication activities v1" and "D5.3 - Plan for the dissemination and exploitation including communication activities v2 (interim)".

Next steps

D5.4 (final plan for dissemination and exploitation) is planned and will consolidate all exploitation, communication, business, and integration-related outcomes. It will include final KERs, exploitation strategies, business models, and the interoperability roadmap.

In Task 5.3, the market analysis will be finalized, and the remaining HRB modules will be implemented. KER workshops will take place from May 2025. The status of the fourth potential KER will be clarified based on its maturity and relevance.

Starting from M28, Task 5.1, "EMS Interoperability Analysis and Roadmap for Integration" led by UNI, and Task 5.2, "SEA Interoperability Analysis and Roadmap for Integration" led by SAT have been launched. These tasks will focus on:

- Assessing and selecting the most relevant products and services from the CENTAUR catalogue for the Copernicus EMS and SESA services.
- Determining which products and services can be integrated into the Copernicus EMS RM, RRM, and SESA portfolio.
- Analyzing and preparing a plan to integrate the selected products and services into the Copernicus EMS and SEA services, respectively.
- If the project is selected, the ERCC and JRC joint initiative will be tested between March and May 2025

The results of these tasks will be reported in deliverable D5.1 - CENTAUR interoperability and impact analysis report, including roadmap for the integration in the EMS and SESA due at M34.

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2.2.6 WP6 – COMMUNICATION, DISSEMINATION AND OUTREACH

The focus of Work Package 6 is on communication, dissemination, and outreach and it is led by SpaceTec Partners (STP). The primary goal is to engage with relevant stakeholder groups, promote and share project outcomes and work towards common programmatic goals. The STP team uses various communication and dissemination tools efficiently to achieve maximum outreach and success. As this is a research project, the team also seeks to inform the scientific community about the progress in remote sensing and machine learning. Therefore, STP work ensures that project outcomes are well-communicated, disseminated, and evaluated to achieve maximum programmatic impact.

During the first 29 months of the project, several significant milestones have already been reached. In particular, the project website has been launched while the D6.1 Communication Strategy and Action Plan deliverable ([RD20]) and the D6.2 Interim Communication Report deliverable ([RD21]) were completed at M6 and M18 respectively. D6.1 served as a blueprint to guide all communication activities throughout the project and ensure consistency and coherence in the messaging, while D6.2 served to measure the success of the activities carried out in the first half of the project and readjust the plan accordingly for the following 18 months including the feedback received at the Interim Review meeting on 5 December 2023.

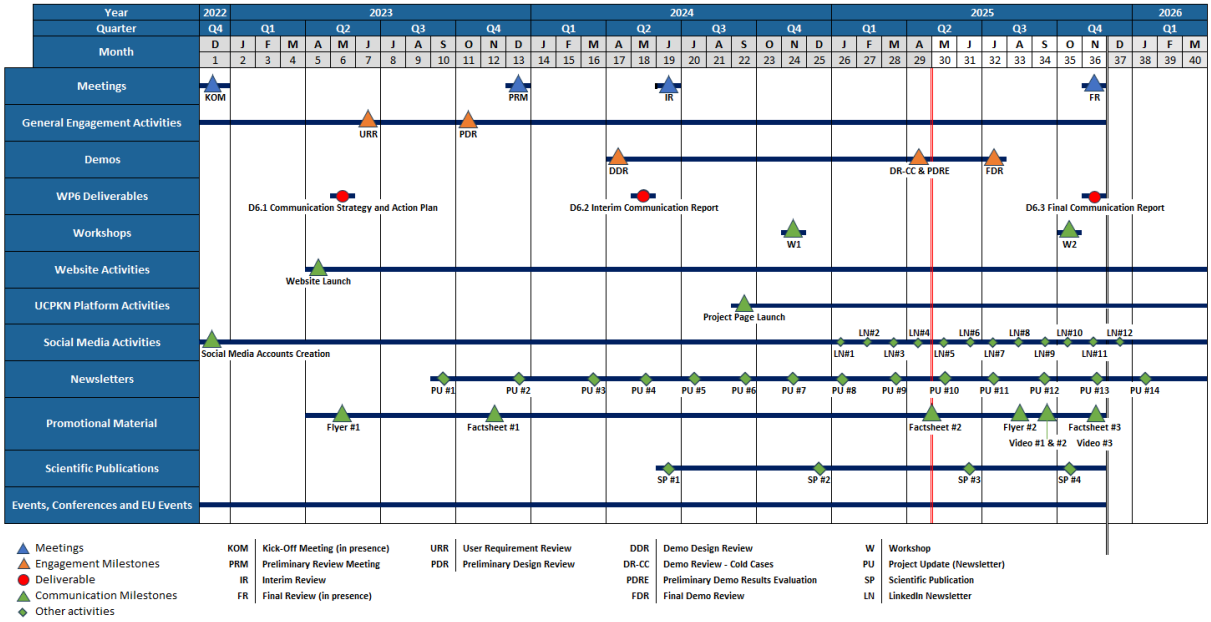

Figure 5: WP6 timeline of the activities and related deliverables

A range of communication activities have been successfully implemented to engage the project's target audience and expand its reach. Key achievements include:

- CENTAUR Social Media: A strong social media presence has been established on LinkedIn and Twitter/X, regularly engaging stakeholders with relevant and insightful content. As of April 2025, the CENTAUR LinkedIn page has seen significant growth (more than doubling the number of total followers compared to April 2024), reflecting an increasing interest in the project's developments and a consistent communication push by the communication team. In addition, following the example set by several scientific institutions, in March 2025 the STP team has opened a CENTAUR account also on BlueSky.
- CENTAUR Newsletters: As of April 2025, ten project newsletters have been published, keeping stakeholders informed about key progress and milestones. Additionally, a monthly LinkedIn Newsletter was launched in 2025, further extending project's reach.

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- CENTAUR Project Page on the Union Civil Protection Knowledge Network (UCPKN) Platform: Since September 2024, CENTAUR has been featured on the UCPKN platform, increasing its visibility among civil protection professionals and fostering engagement with key stakeholders in the disaster risk reduction and emergency management community.
- CENTAUR Workshops: In November 2024, CENTAUR hosted its first workshops (one for the general public and one for the Advisory Board members), bringing at the one open to the public nearly 100 participants, including experts, policymakers, and stakeholders. The event featured engaging discussions on urban flooding, food and water security, and the role of CENTAUR in advancing the product portfolios of Copernicus Emergency Management and Security Services. This workshop significantly boosted engagement, leading to the gain of over 70 new newsletter subscribers and almost 110 additional followers on LinkedIn.
- Flyer and Factsheet: A project flyer and a detailed factsheet have been developed and distributed to raise awareness and foster engagement. While the flyer serves as a concise and visually engaging introduction to CENTAUR's objectives, the factsheet provides a more in-depth overview of key achievements, methodologies, and the project timeline.
- Participation in Conferences and Events: Engagement in industry conferences and relevant events has been a key aspect of CENTAUR's dissemination efforts. These activities have provided valuable opportunities to strengthen relationships with key agencies, improve collaboration within the Copernicus ecosystem, and connect with other Horizon 2020 and Horizon Europe projects. They have also played a crucial role in expanding awareness of the project among other like-minded stakeholders.

STP hold the primary responsibility for the communication, dissemination, and outreach of the CENTAUR Horizon Europe (HE) project. To implement the communication strategy and ensure effective dissemination of project information to relevant stakeholders, STP is in regular contact with all partners from the consortium. In addition, STP manages the website and the CENTAUR social media platforms, engaging the audience with updates, news, and project highlights. Throughout the course of the project, other consortium partners played and continue to play a key role in raising the visibility of CENTAUR. They are actively contributing by sharing relevant information when necessary for content creation, by participating in relevant events to represent the project, and by working on dissemination activities following project's milestones.

Work Package n.	6
Work Package Leader	STP
Work Package Title	Communication, Dissemination and Outreach
Participants	All

Active Tasks for M19-M29 period	Duration
T6.1 - Stakeholder Engagement	[M1-M36]
T6.2 - Outreach	[M1-M36]

Work Package Summary of Progress Towards Objectives
STP continues to implement the communication strategy outlined at M6 ([RD20]) and its subsequent update ([RD21]), ensuring alignment with WP6 objectives. Key stakeholders have been identified and actively engaged, with CENTAUR's objectives and achievements to date being promoted through a range of communication channels. Various strategies have been established to monitor project activities and assess their impact. While

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outreach efforts have been largely successful, there is still potential to further strengthen dissemination activities. Given CENTAUR's role as a high-level research project, an increased focus on dissemination will be prioritised as more publishable and demonstrative scientific results become available, ensuring that CENTAUR remains at the forefront of innovation and contributes meaningfully to knowledge-sharing within the field.

T6.1 - Stakeholder Engagement

Activities performed

The aim of Task 6.1 is to build and sustain relationships with stakeholder communities. A preliminary review was conducted to identify six key stakeholder groups crucial to the success of the project:

- European Commission Agencies.
- Copernicus-related Institutions and Entrusted Entities.
- Copernicus EMS and SESA Users.
- Research Centres, Research Networks, or Associations.
- International Working Groups Focused on Disaster Risk Reduction and Emergency Management.
- Industry, Small and Medium Size Enterprises (SMEs), and Downstream Sector.

To facilitate effective engagement, a comprehensive online stakeholder database has been established to collect accurate information about the target audiences. To date, almost 200 stakeholders have been mapped and included in the WP6 database.

Likewise, Social Media presence has been established on LinkedIn and Twitter/X to engage stakeholders with appealing contents. To this end, we conducted regular social media posting, animation, and research, maintaining engagement on CENTAUR's official social media accounts. A targeted tagging strategy has been employed, aiming to connect with relevant stakeholders, keeping them informed about the project's progress and activities. Consortium partners, through their social media accounts, participated in raising awareness and creating an audience for core topics and services of CENTAUR.

Likewise, relevant events for the CENTAUR consortium to participate in were regularly monitored and identified, mapping more than 60 events related to the project thematic areas. Participation in 15 key international events has been leveraged to interact with and establish relationships with interested agencies and stakeholders.

Achievements

Since M19, significant progress has been made in stakeholder engagement, demonstrated by a near doubling of the number of LinkedIn followers to 460. While this may appear modest in quantity, the quality and relevance of the CENTAUR audience are particularly noteworthy. Among the followers are key stakeholders such as the Directorate-General for Climate Action (DG CLIMA), the EU Ambassador to Mozambique, Antonino Maggiore, and the Food Security Cluster, co-led by the UN World Food Programme (WFP) and the UN Food and Agriculture Organization (FAO). Additionally, numerous Horizon Europe projects, including FOCCUS EU, SEED-FD, RiskPACC, Thinking Earth, Overwatch, ACCIBERG, MedEWSa, XAIDA, Harmonia, AI4PEX, CLIMAAX, CLINT, ASTRAIOS, PARATUS-EU, and SWIFTT, have connected with CENTAUR, reflecting strong interest and alignment with the project's objectives. These achievements are the result of a targeted communication strategy that combines high-quality content with direct outreach and meeting efforts.

One of the most significant achievements was the successful first CENTAUR Online Workshop open to the general public which took place in November 2024 and attracted nearly 100 participants. The event provided an important platform for discussion on early warning systems for food, water security, and urban flooding, fostering valuable exchanges between experts, stakeholders, and project partners. The success of the workshop also contributed to a sharp increase in newsletter subscriptions, with 111 subscribers now receiving CENTAUR updates, alongside an additional 165 subscribers to the project's LinkedIn newsletter.

