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Germ of Life



Interreg Euro-MED Project GERM OF LIFE

“Digital Drought Risk Management enabling the drought mitigation and adaptation strategies for the restoration of the ecosystem equilibrium in Mediterranean European Countries”.

**Test Project (Thematic Project)
Mission: NATURAL HERITAGE**

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1 Executive Summary

The Germ of Life project has had ambitious global objectives as an applied project. We began with a worrying situation across much of Europe, namely the drought phenomenon, which has had a particularly severe impact throughout the Mediterranean basin. To address this problem, within the Germ of Life project, we formed a significant consortium of experts in the field, both scientifically and technologically. The case was made before Europe for the creation of a global technological system capable of mitigating the effects of drought, through technological solutions that incorporated all the scientific knowledge of the Germ of Life project partners.

Since the beginning of the Germ of Life project, in early 2024, all project partners have carried out intense collaborative co-creation work, uniting and merging all knowledge to be able to correctly design the three platforms that make up the project's global solution (drought risk detection platform, vulnerability platform, and bidding platform), which must be smoothly and coherently integrated with each other to offer potential users a comprehensive and effective solution to mitigate the effects of drought. Contacts between all project partners have been constant and continuous in order to be able to create a comprehensive design based on an initial project concept, which had to be translated into a real solution applicable to real-life drought situations throughout Europe.

As planned for the Germ of Life project, all this knowledge sharing and design parameters must be captured in an internal deliverable, which serves as the fundamental basis for the correct implementation of each and every one of the platforms that comprise the global system and that must be properly integrated with each other. This deliverable captures many hours of work from all Germ of Life project partners and is a testament to the success of the collaborative work of all partners. It also clearly demonstrates that the combination of scientific and technical knowledge, perfectly balanced and participatory, can give rise to systems that truly respond to a reality existing in all our territories. This document serves as a fundamental support throughout the project's execution and can be consulted by all project partners should they have any questions or conceptual needs.

1.1 Role of deliverable

This deliverable serves as a design document for the GERM OF LIFE software system platform and especially for bridging machine learning based tools to derive as well as forecast drought indices and associate them with VAT system and in turn link to the IPP subsystem for actions to be taken in the pilot areas.



A fundamental objective in any technological design is to transform a complex real-world problem into a technological system that is as simple as possible for the technology's users. In this project, we are combining technologies of an interesting degree of complexity. We are working with Artificial Intelligence, which supplies data to a vulnerability platform, which ultimately provides information to a bidding platform, where the public service provider receives recommendations for the best technology to solve its drought problem. We must not forget that we are capturing real-time information from field sensors and satellite data. Thanks to a proper balance of scientific and technical knowledge, we are able to create a system that can be used in real-life situations.

D.1.3.1 is an internal and can be described as the bible of what platforms and systems will be designed and in turn developed and commissioned in GERM OF LIFE and be used by the pilot users.

1.2 Relationship to other GERM OF LIFE deliverables

D.1.3.1 is directly linked with work in other deliverables and more specifically with the following ones:

- D.1.1.1 Drought indices review
- D.1.1.2 Description of algorithms
- D.1.4.1 Drought Risk Monitoring and Prediction service
- D.1.5.1 Vulnerability Assessment Tool
- D.1.6.1 Innovation Procurement Platform

The relationship and interwork is very important and provides a smooth and concise view of what is to be developed in GERM OF LIFE as an integrated software platform.

This deliverable 1.3.1 is the core that supports all other deliverables with a technical profile. The entire consortium participated in its creation and integrated knowledge that supports the creation of the remaining deliverables, placing special emphasis on the three documents that will serve as the basis for the three platforms that make up the global drought mitigation system.