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Finally, participation in 15 international events – the most recent one being the 4th Global Flood Forecasting and Monitoring Meeting organised by Copernicus EMS – has significantly increased awareness and interest in the project. These results highlight the effectiveness of the engagement approach and reinforce CENTAUR's growing impact within the targeted communities.

Challenges

Over the past year, changes to Twitter/X's platform policies and functionality have significantly impacted the ability to grow the account. We have observed a 25% decrease in followers from September 2024, unrelated to our activities but rather linked to broader platform trends, including the evolving political landscape and its connection to the U.S. presidential election. In response, social media efforts have been strategically redirected towards LinkedIn, where engagement has been growing steadily. To further adapt to the evolving digital landscape, the team is also assessing the feasibility, and potential benefits of expanding CENTAUR's presence on BlueSky as an alternative platform, ensuring continued visibility and engagement with the project's key audiences.

Moreover, as a consequence of the delayed start of certain project activities related to the use cases, the first user workshop, initially scheduled for June 2024 (M19), was postponed to November 2024 (M24) to ensure maximum impact and relevance. However, extending the event to two days—with the first day open to the general public and the second day reserved for Advisory Board members—has significantly strengthened CENTAUR's stakeholder engagement. This format has already increased collaboration and will continue to facilitate meaningful interactions throughout the third year of the project.

T6.2 - Outreach

Activities performed

Task 6.2 focuses on promoting, communicating, and raising awareness about the CENTAUR Horizon Europe project and its activities. The successful development of the Communication Strategy ([RD20]) provided a comprehensive plan to guide all communication efforts throughout the project, defining key stakeholders, messages, and objectives.

Since its launch at M6, the CENTAUR website undergoes regular monitoring and update and is serving as a central hub for project information, project updates, and other essential details.

As stated in the D6.2 the communication, dissemination, and outreach focus will change according to the phase of the project. Having successfully completed its awareness-raising phase, CENTAUR is now firmly in the community-building phase—the second key stage of its communication strategy. This phase focuses on deepening engagement with stakeholders, fostering interactions, and consolidating a strong network around the project's activities. The next step, which will take shape in the coming months, is the dissemination of results phase, where the project will shift its efforts towards showcasing key findings, achievements, and concrete outcomes to its growing audience.

During the initial awareness phase, the team strategically employed multiple communication channels, including the CENTAUR website, partner platforms, social media, and newsletters, to introduce the project's objectives and expected impact. The goal was to generate interest, attract key stakeholders, and create anticipation around CENTAUR's contributions to early warning systems and activities.

To ensure brand consistency and visibility, all materials developed adhered to CENTAUR's visual identity.

A solid social media presence has been established, with engagement on LinkedIn and Twitter/X. Daily animation is carried out to actively engage with relevant accounts through likes, retweets, and reposts. This approach proved to increase the project's visibility, expand its network, and build a follower base. The use of the #CENTAUR hashtag in posts has ensured an easy interaction with users interested in our content. Given the evolving landscape of social media platforms, LinkedIn has become the main account for outreach activities.

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The Team is also actively evaluating the feasibility, and cost-effectiveness of expanding to BlueSky as a complementary platform.

In addition, to be closer to the emergency management community the CENTAUR team has successfully created a project page which is regularly updated also on the Union Civil Protection Knowledge Network platform. The project is featured in the CP/DRM-related Horizon projects page.

A significant milestone in community building and outreach activities has been the update of CENTAUR's newsletter strategy. Following the Interim Review Meeting on 5 December 2023, the frequency of publication was increased, aligning with the feedback received. As of April 2025, the first ten project updates newsletters were successfully delivered to registered recipients in full compliance with GDPR, featuring project updates, key highlights, and engaging content such as relevant readings. Furthermore, starting in January 2025 an additional newsletter has been launched on LinkedIn signalling the preference for the mentioned Social Media as the most direct and efficient channel to increase the project's outreach efforts towards the general public. In four months, more than 160 people subscribed.

As CENTAUR progresses towards the dissemination of results phase, these efforts will evolve to showcase concrete project outcomes, ensuring that the broader community benefits from the insights and innovations developed within the project.

Achievements

As of April 2025, CENTAUR Social Media contents have been viewed more than 125,000 times, three to five times more than comparable Horizon Europe projects monitored for benchmarking, maintaining excellent engagement rates. This is the result of a constant focus on producing relevant content for the targeted stakeholders on topics such as food and water security, urban floods episodes, and climate-induced displacement.

CENTAUR's inclusion on the Union Civil Protection Knowledge Network (UCPKN) platform in September 2024 has provided greater visibility and improved positioning to reach civil protection professionals. Furthermore, the CENTAUR team has successfully published/presented 3 scientific papers, and its activities have already been featured in three Copernicus Observer articles, and in one DG DEFIS news item.

Finally, the first versions of the project flyer and factsheet have been distributed to several potentially interested stakeholders, providing high-level information about the project.

Challenges

As of February 2025, the biggest challenge for the CENTAUR team in terms of dissemination activities is to reach the target of scientific publications. However, preparation for publication on EC platforms and collaboration with other Horizon Europe projects is underway.

On the other hand, in relation to communication activities, the constant changes in the behaviour of the Twitter/X algorithm have had an impact on the ability to increase the following on the platform as well as on the widgets used to connect CENTAUR's social media accounts to the project's website. The introduction of new features, algorithm adjustments, and changes in content visibility have required a strategic reassessment of the communication approach as well as evaluation of other potential platforms to be used.

Achievements, results, and challenges
The CENTAUR outreach team proved to be on track and adopting a coherent approach to communication, dissemination and outreach activities. Since M19 LinkedIn followers nearly doubled to 460, including key stakeholders and several Horizon Europe projects. The project has also been featured in several Copernicus Observer articles, and consortium members participated presenting the project in 14 international events.

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The CENTAUR's first online workshop gathered nearly 100 online participants, boosting engagement and newsletter subscriptions, now exceeding 110 via email and 160 on LinkedIn. Moreover, its presence on the Union Civil Protection Knowledge Network (UCPKN) platform has further strengthened connections with civil protection professionals.

Despite Twitter/X challenges, the STP team has successfully shifted focus to LinkedIn and is exploring BlueSky to maintain outreach. With strong momentum, CENTAUR is now moving into its final phase, prioritising dissemination, impact, and legacy-building activities in order to address the difficulties in developing scientific publications, which was primarily related to delays in the project schedule.

Next steps

As the CENTAUR project progresses into its third year, communication and outreach efforts will intensify to maximise visibility, stakeholder engagement, and impact. Entering soon the *Dissemination of Results Phase*, which will ensure sustained momentum and increased recognition of the project's contributions.

Strengthening Social Media and Website Content Production

STP will continue developing engaging content for LinkedIn as well as BlueSky as an alternative platform to Twitter/X and revamp the project website. In addition, collaborative content creation with similar Horizon Europe project will be explored.

Scientific and Institutional Dissemination

Beyond social media, STP will facilitate the publication of scientific articles in peer-reviewed journals, ensuring that CENTAUR's findings contribute to academic and professional discussions. Efforts will be made to feature project activities in high-profile European Commission platforms, such as Horizon Magazine and the Copernicus Observer also cooperating with other Horizon Europe projects with which we share thematic areas.

Maximising Event Participation and Visibility

The identification of relevant conferences, workshops, and networking opportunities will intensify as more publishable technical results become available. The team will ensure CENTAUR is well-represented at key events.

Updated Communication Materials and Video Production

In alignment with the Communication Strategy, an updated project flyer and factsheet will be developed and released soon, providing stakeholders with a concise overview of CENTAUR's objectives, latest achievements, and future steps. Towards the final project phase, three professional videos will be produced, summarising key results and reinforcing CENTAUR's impact and outreach.

Key Stakeholders and Community Engagement, and Final Workshop

To ensure sustained stakeholder engagement, two types of newsletters will be regularly published. One will be distributed via email keeping the target subscribers informed on project updates and will run in parallel with the LinkedIn Newsletter, which will be further improved to increase subscriptions, expand the project's follower base, and boost engagement among key stakeholders — including those interested in the Key Exploitable Results (KER). Interactive elements, such as quizzes, will also be leveraged to encourage participation and discussion. A major milestone in this final phase will be CENTAUR's Final Workshop, scheduled for M35, which will serve as a cornerstone event for presenting the project's results. The workshop will be meticulously planned and extensively promoted to attract strong participation from key stakeholders, ensuring that project insights and innovations reach the widest possible audience. By implementing these strategic communication actions, the CENTAUR project team will ensure its results are widely disseminated across relevant communities.

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2.2.7 WP7 – PROJECT MANAGEMENT

The WP7 objective is the overall management of the project according to the Contract, EC directives and Consortium decisions. The WP activities include the consortium management, the establishment and coordination of a Consortium Board, the interface towards EC, the monitoring and control of the project progress, the administrative and financial management, the technical management of the project, the management, and the conduction of the Steering Committee and of the Advisory Board.

WP7 will last the entire duration of the project, distributing the start and end dates of the different tasks as per the following timeline (Figure 6).

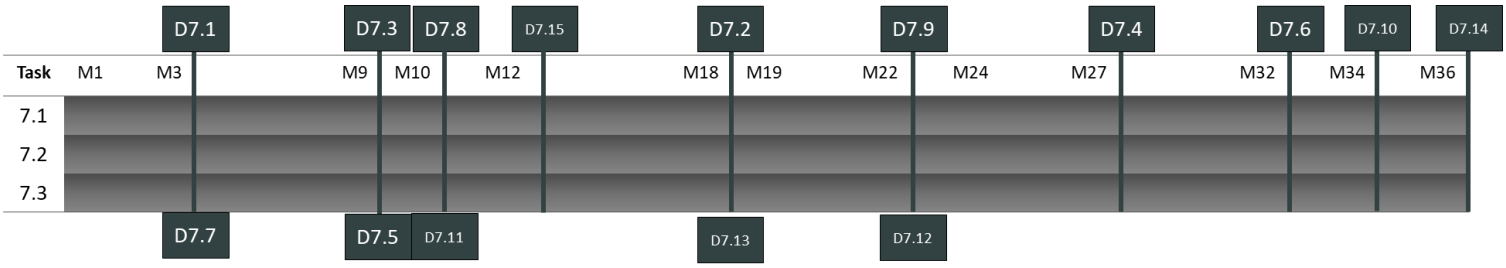

Figure 6: WP7 timeline of the activities and related deliverables

Work Package n.	7
Work Package Leader	EG
Work Package Title	Project Management
Participants	EG

Active Tasks for M19-M29 period	Duration
T7.1 - Consortium Coordination	[M1-M36]
T7.2 – Technical Coordination	[M1-M36]
T7.3 – Steering and Advisory	[M1-M36]

Work Package Summary of Progress Towards Objectives
The daily project coordination covered and will cover the following tasks: ➢ Overall management and coordination of CENTAUR consortium. ➢ Interaction with the consortium, as well as with the Commission and reference Advisory Board members, including the communication and the organization of periodic project meetings and conference calls for various bodies and provision of meeting minutes. ➢ Provision and implementation of guidelines on project management, quality assurance, data management, reporting and periodic monitoring activities. ➢ Overseeing CENTAUR project delivery process, including the deliverables preparation, organisation and monitoring of the reviewing to verify the consistency of the reports submission to the European Commission (EC).

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Legal and financial management have covered the following tasks:

- Monitoring of expenditure of project resources.
- Management of budgets, coordination of financial reporting and distribution of payments to partners (assigned to the financial officer within CENTAUR).
- Communication between consortium partners and the EU on project and funding-related questions.

As part of the activities carried out in WP7, the following meetings, during the reporting period, were organised at the consortium level, as well as including the Advisory Board members whether relevant:

1. Mid-term Review Meeting (June 2024 – in virtual teleconference)
2. 1° Workshop held in two days 21st and 22nd November 2024 (in virtual teleconference)
3. DDR-CC – Demo Review Cold Cases & PDRE – Preliminary Demo Results Evaluation Joint Milestone Meeting (11th April 2025 – in virtual teleconference)
4. Participating in every WP progress meeting and directly follow-up on technical matters, monitoring the progress and the status of specific activities
5. Organizing and chairing Cross-WPs Progress Meeting on a bi-weekly basis (agenda, minutes, etc) due to the many interdependencies of the various WPs.

T7.1 – Consortium Coordination

The activities performed in Task 7.1 are listed below:

- Ensuring the correct execution of CENTAUR project, according to the organization setup, the objectives fixed and the project master plan.
- Acting as an interface between CENTAUR Consortium and the Commission.
- Coordination, consolidation, and harmonization of the organizational structure of the Consortium through the following actions:
  - Establishing a Consortium Board (CB) the formal decision-making body, constituted by the coordinator and one representative per partner.
  - Establishing a Steering Committee (SC) made up by subject matter domain expert; it steers the project implementation, reviews project strategy, and advises the Coordinator and the Consortium Board in analysing and approving project scope, results, as well as give advice on IPR and Ethical issues.
  - Deploying processes and interfaces for Project management with Technical Manager, the Communication Manager and the WP leaders.
- Monitoring CENTAUR project resources availability, so that each work-package can be executed properly and successfully, from the perspective of time planning, activities scheduling, budget allocation and technical objectives.
- Evaluation of project progress and performance, identification of inconsistency and implementation of corrective activities/actions.
- Reporting every progress and results achieved at CENTAUR project level.
- Performing review of each deliverable and progress report to verify the consistency of the actions performed in each task, before the final submission to the Commission.
- Ensuring the timeliness of all the deliverables, their dissemination at the CENTAUR Consortium level, and at the Commission level, through an effective management process.
- Organizing and chairing progress meetings on a periodic basis and duly planned, whether specific issues need to be followed and promptly addressed.
- Disseminating agenda, minutes, etc both at the Consortium level and Advisory Board level, when involved in specific interactions/meetings.
- Ensuring the set up and maintenance of the Consortium Agreement (CA) ([RD28]).
- Ensuring the overall legal, ethical, financial, and administrative management.

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- Managing the Consortium budget and the Community financial contribution regarding its allocation between partners and activities, in accordance with the Contract with the Commission and the decisions taken by the consortium (with the Financial Officer existing within CENTAUR).
- Monitoring partners' duties compliance with respect to the GA ([RD01]) and the CA ([RD28]).
- Advise partners on contractual status and implications.
- Ensure the coordination of the Advisory Board works, including the proper analysis and monitoring of ethical issues associated to the Project.

The PC is in charge in uploading the deliverables on the EC portal, according to the deadline for the submission. for full information on the submission of deliverables please refer to paragraph "Summary of deliverables up to M29".

T7.2 – Technical Coordination

The activities performed in Task 7.2 are listed below:

- Ensuring the overall technical coordination of CENTAUR project.
- Providing guidelines to CENTAUR partners so that the activities could be executed in agreement with the GA, as well as the performance and progress could be monitored.
- Maintaining the project management plan in coordination with the PC with reference to each WP (related tasks and efforts), partners' roles and responsibilities to direct project activities.
- Ensuring the harmonisation of the activities carried out in the different WPs by establishing an efficient inputs/outputs exchange during the whole project lifecycle and by ensuring the alignment and the harmonisation of the different WPs Work Plans with the project master plan.
- In collaboration with the WP Leaders (WPL), proposing and harmonising the technical contents for results and related technical matters dissemination.
- Identifying events which could affect the achievement of the project objectives and plan mitigation actions.

T7.3 – Steering and Advisory

The activities performed in Task 7.3 are listed below:

- Assessing the risks at CENTAUR project level and applying mitigation actions whether encountered.
- Monitoring the overall technical progress and advising the project activities in line with users' demand.
- Ensuring the execution of the Steering Committee (SC) and the coordination of the Advisory Board activities and interactions at project level.
- Performing a proper analysis and monitoring of the ethical issues associated to the Project.
- Co-ordination of the workshop for the presentation of cold case results

Achievements, results, and challenges

Achievements:

- **Project Coordination & Management:**
  Successful coordination of the CENTAUR consortium, ensuring effective communication and collaboration among partners.
  Establishment of governance bodies (Consortium Board and Steering Committee) to guide decision-making and oversee project implementation.
  Regular progress meetings and workshops organized, ensuring alignment with European Commission (EC) requirements and timely submission of deliverables.
  Coordination of Consortium members, including the submission of timely progress and usage reports, and financial monitoring.

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- **Project Management & Procedures:**
  Development and documentation of a comprehensive Project Management Plan (D7.1) and Data Management Plan (D7.7), ensuring structured project execution.
  Implementation of quality assurance processes to maintain high standards throughout the project.
  Risk management procedures established and documented (D7.1, D7.2), with proactive monitoring and mitigation of risks.
- **Innovation & Data Management:**
  Establishment and implementation of innovation management tools (D7.5 - IPR and Innovation Plan v1), enabling strategic oversight of project activities.
  Successful execution of a Data Management Plan ensuring adherence to FAIR principles, ensuring research data is findable, accessible, interoperable, and reusable.

Results:

- Timely submission of deliverables and progress reports to the EC, ensuring compliance with project timelines.
- Effective coordination of technical efforts, with seamless integration of outputs across WPs.
- Ongoing monitoring and evaluation of project resources to ensure successful execution of tasks.
- Proactive risk management, with mitigation actions implemented to address potential obstacles.
- Financial and technical reporting maintained throughout, ensuring transparency and accountability.

Challenges:

- Managing the interdependencies between different WPs, requiring continuous coordination and oversight.
- Ensuring resource availability across all WPs while adhering to the project's budget and timeline.
- Addressing unforeseen technical or organizational issues as the project progresses.
- Coordinating Advisory Board activities and maintaining alignment with user needs and expectations.

Next steps
Activities reported in the Tasks 7.1, 7.2 and 7.3 will be conducted throughout the entire lifecycle of the project.

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2.3 SUMMARY OF DELIVERABLES UP TO M29

WP N.	Deliverable number and name	Lead Beneficiary	Type	Dissemin. level	Due date	Delivery date	Rev. due date	Rev. delivery date	Status
WP1	D1.1 - Report on Urban Flood and Water & Food security indicators	SAT	R	PU	31.05.2023	15.06.2023	-	-	Approved
WP1	D1.2 - Report on CENTAUR Use Cases and Indexes definition	UNISTRA	R	PU	30.11.2023	30.11.2023	-	-	Approved
WP2	D2.1 - Catalogue of CENTAUR data and related specifications	EG	R	PU	31.08.2023	31.08.2023	-	-	Approved
WP2	D2.2 - Urban Flood and Water & Food Insecurity design	EG	R	PU	31.08.2023	31.08.2023	-	-	Approved
WP2	D2.3 - Urban Flood and Water & Food Insecurity service pipelines v1 (baseline set up)	EG	DEM	PU	30.11.2023	30.11.2023	-	-	Approved
WP2	D2.4 - Urban Flood and Water&Food Insecurity service pipelines v2 (tuning and adaptation)	EG	DEM	PU	29.02.2024	29.02.2024	-	-	Approved
WP2	D2.5 - CENTAUR multi-criteria indexes design	CHE	R	SEN	29.02.2024	29.02.2024	-	-	Approved
WP2	D2.6 - CENTAUR multi-criteria analysis and indexes generation pipelines v1 (using indicators from the baseline)	CHE	DEM	SEN	28.02.2025	28.02.2025	-	-	Submitted – Under approval
WP3	D3.1 - Platform Design Document (all the theoretical background related to service design and implementation) v1	GMV	R	PU	31.08.2023	31.08.2023	-	-	Approved
WP3	D3.2 - Platform Design Document v2	GMV	R	PU	29.02.2024	29.02.2024	-	-	Approved
WP3	D3.3 - CENTAUR integrated platform including Urban Flood and Water&Food Indexes v1 (baseline)	GMV	DEM	PU	29.02.2024	29.02.2024	-	-	Approved
WP3	D3.5 - CENTAUR integrated platform test document v1 (baseline)	GMV	R	PU	29.02.2024	29.02.2024	-	-	Approved
WP4	D4.1 - CENTAUR demonstration plan v1 (cold case)	UNISTRA	R	PU	29.02.2024	29.02.2024	-	-	Approved
WP4	D4.2 - CENTAUR demonstration plan v2 (hot case)	UNISTRA	R	PU	31.05.2024	31.05.2024	-	-	Approved

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WP N.	Deliverable number and name	Lead Beneficiary	Type	Dissemin. level	Due date	Delivery date	Rev. due date	Rev. delivery date	Status
WP4	D4.3 - CENTAUR demonstration operational report and validation result - cold cases	UNISTRA	R	PU	31.05.2024	31.05.2024	28.02.2025	28.02.2025	Submitted – Under approval
WP4	D4.4 - CENTAUR demonstration operational report and validation result v1 - hot cases (intermediate)	UNISTRA	R	PU	28.02.2025	28.02.2025	-	-	Submitted – Under approval
WP5	D5.2 - Plan for the dissemination and exploitation including communication activities v1	EG	R	PU	31.05.2023	31.05.2023	-	-	Approved
WP5	D5.3 - Plan for the dissemination and exploitation including communication activities v2 (interim)	EG	R	PU	31.05.2024	31.05.2024	-	-	Approved
WP6	D6.1 - Communication strategy and action plan	STP	R	SEN	31.05.2023	31.05.2023	-	-	Approved
WP6	D6.2 - Interim communication report	STP	R	SEN	31.05.2024	31.05.2024	-	-	Approved
WP7	D7.1 - Project Mgmt Plan v1	EG	R	PU	28.02.2023	03.03.2023	-	-	Approved
WP7	D7.2 - Project Mgmt Plan v2	EG	R	PU	31.05.2024	31.05.2024	-	-	Approved
WP7	D7.3 - Progress Report 1	EG	R	PU	31.08.2023	31.08.2023	30.11.2023	30.11.2023	Approved
WP7	D7.4 - Progress Report 2	EG	R	PU	28.02.2025	28.02.2025	05.05.2025	-	Submitted – Under approval
WP7	D7.5 - IPR and Innovation Plan v1	EG	R	PU	31.08.2023	31.08.2023	-	-	Approved
WP7	D7.7 - Data Management Plan	EG	DMP	PU	28.02.2023	03.03.2023	-	-	Approved
WP7	D7.8 - DWH use for 2023	EG	DMP	PU	30.09.2023	28.09.2023	-	-	Approved
WP7	D7.9 - DWH use for 2024	EG	DMP	PU	30.09.2024	30.09.2024	-	-	Submitted – Under approval
WP7	D7.11 - DWH request for 2024	EG	DMP	PU	30.09.2023	28.09.2023	30.11.2023	22.11.2023	Approved
WP7	D7.12 - DWH request for 2025	EG	DMP	PU	30.09.2024	30.09.2024	-	-	Submitted – Under approval
WP7	D7.13 - Report on Steering and Advisory activities v1	EG	R	PU	31.05.2024	31.05.2024	-	-	Approved