1.3 Structure of the document

This document is organized coherently, establishing the fundamental concepts that apply to the development of the systems, such as the rationale and types of droughts that exist, and discussing the specific characteristics of each of the pilots comprising this project. It begins with an analysis of parameters of interest for determining the drought process. The entire innovation process is analyzed, starting with the data required for monitoring how drought impacts ecosystems, and the justification for the need for a



vulnerability and advisory platform. All this will provide public managers with a simple and intuitive system, consisting of a prediction platform, a vulnerability platform, and finally a bidding platform. To achieve this entire design process, the entire co-design process used to establish collaboration among all partners is detailed, with the decisive participation of the four pilots that are part of the project.

Once the general concepts have been established, a detailed study of the parameters to be monitored is conducted, properly justifying the decision regarding each one. This process is key since it is the technical core of the overall system and the basis for predicting the risk platform. The vulnerability platform is then analyzed, including both the monitoring parameters and the indicators linked to each of the pilots. It is important to highlight the calculation of the key parameter in this platform, VAI (Vulnerability Assessment Index), since it has involved numerous contacts and extensive knowledge sharing. A list of vulnerability platform mockups is shown. Finally, a detailed analysis of the bidding platform is conducted, including a list of mockups.



2 Preliminary Study Insights (A1.1)

2.1 Territorial Characteristics

The Mediterranean region is increasingly recognized as one of Europe's most climate-vulnerable zones due to its distinct geographical and climatic features. Its susceptibility to drought is amplified by warming trends exceeding global averages, coupled with declining precipitation rates. These climatic shifts have profound implications for ecosystems, agriculture, and water resource management across the region. The Germ of Life project's pilot areas, located in Greece, Italy, Portugal, and Spain, serve as focal points for studying these impacts and developing tailored mitigation strategies.

In Greece, the selected pilot site is situated in Western Greece, a semi-mountainous region with a long-standing tradition of viticulture. Declining precipitation has already been recorded across all climatic zones. The impacts are particularly severe in the high-altitude vineyards, where water shortages exacerbate the challenges of sustainable agriculture. Farmers report significant reductions in grape harvests, with some experiencing a 50% decrease in yields in recent years due to persistent drought conditions.

Italy's pilot site lies in the Piedmontese portion of the Po River basin. This region has experienced a notable 9% reduction in annual precipitation and a 1.3 K rise in average annual temperature compared to historical norms. These shifts have led to widespread water scarcity and changes in native vegetation. Drought phenomena in the area are analyzed using advanced classification indices, providing insights into the severity, duration, and spatial extent of drought episodes. Local reforestation initiatives aim to introduce more drought-resilient species to counteract ecosystem degradation.

In Portugal, the pilot area is monitored by the EDIA weather station, which provides valuable data on temperature and precipitation trends. Over the past four years, the region has endured worsening drought conditions, threatening its biodiversity. Temporary ponds, crucial for local flora and fauna, have experienced significant water shortages. This has allowed invasive species to outcompete native vegetation, altering the ecological balance.

Spain's pilot site in Andalusia faces similar challenges. Recent climate data indicate a 0.4 K increase in annual average temperatures over the 30-year period from 1991 to 2020, coupled with an 11% decline in precipitation. These changes have resulted in shorter but more frequent drought cycles, as measured by the Standardized Precipitation Drought



Index. Such patterns not only strain water resources but also disrupt traditional agricultural practices.

Table 1: Key Climatic and Ecological Characteristics of Pilot Areas

Pilot Area	Key Climatic Trends	Ecological Features	Key Challenges
Greece	Decline in precipitation, warming	Semi-mountainous vineyards	Reduced grape yields, irrigation needs
Italy	Reduced precipitation (9%); +1.3 degrees Celsius	Piedmontese Po River basin	Water scarcity, vegetation stress
Portugal	Increased drought conditions	Temporary ponds	Biodiversity loss, invasive species
Spain	+0.4 degrees Celsius over 30 years; -11% precipitation	Andalusian agricultural lands	Frequent short drought cycles

2.2 Drought Type and Management Experiences

2.2.1 Drought types and their impact

Drought is one of the least understood natural phenomena induced by hydrological imbalances and precipitation deficiencies. Droughts have drastic impacts on human health, agriculture, the economy and water resources. In recent decades, the frequency of occurrence and intensity of droughts have increased, while the ever-growing demand for water resources and the compound uncertainty of hydroclimatic factors have exacerbated the potential impacts of droughts on agro-ecosystems. More



frequent heatwaves and climate extremes are expected to further worsen droughts and their influences in many regions worldwide¹.