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2.4 SUMMARY OF MILESTONES AND ACHIEVEMENTS UP TO M29

Milestone N.	Milestone name	WP number	Lead beneficiary	Means of verification	Due month	Status
1	KOM – KickOff Meeting	WP6, WP1, WP3, WP4, WP2, WP7, WP5	EG	Contract Signed	M1	Achieved KOM meeting performed on the 14th – 15th December 2022 (Hybrid)
2	URR – User Requirements Review	WP6, WP1, WP7, WP5	EG	Due deliverables: D1.1, D5.2, D6.1, D7.1, D7.7 CENTAUR portal CENTAUR social accounts	M6	Achieved URR meeting performed with the attendance of the Advisory Board members – 8th June 2023 (VTC)
3	PDR – Preliminary Design Review	WP3, WP2, WP7	EG	Due Deliverables: D2.1, D2.2, D3.1, D7.3, D7.5	M9	Achieved PDR meeting performed with the attendance of the Advisory Board members – 17th October 2023 (VTC)
4	DDR – Demo Design Review	WP2, WP1, WP4, WP3, WP7	EG	Due deliverables: D1.2, D2.3, D2.4, D2.5, D3.2, D3.3, D3.5, D4.1, D7.8, D7.11	M17	Achieved DDR meeting performed with the attendance of the Advisory Board members – 15th April 2024 (VTC)
5	IR – Interim Review	WP2, WP1, WP4, WP3, WP6, WP5, WP7	EG	Due deliverables: D5.3, D6.2, D7.1, D7.13 Review with EC Officer and Reviewers	M19	Achieved IR meeting performed with the attendance of the EC Officer and Reviewers – 26th June 2024 (VTC)
6	DDR-CC – Demo Review Cold Cases	WP6, WP4	EG	Due deliverables: D4.2, D4.3	M29	Achieved DDR-CC & PDRE have been performed as a joint milestone with the attendance of the Advisory Board members – 11th April 2025 (VTC)
7	PDRE – Preliminary Demo Results Evaluation	WP4, WP2, WP7	EG	Due deliverables: D2.6, D4.4, D7.7		

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2.5 IMPACT

The information contained in Section 2.1 of the DoA is still relevant to this project.

However, slightly modifications are marked below:

- Regarding Outcome 2 "*Significant improvement in resolution, detection capabilities, timely access to data and delivery of information according to the requirements of emergency and security applications*", it should be noted that for the Urban Flood topic, CENTAUR offers a continuous monitoring service through frequently updated weather forecasts indicators and indices at regional level. This information will provide alerts and trigger the generation of crisis indicators and indices before and during the occurrence of a flood event.
- Regarding Outcome 4 "*Development of processing chain(s) to handle an increasing volume of satellite data, keeping underlying technology up-to-date and include new paradigms in data fusion, processing and automation to match users increasing expectations in added-value, easiness of access and visualisation*", it should be noted that not all thematic indicators and crisis indexes for urban flood and food security will be generated automatically. Some of them require human intervention, are produced semi-automatically, and will be ingested by the CENTAUR platform after the event occurred.

- The introduction of the Urban Flood Indices (UF-IDs) could significantly revolutionize, especially for the Copernicus Emergency services, the provision of crucial information for early flood warnings and the implementation of risk mitigation strategies. These indices play a pivotal role in equipping authorities with essential insights to protect vulnerable populations and assets in flood-prone areas.
  - UF-ID-1 - Static Map of Precipitation Associated with Return Periods: the estimation of return periods associated with extreme precipitation events over urban areas in Europe and Mozambique at high resolution is a major advancement. These maps, alongside high-resolution inundation maps derived from the GoFlood model, allow the identification and delineation of extreme events and their extent and severity. This innovation significantly contributes to early warning systems by identifying potential severe precipitation events up to three days in advance.
  - UF-ID-2 - Forecast of Return Periods: a novel forecasting system for return periods of extreme precipitation represents a leap forward in predicting impactful extremes up to three days in advance. This capability to forecast return periods represents a fundamental shift in preparing for impending extreme weather events.
  - UF-ID-3 - High-Resolution Urban Flood Risk Maps: the generation of high-resolution flood risk maps with associated return period using the GoFlood algorithm (and at least temporarily INFLOS) calibrated on JRC flood hazard maps analysis aids flood management by pinpointing high-risk flood zones within urban contexts. This innovative tool facilitates rapid assessment and planning for flood-prone urban areas, enhancing preparedness and risk reduction strategies.
  - UF-ID-4 - Inferred INSAR Urban Flood Extent: the use of SAR satellite data and AI to detect floodwater over urban areas represents a significant advancement in rapid flood identification. This indicator's capability to map urban flooding using InSAR techniques fills a critical gap in flood management, offering a novel approach for timely flood area delineation.
  - UF-ID-5 - Enhanced Urban Flood Damage Assessment: the ability to map urban flooding through the combined use of the GoFlood tool, INFLOS and In-SAR techniques, and the integration of flood damage assessment models, provides comprehensive insight into flood-related damage in urban areas. By categorizing damage grades correlated with flooding depths, this indicator revolutionizes damage assessment, expediting precise evaluations without sacrificing accuracy.

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- UF-ID-6 - Social/Traditional Media Indicators for Urban Flooding Map: this indicator's ability to swiftly analyse social and traditional media markers related to flood events offers rapid situational understanding within urban areas. The generated maps featuring geo-tagged markers aid in timely intervention and response measures during emergencies, significantly enhancing emergency responsiveness.
- UF-ID-7 - Hazard Web Sources Index: utilizing web-based data to characterize extreme flood events significantly improves flood hazard assessment in specific areas. This comprehensive approach allows quick identification of vulnerable urban areas, highlighting various aspects crucial for emergency response planning.
- UF-ID-9/10/13 – Flood vulnerability indicators: combining official and open-source data with data from the partners - i.e. media-derived data from HEN and high-resolution population density and imperviousness data from DLR - these indicators allow to identify most vulnerable populations in urban areas enabling the creation of high-resolution hotspot maps, as well as a more accurate estimation of the (potential) human impact of urban floods.

The impact of these indicators is profound, providing detailed insights into flood-prone areas, allowing local authorities to implement effective emergency responsiveness strategies, and enhancing future risk reduction planning within urban contexts.

➢ The technical objectives related to Water & Food Insecurity indicator development have slightly shifted to better serve the needs of the end users. In terms of agricultural drought indicators, we are now focusing on forecasting agricultural droughts rather than purely increasing the spatial resolution of already existing indicators. We are convinced that this shift in strategy will have a positive impact on the outcomes of the project in terms of usefulness of WFS indicators to the broader user community. From a users' perspective, it is more important to be informed about upcoming drought events well in advance, rather than to have this information available at individual field scale. Timely information provides end users with the opportunity to implement the necessary countermeasures and prevent devastating impacts of droughts on crop production and food security. Accordingly, the corresponding WFS indicator definition have been adjusted to better meet these objectives: four indicators will now explicitly focus on this aspect of forecasting both meteorological and agricultural droughts and their intensity:

  - WFS-ID-1 Meteorological drought indicator (Monitoring): This monitoring drought indicator enables us to identify ongoing droughts worldwide in near real-time. Several time ranges are considered, i.e. 1, 3, 6 and 12 months. The short-term indicators are typically used to indicate immediate impacts, such as reduced soil moisture or snowpack and decreasing flow in smaller creeks. The indicators aggregated over longer time scales are commonly used to indicate reduced stream flow and reservoir storage.
  - WFS-ID-2 Meteorological drought indicator (Forecast): The forecast drought indicator allows timely identification of potential meteorological drought events at regional scale. This indicator serves as a basis to predict future impacts of droughts on agricultural production (see indicator WFS-ID-5). Having access to these forecasts would allow local governments to take the necessary actions to diminish the impact of future drought events on the local population and livelihoods.
  - WFS-ID-3 Meteorological drought indicator (danger levels): This indicator summarizes, on a monthly basis and at administrative levels, the information contained within the previous two indicators and can as such be used to quickly evaluate the local situation in terms of ongoing and expected meteorological droughts. This indicator provides an ideal means of communicating the wealth of information to local stakeholders and governments.
  - WFS-ID-4 Agricultural drought monitoring (near real-time): This indicator combines data on current climatic conditions with the current state of vegetation and local agricultural practices to estimate the impact of ongoing drought events on agricultural production. As such, it

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translates the meteorological drought indicator (WFS-ID-1) to a more tangible indicator directly relevant to stakeholders in the agricultural sector.

- WFS-ID-5 Agricultural drought forecast: Like WFS-ID-4, this indicator converts meteorological drought forecasts into a more meaningful indicator of estimated impact on agricultural productivity. Most drought early warning systems in place today mainly focus on the current situation, without looking too much ahead in the future. The proposed indicator WFS-ID-5 tries to fill this gap by providing information up to 6 months ahead in time.
- WFS-ID-6 Agricultural drought risk zones: Like WFS-ID-3, this indicator summarizes all information contained in WFS-ID-4 and WFS-ID-5 in an easily digestible format, making it an ideal means of communication towards local stakeholders and governments.

2.6 UPDATE OF THE PLAN FOR THE EXPLOITATION AND DISSEMINATION OF RESULTS

The exploitation plan aims to define the activities to be carried out to enhance the successful exploitation of the project results (KERs) and its placing on the market.

The intermediate Exploitation Plan delivered contained:

- Identification of the Key Exploitable Results from CENTAUR.
- An initial market analysis relevant for the exploitable results of CENTAUR, including market segmentation and market dynamics on the technology and products relevant for the work conducted in CENTAUR.
- An initial description of the user segmentation and next steps towards building a final Business Model and Business Plan.

The table below summarizes the main results identified:

Table 1: CENTAUR Key Exploitable Results

KER	Partner(s) Involved	Short Description
Forecast of Impact of Heavy Precipitation Events in Urban Areas	ECMWF	Pre-warning system that raises alarms for unusually high and impactful precipitation in urban areas. Maps that show the intensity and extension of expected precipitation events up to three days in advance are provided and indicate of the potential impact through an actionable risk/warning index. Real-time operation and fully automated alerting mechanism over large areas represent the fundamental assets for service positioning, where the prediction of impact-based forecasts is adopted to innovate the already existing CEMS.
Drought Early Warning System	VITO	Within the Water & Food Insecurity domain the key exploitable result will be an early warning system for major meteorological and agricultural drought events. This early warning system will be established based on a combination of indicators describing current vegetation and drought conditions on one hand and future meteorological conditions on the other hand. Current vegetation and drought conditions will be approximated by comparing near-real time observations of meteorological conditions and Normalized Difference

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		Vegetation Index (NDVI) with past time series, phenology, and environmental conditions. A combination of near-real time observations of NDVI, agroecological indicators, phenology, soil characteristics, soil moisture, and topography is used in step with meteorological forecasts on air temperature, precipitation, solar radiation, and evapotranspiration to make predictions of future (agricultural) drought conditions for the coming 10 days to 3 months.
Enhanced flood delineation and damage assessment in urban areas for real flood scenarios	e-GEOS	The products will provide an enhanced flood delineation and an enhanced flood damage assessment on the examined areas in fast times increasing the quality of products on the market by innovating existing CEMS portfolio products. The enhanced flood mask of the inundated area, generated combining a general flood mask from SAR techniques and an enhanced urban flooding mask using the FLORIA model, is used as input to generate the flood extent calculated by the GoFlood model, ensuring the creation of an exceptionally accurate flood map that covers all contexts within the AoI. The obtained flood map is then used as an input to analyze the post-event damage on buildings, structures, and linear infrastructure in the area affected by the event in relation to the depth of the flood, and a damage class and associated economic impact (€/m2) are assigned.

The preliminary target market analyzed in the document identified four different market segments summarized (Table 2).

Table 2: CENTAUR additional results vs Market Segments

Market Segment	CENTAUR Key Exploitable Results
Climate Services	Dual mode monitoring system (continuous): early warning forecast index, flood hazard index. Risk monitoring and Situation monitoring tool, Data viewer (dashboard): Drought-induced increase in food insecurity, Drought-induced increase in economic insecurity, Drought-related instability and violence, Drought-related displacement
Emergency Management and Humanitarian Aid	Dual mode monitoring system (continuous): early warning forecast index, flood hazard index. Risk monitoring and Situation monitoring tool, Data viewer (dashboard): Drought-induced increase in food insecurity, Drought-induced increase in economic insecurity, Drought-related instability and violence, Drought-related displacement
Environmental Monitoring	Dual mode monitoring system (continuous): early warning forecast index, flood hazard index. Risk monitoring and Situation monitoring tool, Data viewer (dashboard): Drought-induced increase in food insecurity,

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	Drought-induced increase in economic insecurity, Drought-related instability and violence, Drought-related displacement
Urban Development and Cultural Heritage	Dual mode monitoring system (continuous): early warning forecast index, flood impact assessment. Risk monitoring and Situation monitoring tool, Data viewer (dashboard): Drought-induced increase in food insecurity, Drought-induced increase in economic insecurity, Drought-related instability and violence, Drought-related displacement

Based on the market analysis, market segmentation and the identification of the target markets, a preliminary user segmentation was carried out and is summarized below (Table 3).

Table 3: Users' segmentation

User type	User needs
Policy makers	Assist in the creation of effective flood mitigation strategies, infrastructure planning, and response plans. Aid in the allocation of resources for disaster response and recovery. Inform policy decision related to water management and agricultural planning. The proposed information layers include: ➢ Urban flood modelling on various scenarios ➢ Maximum extent, depth and impact on urban infrastructure of past flood events ➢ Economic impact of past flood events
Risk managers	Forecasting, prevention, mitigation of urban flood events, handling events and event lessons learnt with the following information: ➢ Urban flood modelling on various scenarios. ➢ (Maximum) flood extent. ➢ Flood depth. ➢ Flood impact on urban infrastructure.
Civil protection services and NGOs	Dimension emergency teams and identify priority areas to assist population in emergency, with the following information: ➢ Daily (or more frequent if possible) flood extent mapping and monitoring. ➢ Rapid identification of flood affected buildings. ➢ Rapid identification of road block / accessibility + other communication network (airport). ➢ Rapid identification of areas potentially suitable for temporary shelters dedicated to affected population. ➢ Rapid identification of dike breaches. ➢ Rapid identification of areas of spontaneous gathering of population.
Insurance industry	Evaluate the cost of a flood event in the few days following the event. Accurately price policies and assess claims related to crop losses. The proposed information layers include: ➢ Rapid delineation of (maximum) flood extent particular in urban / peri-urban areas ➢ Rapid estimation of flood depth ➢ Rapid assessment of damage grade on flood affected buildings (and urban infrastructure in general) ➢ Rapid assessment of economic impact of the flood

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Communication and power network managers	Identify in emergency the areas with (potentially) affected network. Improve infrastructure development and maintenance planning to mitigate water shortages. The proposed information layers include: ➢ Daily flood extent mapping and monitoring. ➢ Rapid identification of communication network affected.
Agriculture sector	Assess flood risk for specific agricultural regions. Make informed decisions about crop selection, irrigation strategies, and disaster management planning in agriculture. Develop contingency plans for potential flood, climatic or meteorological events. The proposed information layers include: ➢ Maximum flood extent. ➢ Flood depth. ➢ Biophysical parameters (NDVI, LAI, FAPAR, FCOVER). ➢ Daily drought indicator, monitoring, forecasting. ➢ Daily moisture indicator, monitoring, forecasting. ➢ Daily precipitation, monitoring, forecasting ➢ Daily temperature, monitoring, forecasting.
Real estate and construction industry	Make informed decisions about site selection for a project. Avoid flood-prone areas, thus reducing future risks and liabilities. The proposed information layers include: ➢ Maximum flood extent ➢ Flood depth ➢ Impact of past events on infrastructures
Environmental and climate research institutions	Analyse the changing patterns of flood risks due to climate change and urbanization. Study the impacts of climate change on water availability and food production. Develop more resilient agricultural practices and improved water conservation measures. The proposed information layers include: ➢ All of the above, depending on the topic
Water and water basin managers	Identify means to diminish and manage flood peaks and flood waters

Table 4 shows the potential users that would be interested in adopting the KERs so far identified in their activities.

Table 4: Users identified for CENTAUR KERs

KERs	Users identified
FORECAST OF IMPACT OF HEAVY PRECIPITATION EVENTS IN URBAN AREAS	A variety of actors involved in managing security at a national local and global scale. Public authorities: ➢ from local, regional and national civil protection and governmental authorities to top global scale, civil security and defence institutions, ➢ water and water basin authorities, ➢ research institutions. Private sector: insurance industry, communication and power network managers, real estate and construction industry.
DROUGHT EARLY WARNING SYSTEM	➢ International organizations active in the field of food security (FAO, GEOGLAM, WFP, World Bank, …)

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	➢ Decision makers (politicians, technical staff of high rank) ➢ Local or Regional authorities (Department – district majors) ➢ Local farmers
ENHANCED FLOOD DELINEATION AND DAMAGE ASSESSMENT IN URBAN AREAS FOR REAL FLOOD SCENARIOS	A variety of actors involved in managing security at a national local and global scale. Public authorities: ➢ from local, regional and national civil protection and governmental authorities to top global scale, civil security and defence institutions, ➢ water and water basin authorities, ➢ research institutions. ➢ private sector: insurance industry, communication and power network managers, real estate and construction industry.

The inclusion of a fourth Key Exploitable Result (KER) is currently under evaluation, based on the work carried out by Cherrydata on the DCPI and DDPI indices. This assessment will be further supported by the expertise of HRB service specialists.

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3 FOLLOW-UP OF RECOMMENDATIONS AND COMMENTS FROM PREVIOUS REVIEW(S)

Table 5: Recommendation from Mid-Term review and actions taken

ID	Recommendation	Action
[ID1]	The consortium should define and implement a clear roadmap with all required technical and validation activities towards the timely integration of the developed services and outcomes with the CEMS and SESA Services. A closer (technical) collaboration with the CEMS and SESA service operators (e.g., JRC, etc) can further facilitate this and enhance the overall impact of the project.	The consortium remains committed to defining a clear roadmap for the technical and validation activities required to align CENTAUR's developments with Copernicus SESA and CEMS services. With some of the urban flood products, CENTAUR has responded to a call for testing innovative solutions for integration in CEMS and is awaiting response. Dedicated technical meetings to assess the maturity and automation levels of the production chains, clarify potential integration pathways, and identify any technical constraints or requirements, will be organized. While full deployment within SatCen infrastructure is not foreseen by the project, the lack of integration may limit the ability to fully evaluate the usability and impact of the developed services. Moreover, special attention is currently being given to this aspect, as tasks T5.1 and T5.2 began in M28. These tasks aim to conduct an analysis of interoperability and develop the roadmap for integrating EMS and SESA.
[ID2]	Also, please take the necessary action (incl. consultation with JRC) to ensure/increase the robustness and reliability of the foreseen Urban Flood Service, considering the limitations identified regarding the use of Speedy flow and of SAR imagery, which could impact on the reliability of UF-ID-4 - Inferred INSAR Urban Flood Extent, and of UF-ID-5 - Enhanced Urban Flood Damage Assessment.	In response to the identified limitations several actions are being taken to enhance the robustness and reliability of the Urban Flood Service. The Speedy Flood model has already been replaced with the improved GoFlood algorithm, which has been fully automated and optimized to produce a more reliable flood extension, especially for urban areas. For a competitive flood depth estimation, the service currently relies on the INFLOS algorithm, which has been authorized by SERTIT for use within the CENTAUR project. In addition, UF-ID-5 depends on UF-ID-4, which provides inferred flood extent derived from InSAR data. Validation during the Cold Phase revealed several commission errors in over half of the use cases, which may affect the accuracy of UF-ID-5. To address these concerns, future improvements to UF-ID-4 will include additional post-processing and a revised deep learning backend for better inference. Finally, it is worth noting that e-GEOS, as the lead for UF-ID-3 and UF-ID-5, announced during the Joint Milestone Meeting (DDR-CC & PDRE) that it will organize a meeting with the JRC in May. This session will not only present the improved Cold Case results - particularly advancements in flood extent and depth accuracy - but will also serve as an opportunity to gather updated feedback from the JRC to further guide ongoing improvements.

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[ID3]	Even if D4.3 convincingly defines the template that will be used for the testing and validation of the services, the integration and interpretation of the findings and feedback from end users during the foreseen workshop should be fully documented in D4.3. In view of this, it is recommended that a further review meeting be scheduled upon the submission of the updated D4.3. Although is appropriately foreseen to collect end user feedback through the use of questionnaires, experience suggests it can be challenging to collect a sufficient number of responses that are of good quality. It is recommended to anticipate this possibility, and to foresee using alternative routes to obtain end user feedback. One such route could be to use the questionnaire as a script to conduct one-to-one interviews, whereby the interview focuses on those aspects to which the interviewed person is interested in.	Engagement with AB members was ensured through the cold phase workshop organised in November 2024, as well as with one-on-one meetings with the relevant entities to collect feedback and fill in questionnaires. Except for 2 end-users for the German UF use case, all the other questionnaires have been filled and shared with the CENTAUR consortium. One-on-one meetings were notably organised between e-GEOS and Helpcode for Mozambique UC, between CLS and the CCR for French one and Adelphi and GFFO for the three WFS UCs. Additionally, Ithaca held an in-person meeting on 11.02.2025 with the Municipality of Turin regarding the Italian cold cases (Ceva and Turin). During this meeting, the project's technical developments, current status, feedback on UF Italian use cases from civil protection authorities, and potential service improvements were discussed. Their recommendations are documented in the User Feedback Form.
[ID4]	The exploitation of project outcomes should be further elaborated, and the business plan should be comprehensively conducted. Dissemination and communication activities should be conducted and achieved as initially was foreseen. The further deployment of the Booster Service in the coming months is positive, yet it is highly recommended that the market analysis for the newly added KER (KER 3 Enhanced flood delineation and damage assessment in urban areas for real flood scenarios) is carried out as a foremost priority.	The HRB Booster service activation request was submitted on 13/01 and approved on 15/01. An introductory call on 24/01 led to the completion of the HRB Readiness Assessment Tool, discussed in the 10/02 meeting, resulting in the activation of the following services: **Module A (Kick-off):** March 2025; **Module B (Unique Value Proposition & Key Exploitable Result(s)):** April–May 2025; **Module C (Exploitation Strategy):** May 2025; **Module D (Business Plan):** June 2025; **Module E (Access to other funding & entrepreneurship support):** July 2025. As part of this service, a more in-depth market analysis, already initiated by the team, will also be carried out for KER3.
[ID5]	It is also highly recommended that the appropriately stepped-up efforts in respect of dissemination are maintained throughout the remainder of the project duration. e-Newsletters are recommended to be made available also for download through the project website.	Regarding newsletters-type of dissemination activity, the team has stepped-up its effort publishing a total of 10 e-Newsletters and ensured that all editions have been made available for download on the project website to maximise accessibility and engagement with our stakeholders. In addition as of January 2025 a LinkedIn newsletter to reach also the general audience has been made available. This aligns well with our ongoing efforts to increase the project's visibility and provide key project updates.
[ID6]	Finally, it is recommended that every effort is made to maintain the KPI in respect of publications at seven (7), including e.g. through one or more publications on the EC Research platform.	The consortium fully recognises the importance of fostering and increasing dissemination efforts throughout the remainder of the project and is committed to ensuring that CENTAUR's results reach the widest possible audience. As of April 2025, 3 publications have already taken place, and more are under preparation also leveraging EC dissemination opportunities.