Water availability is a critical factor limiting ecosystem growth and productivity across much of the Earth's surface. In arid, semi-arid and Mediterranean ecosystems, limited water availability is a recurrent phenomenon that governs plant growth and phenology². Agriculture is one of the sectors most directly affected by the increased frequency of droughts. Adaptations must be made to address these events, which are likely to become more extreme in both intensity and duration under climate change. As one of society's most pressing concerns, this challenge to the food supply has stimulated keen interest in the solutions that research can provide.

Recent studies have improved understanding of droughts and – based on the recognition that drought is more than just a lack of rainfall – led to many different definitions of droughts.

The following types of droughts³ are commonly identified:

- **Meteorological drought:** occurs when there is a lack of precipitation (rain or snow);
- **Agricultural drought:** occurs when soil moisture is insufficient to support plants;
- **Hydrological drought:** occurs when river flows and groundwater levels are unusually low.

Droughts are among the most complex natural hazards to analyse and understand due to their wide-ranging and cascading impacts (Fig. 1) that may be caused or intensified by various drought aspects or external factors, such as precipitation deficits (or the absence of extreme rainfall events), actual and potential evapotranspiration and its driving variables, soil moisture deficits and groundwater depletion.

Meteorological drought triggered by a prolonged lack of rainfall, often leads to other types of drought. The absence of precipitation combined with rising temperatures and

¹ Fu, Z. et al., 2020. Sensitivity of gross primary productivity to climatic drivers during the summer drought of 2018 in Europe. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 375(1810): 20190747.

² Reichstein, M. et al., 2005. On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm. *Global Change Biology*, 11(9): 1424-1439.

³ Kiem, A. S., Johnson, F., Westra, S., van Dijk, A., Evans, J. P., O'Donnell, A., ... & Mehrotra, R. (2016). Natural hazards in Australia: droughts. *Climatic Change*, 139, 37-54.



the consequent increase in evapotranspiration, results in hydrological drought characterised by watershed depletion and agricultural drought, marked by soil moisture loss, which leads to reduced agricultural productivity. Furthermore, agricultural and hydrological droughts contribute to unpredictable socioeconomic losses and ecosystem degradation, referred to as socio-economic drought.