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4 DEVIATIONS FROM ANNEX 1 AND ANNEX 2

4.1 WORK PACKAGES, TASKS AND TIME

4.1.1 WP1 – ANALYSIS OF REQUIREMENTS AND USE CASES DEFINITION

Since WP1 ended at M12, no deviations are reported for this period.

4.1.2 WP2 – THEMATIC PRODUCT ENGINEERING

- The focus of agricultural indicator development: according to the original proposal quite some effort would be devoted towards enhancing the spatial resolution of existing indicators. While this is still the case for the meteorological indicators produced by ECMWF, for the agricultural indicators we shifted the focus towards the temporal domain (forecasting) rather than the spatial domain. We found this to be more relevant given the current state of the art and given the objectives of the project overall and the crisis indexes.
- Based on a careful analysis of both the end user requirements and the state-of-the-art in drought monitoring in WP1, we have further refined the technical objectives related to the Water & Food Insecurity domain to be pursued in WP2 (innovative indicator development). According to the original proposal quite some effort would be devoted towards enhancing the spatial resolution of existing indicators. While this is still the case for the meteorological drought indicators to be produced by ECMWF, for the agricultural drought indicators we shifted the focus towards the temporal domain (forecasting) rather than the spatial domain. We are convinced that by focusing on forecasting of agricultural droughts, we will be better able to serve the goals of the project overall and the identified composite crisis indexes defined in Task 1.3. Agricultural droughts typically occur over larger areas, thereby justifying the use of lower resolution data (1 km). Producing low spatial resolution indicators also drastically improves the practical feasibility of upscaling the developed indicators to country and continental scales. By focusing instead on forecasting in the temporal domain we hope to contribute to increasing preparedness and resilience of communities to drought events. In terms of water insecurity, after careful discussion with all partners involved, the decision has been made to focus on run-off indicators as input to determine water insecurity rather than surface water availability.

  In conclusion, the specific technical objectives related to the Water & Food Insecurity domain have been more clearly defined. Based on these objectives, the innovative indicators to be produced in WP2 have been identified and technical developments are on track to support these objectives.
- From the Urban Flood perspective, there have been no deviations from the Declaration of Assurance (DoA). The development of indicators followed by the subsequent creation of indices has been in strict adherence to the predetermined project requirements outlined by CENTAUR. The development process, from the initial formulation of indicators to the eventual creation of indices, has consistently aligned with the project's outlined specifications and objectives. All stages have been meticulously planned and executed to fulfil the anticipated goals within the CENTAUR project framework. This adherence to the predefined project guidelines and objectives signifies the commitment to maintaining the project's integrity and ensuring that the deliverables align with the expected outcomes specified in the Declaration of Assurance. There have been no observed deviations or discrepancies from the established project guidelines, reflecting a comprehensive and focused approach toward achieving the project's goals.
- Development of socio-economic indicators in Task 2.4 have required the participation of working group leaders in charge of the different Urban Flood scenarios. In particular, TRA, CLS, ITH, and UNI have been involved in the creation of UF-ID-9/10/13, even though their participation in Task 2.4 was not foreseen in the Annex to the Grant Agreement. Their participation and expertise were nevertheless necessary to

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ensure access to relevant datasets and the quality of produced indicators.

- Moreover, the recent cessation shutdown of the FEWSNET Data warehouse and API (supported by USAID) makes it necessary to search for an alternative data source of comparable quality (carefully curated data, API access, coverage of CENTAUR AOI, regular updates). This will very likely lead to delays and a minor increase in costs for WP2 for ADE, which will be covered partly by reallocating budget from other WPs and partly by reallocating budget from ADE's unused budget for travel and for "other goods and services".

No delays were produced in the submission deliverables related to WP2.

4.1.3 WP3 – SERVICE DEPLOYMENT

Implementation started in September with the integration of several processors. The technical requirements of the production environment have not been defined and a delay in the deployment schedule might be produced.

Requirements placed on every consortium member to host a local node for the seamless functioning of the CENTAUR services have made it necessary for ADE to participate in WP3 (originally not foreseen in the Grant Agreement). Participation includes hosting a server on ADE premises, as well as coordinating with other partners in WP3 to ensure that data pipelines are aligned and connected. Personnel costs for ADE in WP3 (expected to remain reasonably low) will be covered partly by reallocating budget from other WPs and partly by reallocating budget from ADE's unused budget for travel and for "other goods and services".

No delays were produced in the submission deliverables related to WP3.

4.1.4 WP4 – CLIMATE CHANGE CRISIS AND NATURAL DISASTER DEMONSTRATION

The cold phase activities related to WP2-WP3 experienced some delays, which also affected the iterations required with WP4. Consequently, the submission of deliverable D4.3 for WP4 was delayed. The cold phase was initially planned to be closed at month 21 and has finally been closed at month 27. As a result, D4.3 CENTAUR demonstration operational report and validation result - cold cases was submitted at month 27 for the second document version, and D4.4 - CENTAUR demonstration operational report and validation result v1 - hot cases (intermediate) is submitted on time at month 27. However, this version provided updates on the hot phase scenarios, alerts, notifications, and the revised implementation plan, which incorporated lessons learned during the cold phase, as no relevant live events have occurred so far in AOIs

As the cold phase activities required to be performed, both in number and time, have been more intensive and time consuming than initially planned, more resources have been consumed, over the additional 6 extra months of the cold phase. That should compensate with the resources required during the hot phase.

The hot phase has been compressed and covers month 25 – 31, with the implementation on WP2-WP3 starting on month 28 (March), with WP4 planned to start around month 29 (April) 2025. To address the absence of live crisis events, additional efforts were planned to coordinate a "cold-hot" phase. This strategy was not initially planned as part of CENTAUR but was developed proactively by the consortium to ensure the success of the project. Indeed, cold-hot cases include use cases in CENTAUR's countries of interest, focusing on areas of interest other than the ones initially selected. Notably, this allows being able to leverage parts of the available static input data collected during the cold phase. As of April 2025, one cold-hot case has been successfully executed in Valencia, Spain, following the largest flooding event in a European country, in 2024. Additional cold-hot cases are already being discussed, with tentative areas of interest in Italy and Mozambique, based on events in late 2024 and early 2025. However, cold-hot cases were specifically designed for Urban Floods, as this track depends on discrete events. Water & Food Security maintains the original strategy, benefiting from a longer timeframe due to a more pronounced inertia in the underlying processes that control the proposed indicators and indexes.

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4.1.5 WP5 – ANALYSIS OF THE INTEGRATION IN THE OPERATIONAL SETUP OF COPERNICUS EMS AND SEA, IMPACT AND FURTHER EXPLOITATION

No delays in deliverables submission were produced in WP5.

4.1.6 WP6 – COMMUNICATION, DISSEMINATION AND OUTREACH

No delays in deliverables submission were produced in WP6.

4.1.7 WP7 – PROJECT MANAGEMENT

The workshop, initially scheduled for June 2024, was postponed several times—first to September, and ultimately to November 2024. This decision was made after careful consideration of overlapping commitments, particularly the Interim Review on June 26 and the anticipated lower participation from Advisory Board members during the summer.

Looking back, we concluded that rescheduling the workshop to November ultimately provided a much more valuable experience for the Advisory Committee members. The additional time allowed us to better prepare for key activities, ensuring a more productive and engaging event.

The factors contributing to the extended preparation time and postponement of the workshop include:

- Expansion of Indicator catalogue: the team has expanded the catalogue of available indicators to provide a more comprehensive support for Advisory Committee members, trying to meet as much as possible the end users' needs collected during the first phase of the project.

- Regeneration of Products: the consortium has been actively refining certain products based on valuable feedback received during the validation process in order to ensure that the materials presented are of the highest quality and meet end users' expectations.

- Enhanced User Experience: the team has focused on developing a more user-friendly platform and an informative landing page, to significantly improve accessibility for end users and enhance their overall experience.

- Technical Challenges: the consortium has encountered unforeseen technical challenges during the integration of new tools to optimize products visualization into the platform, which required additional time to resolve and test thoroughly.

- Development of Automatic Loading System: given the volume of products and in preparation for the next phase involving hot cases, the team has been implementing an automatic loading system. This system will streamline the process, ensuring efficiency and accuracy as we move forward.

- Tailored products visualization: the team is in the process of ingesting over 1,000 heterogeneous products into our production platform. This integration requires careful attention to detail, as each product has unique visualization requirements that necessitate the development of tailored solutions.

- Thorough Demo Execution: to ensure that all indicators are accurately visualized, the consortium needed to conduct a thorough demonstration execution. This step was crucial in verifying that the final outputs meet quality standards and effectively communicate the intended information.

In November 2024, CENTAUR hosted its first workshops (one for the general public and one for the Advisory Board members), bringing at the one open to the public nearly 100 participants, including experts, policymakers, and

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stakeholders. The event featured engaging discussions on urban flooding, food and water security, and the role of CENTAUR in advancing the product portfolios of Copernicus Emergency Management and Security Services. This workshop significantly boosted engagement, leading to the gain of over 70 new newsletter subscribers and almost 110 additional followers on LinkedIn.

On the following day, the workshop dedicated only to AB members was also held to show the indicators/indices developed during the cold cases through the CENTAUR platform developed. It provided an opportunity for the team to engage directly with the end-users, gaining valuable insights into how the platform and its datasets could be utilized in real-world scenarios. With the exception of 2 end-users, all the others have provided feedback on the workshop and available datasets, with positive feedback overall, indicating that they found the workshop informative and beneficial for understanding the project's outputs. This feedback will be crucial for refining the work done by the team.

As a result of this delay, the DDR - CC Demo Review Cold Cases milestone, originally scheduled for M21, was postponed due to the extended collection of workshop feedback, which was completed at M27. However, the consortium turned this delay into an opportunity by combining the aforementioned milestone with the PDRE - Preliminary Demo Results Evaluation, held on 11/04/2025. This strategic adjustment not only allowed for the official closure of the cold cases but also provided the opportunity to showcase new platform features for the hot cases, along with presenting the results from the first cold-hot case in Valencia. By aligning these milestones, we were able to maximize the value of both events and ensure a more comprehensive and impactful demonstration

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4.2 USE OF RESOURCES

4.2.1 Gender balance

The specific topic referred to in CENTAUR's proposal is not listed as topic with a gender dimension in the H2020 participants portal. Nevertheless, for all aspects of internal organization, CENTAUR is fostering gender balance in the research team, as well as ensuring women are properly represented in the decision-making process.