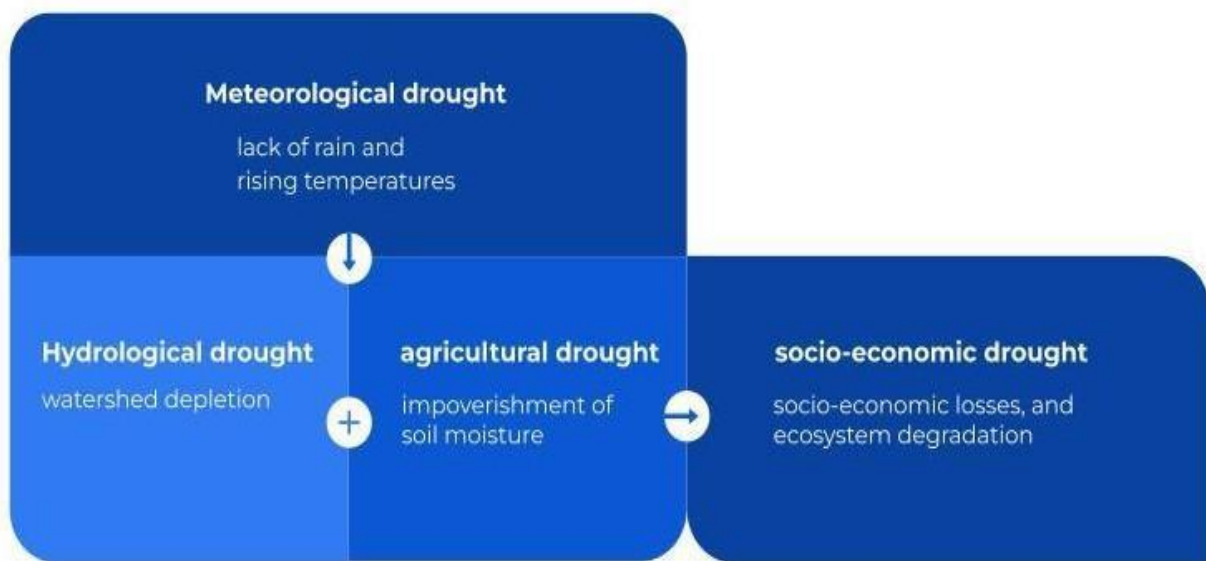


Figure 1. Drought types and their correlation (Germ of Life -Deliverable D1.1.1)

In the Germ of Life project we investigate ‘droughts’ in the context of their impact on vegetation growth and productivity in relation to meteorological conditions and soil water availability. This focus aligns more closely to the definition of ‘**agro-meteorological droughts**’ which considers both the impact of rainfall deficiency and low soil water availability on vegetation status and productivity.

2.2.2 Drought Management

Drought management in the Mediterranean region combines traditional practices, technological innovations, and policy interventions. The Germ of Life project leverages these experiences to inform its strategies for drought mitigation and adaptation.

Table 2: Drought Management Strategies and Applications



Strategy	Description	Example Application
Monitoring Systems	Use of SPI, SMDI, and other indices	SPI in Spain, synthetic indices in Italy
Early-Warning Systems	Real-time alerts using predictive models	Sub-seasonal drought projections
Policy Frameworks	Regional policies for water management	Reforestation projects in Italy
Technological Advancements	Satellite data, machine learning algorithms	NDVI and MSI indices

A cornerstone of effective drought management is robust monitoring systems. Advanced tools such as the Standardized Precipitation Index (SPI) and the Soil Moisture Deficit Index (SMDI) are used to track drought conditions across the pilot sites. In Spain, the SPI has been integrated with regional meteorological data to predict water shortages and guide agricultural planning. Similarly, Italy employs synthetic indices to analyse drought severity, providing a comprehensive view of water availability and ecosystem stress.

Early-warning systems play a pivotal role in proactive drought management. These systems rely on real-time data and predictive models to alert stakeholders about impending drought conditions. For instance, predictive models tailored to the specific needs of each pilot site project drought vulnerability on a sub-seasonal scale, enabling timely interventions.

Policy frameworks also support drought management efforts. National and regional policies emphasize efficient water resource utilisation and ecosystem restoration. In Greece, adaptive irrigation techniques are increasingly being adopted to combat water scarcity in vineyards. Italy’s reforestation projects focus on planting drought-resistant species to enhance ecosystem resilience. Portugal and Spain have developed systems of climate indicators to monitor and address the impacts of drought more effectively. Technological advancements further strengthen these efforts.

Satellite-derived vegetation indices, such as the Normalized Difference Vegetation Index (NDVI) and the Moisture Stress Index (MSI), provide critical insights into vegetation health and drought impacts. Machine learning algorithms are also being employed to model the effects of drought on ecosystems, improving prediction accuracy and facilitating data-driven decision-making.

Despite these advancements, gaps in resource allocation and strategy implementation persist, highlighting the need for a more integrated approach to drought management across the region.

2.3 Identified Drawbacks



While the Mediterranean region has made significant progress in drought management, several challenges hinder the development and implementation of effective solutions. These challenges are both structural and systemic, requiring targeted interventions to address them.