The overall gender balance among the Consortium declared for the reporting period is a little bite less than in the previous reported period, but still an improvement in comparison with the current workforce market in the sector.

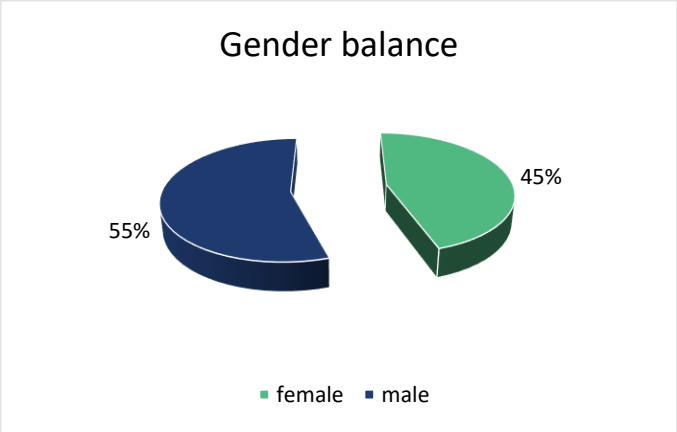

Figure 7: Gender Balance of Consortium Members by Percentage

4.2.2 Effort / budget consumption

Figure 8 reports the actual - for the reporting period (M19-M29) and planned (for the whole project) use of resources per each Work Package in terms of person/month (p/m):

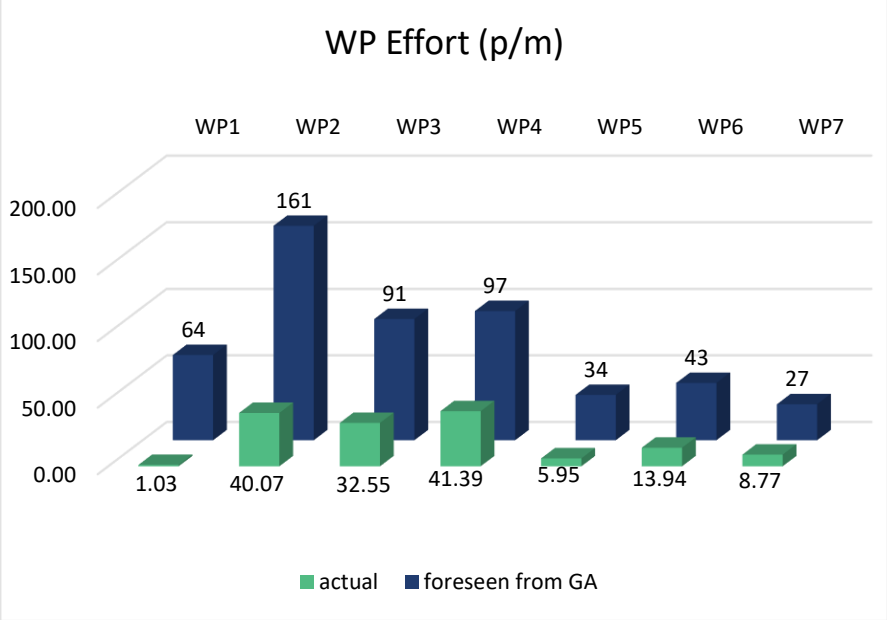

Figure 8: Use of resources (persons/month) during the reporting period (M19-M29)

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Figure 9 reports the actual (from M1 to M29) and planned (for the whole project) use of resources per each Work Package in terms of person/month (p/m):

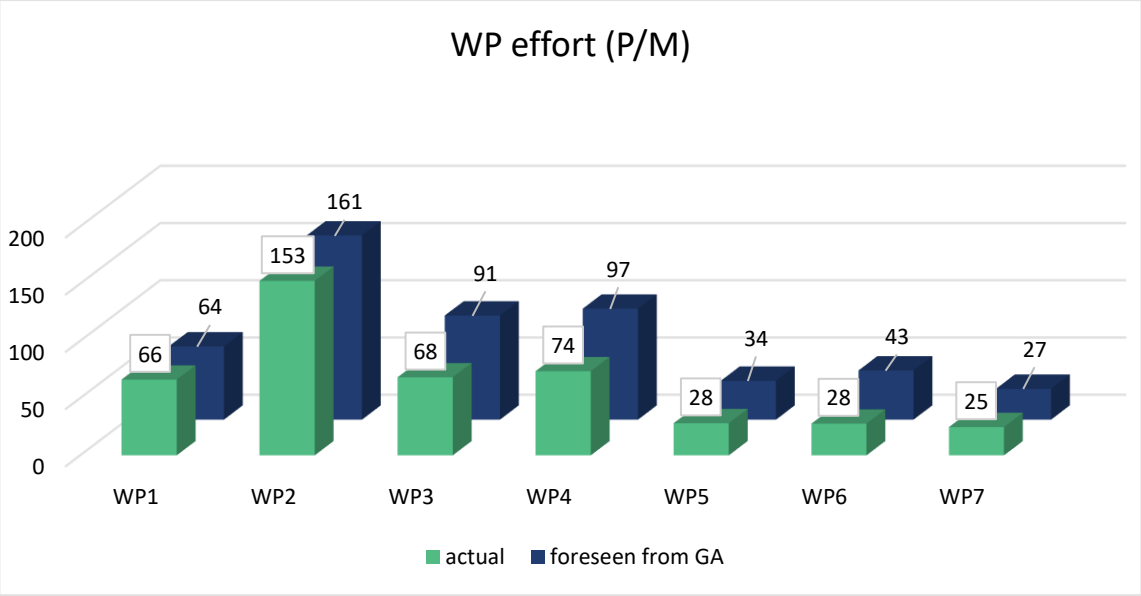

Figure 9: Use of the resources (persons/month) from M1 to M29

The effort spent on the various WPs corresponds to our tasks as per the GA and is in line with foreseen values. Only WP1 (closed) shows a little bit more effort than planned.

The effort (i.e. person months) for each partner has been also reported in Figure 10 during the reporting period (M19-M29).

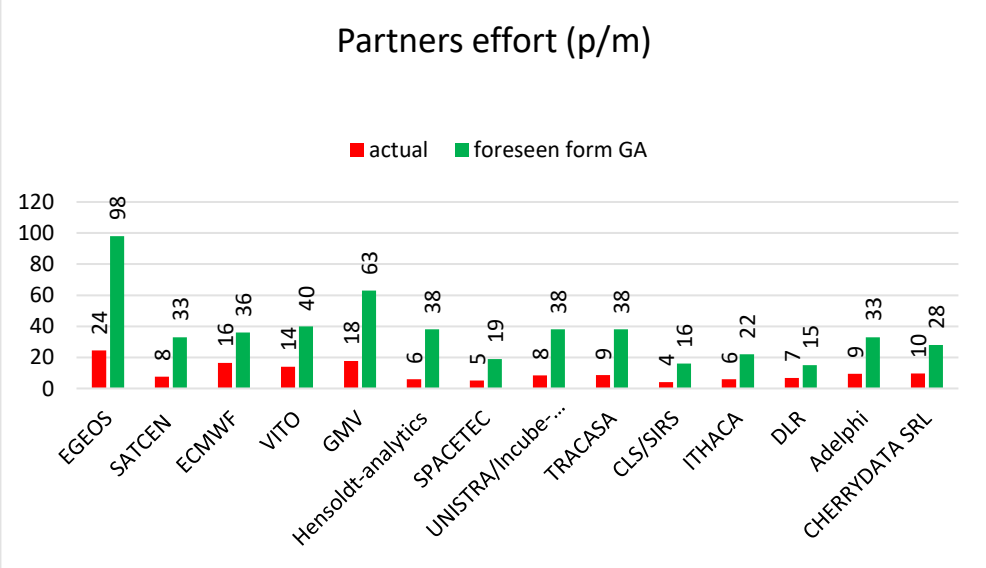

Figure 10: Use of resources (persons/month) per partner during the reporting period (M19-M29)

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And the following figure reports the effort (i.e. person months) for each partner from the beginning of the project up to now (M1-M29):

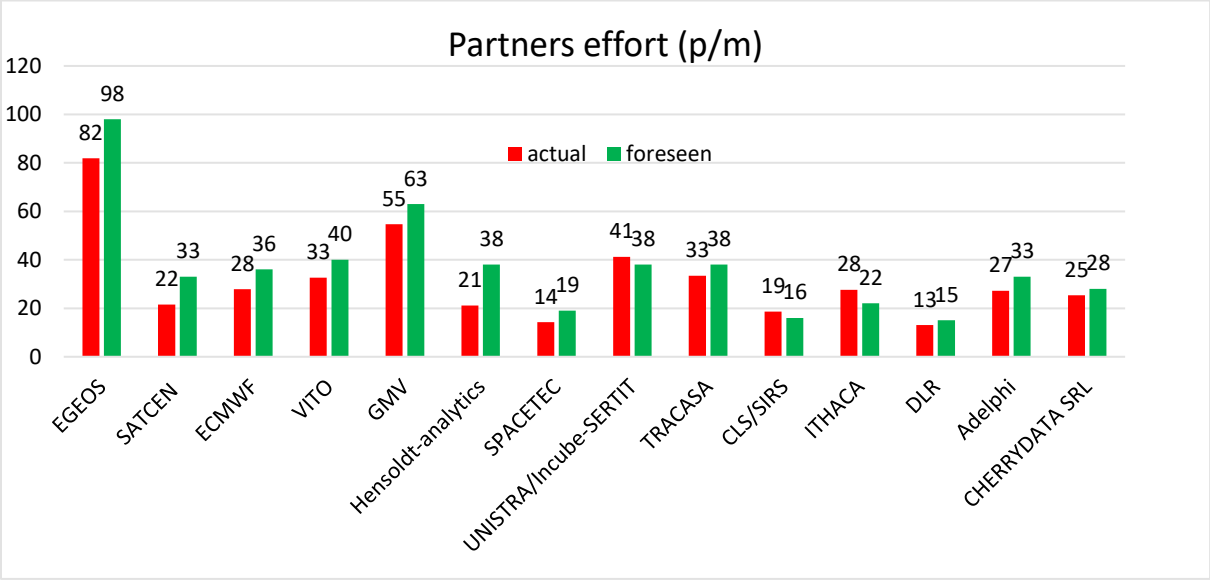

Figure 11: Use of resources (persons/month) per partner from M1 to M29

In light of the above graph, significant deviations in SERTIT, CLS, and Ithaca person/month consumption and their reasons are reported:

SERTIT: has been involved in unplanned activities, including Socioeconomic Indicators, UF-ID-5 Support, INFLOS Integration, and Hot Cases. Despite these additional tasks, SERTIT anticipates completing its contributions within the originally allocated budget.

CLS: The resources dedicated to WP4 are slightly higher than those described in the grant agreement, due to the increased validation effort required to cover all indicators and hot cases. Overall budget consumption is in line with the grant agreement.

ITHACA: The higher person/month effort is due to the use of more junior resources than initially planned, resulting in more effort being required to achieve the same outcomes at the same cost

These deviations will lead to larger-than-planned efforts, as more man-hours were used than initially allocated.

To accommodate this increased effort, some partners are considering reallocating budget from other categories-such as "Travel" and "Other Goods, works and services" - to support additional personnel costs. Notably, the travel budget has remained unused, as most project meetings have been conducted virtually. However, tis shift has not impacted project execution, with regular meetings still held with Advisory Board members and end users (refer to D7.13 for more details).

While these adjustments may lead to a revised distribution across budget categories, the overall project spending is expected to remain in full alignment with the total budget defined in the Grant Agreement.

The following figure presents the actual budget consumption for months M19-M29 and the planned budget consumption for the entire project, expressed in monetary terms.

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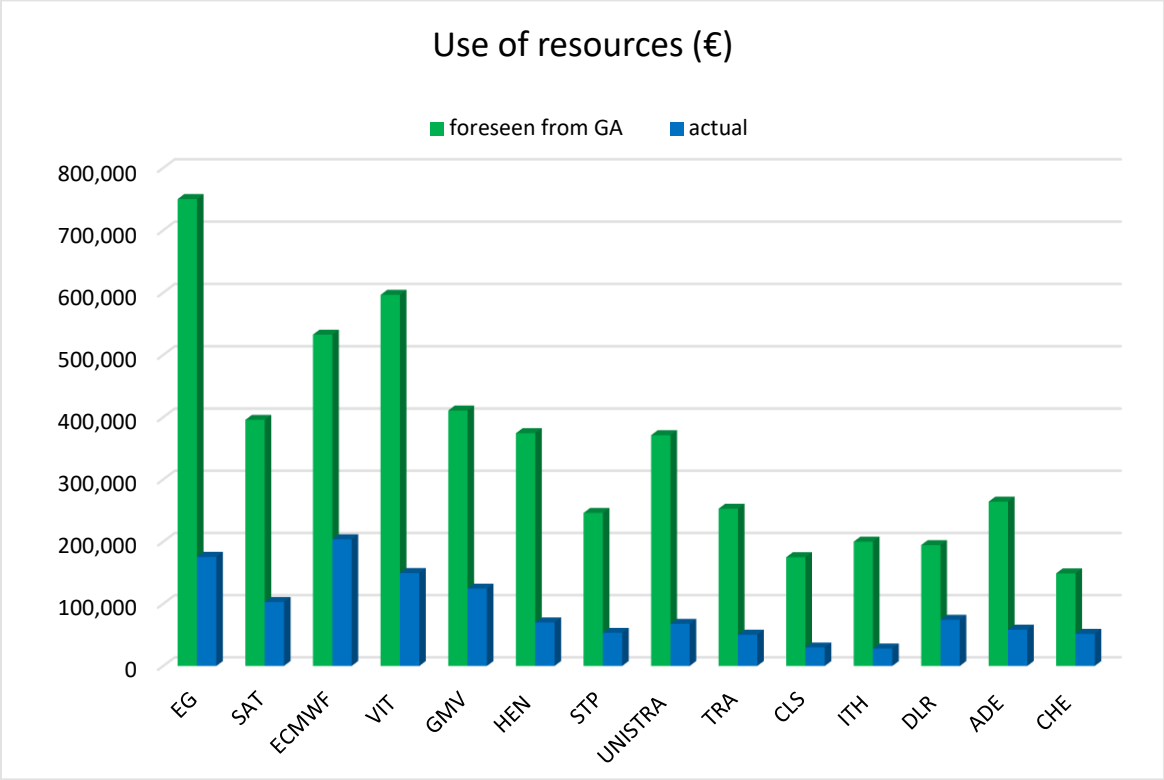

Figure 12: Use of resources during the reporting period (M19-M29) for each partner

The next figure shows the same data, but from the start of the project, along with a separate figure detailing the budget distribution.

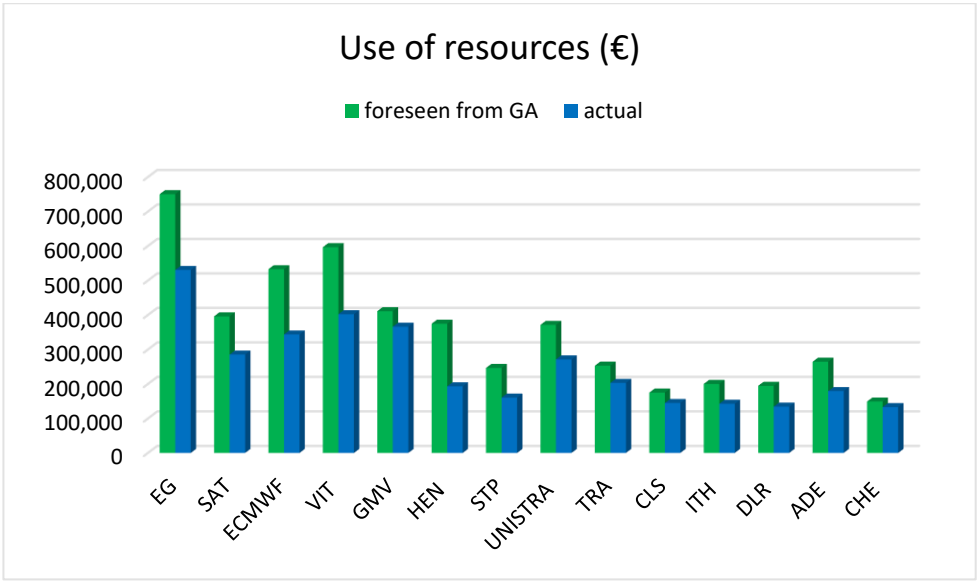

Figure 13: Use of resources from M1 to M29 for each partner

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While person-month consumption is largely in line with or exceeds the original plan (Figure 11), actual financial consumption (Figure 13) appears lower at this stage for some of the consortium members. This discrepancy is primarily due to the use of more cost-effective resources (e.g., junior staff), as well as an underuse of non-personnel categories such as travel and external services.

It is important to emphasize that this does not indicate underspending due to inactivity or delays. Rather, it reflects the consortium's efficient resource utilization and its ability to adapt to evolving work condition - most notably, the transition to virtual meetings, which has significantly reduced travel-related expenses.

Looking ahead, substantial spending is anticipated in the final phase of the project, particularly for the implementation of Hot Cases, dissemination activities, and integration within the EMS and SESA domains. Accordingly, we expect the project to fully execute its allocated budget by completion. The consortium continues to closely monitor both effort and financial consumption to ensure alignment with the Grant Agreement and to proactively address any emerging deviations.

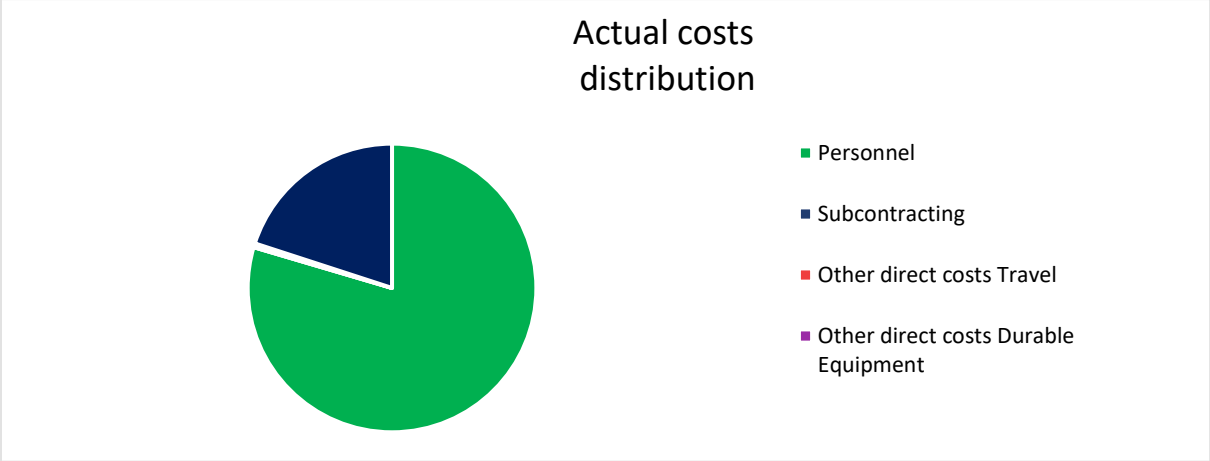

Figure 14: Allocation of costs among categories

Main effort has been spent for personnel (except for the KOM there have been no travels).

At the end of the reported period, no contingency plan is required because all partners are going to complete their work with assigned budget, as reported in Figure 15.

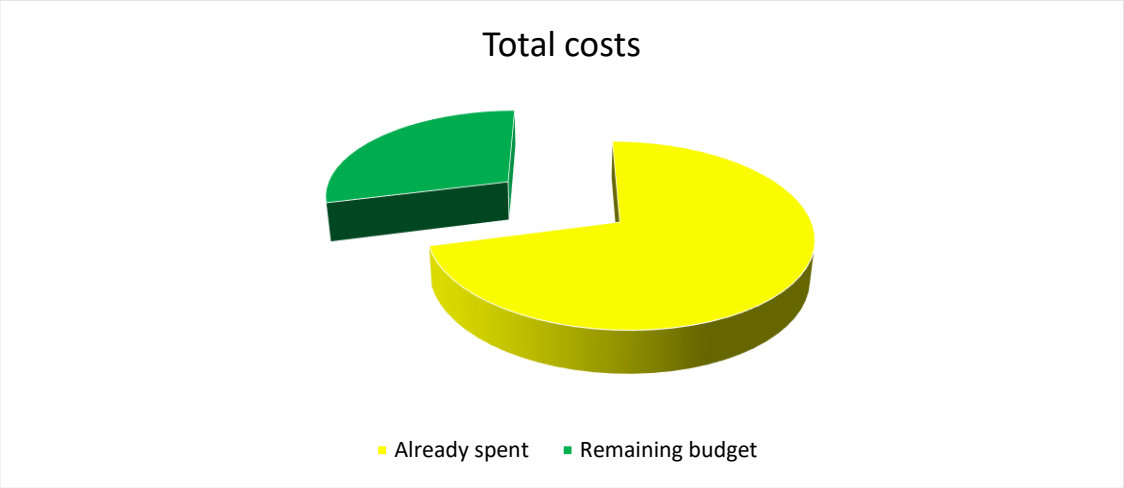

Figure 15: Comparison between used and remaining budget

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4.2.3 Unforeseen subcontracting

Not applicable.

4.2.4 Unforeseen use of in-kind contribution from third party against payment or free of charges

Not applicable.

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5 CONCLUSIONS

The activities in the project are progressing smoothly, with consistent alignment to the established timeline. Although the cold cases phase required more time and effort than initially anticipated, the consortium proactively addressed these challenges by implementing effective countermeasures, ensuring the overall goals remained achievable. To mitigate potential delays or complications in the hot cases phase, the consortium decided to adopt a "cold-hot" strategy, allowing for testing of indicators against more recent (2024) CEMS situations, thus ensuring preparedness in the event of major occurrences during the hot cases phase.

The CENTAUR team remains fully committed to reaching the final objectives, maintaining a strong focus on meeting end-user requirements, which continue to serve as the cornerstone for both the design and implementation of all project activities. Engaging end-users throughout the project not only helps validate progress but also provides invaluable insights into refining the system, ensuring its relevance and effectiveness in real-world applications. This collaboration will be crucial as the project moves into the upcoming demonstration phase and beyond, guiding future developments and ensuring the project delivers lasting value to its stakeholders.

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