One of the primary challenges is **inconsistent data collection**. Variations in data collection methodologies and the use of diverse drought indices across pilot sites create difficulties in harmonising monitoring and assessment processes. For example, while Spain relies heavily on the Standardized Precipitation Index, Portugal incorporates additional metrics such as the Standardized Precipitation Evapotranspiration Index (**SPEI**). This lack of standardization complicates cross-regional comparisons and collaborative efforts.

Resource limitations also pose a significant barrier. Many pilot areas lack the necessary infrastructure for comprehensive monitoring and real-time data analysis. In Greece, for instance, the reliance on gridded reanalysis data due to insufficient local meteorological stations reduces the precision of drought predictions. This resource gap limits the effectiveness of early-warning systems and long-term planning.

The increasing variability of climate patterns further exacerbates these challenges. Shorter but more frequent drought cycles, as observed in Spain, undermine traditional water management strategies. Similarly, the unpredictability of precipitation patterns in Italy and Portugal complicates the planning and implementation of mitigation measures.

Socioeconomic constraints add another layer of complexity. The economic impact of drought disproportionately affects small-scale farmers and local communities. In Western Greece, for example, declining grape harvests have forced many farmers to adopt costly irrigation methods or abandon traditional practices altogether. This economic strain hampers the adoption of innovative drought management solutions. Finally, ecological imbalances caused by drought-induced changes in biodiversity pose a significant threat. In Portugal, water shortages in temporary ponds have allowed invasive species to displace endemic flora, disrupting the delicate balance of local ecosystems. Similar trends are observed in other pilot sites, where native species struggle to adapt to the changing environmental conditions.

Table 3: Challenges in Drought Management Across Pilot Sites



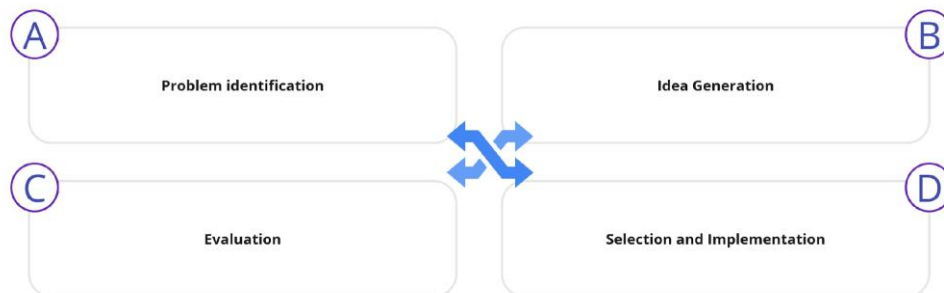
Challenge	Description	Example Site
Data Inconsistency	Lack of standardized indices	SPI vs. SPEI in Spain and Portugal
Resource Limitations	Insufficient infrastructure for monitoring	Reliance on reanalysis data in Greece
Climate Variability	Unpredictable precipitation patterns	Frequent short droughts in Spain
Socioeconomic Constraints	Economic impact on small-scale farmers	Grape harvest decline in Greece
Ecological Imbalances	Proliferation of invasive species	Biodiversity shifts in Portugal

The insights derived from the territorial characteristics, drought management experiences, and identified drawbacks across the Mediterranean pilot sites underscore the urgency of developing tailored solutions. By addressing inconsistencies in data collection, improving resource allocation, and leveraging advanced technologies, the Germ of Life project aims to enhance drought mitigation and ecosystem restoration efforts. The lessons learned from these pilot sites will serve as a blueprint for implementing sustainable strategies in other drought-prone regions, ensuring a resilient future for Mediterranean ecosystems and communities.



3 Systematic Innovation process (A1.3)

3.1 Overview of the process



A

The Germ of Life project, initiated in 2024, aims to address critical drought-related challenges in the Mediterranean (MED) area. During the first year of implementation, four primary problem areas were identified and tackled. This chapter focuses on the identification of these problems and the strategies employed to address them.

Problem 1. Monitoring Data and Drought Hazard Indexes Harmonization

One of the significant challenges encountered was the inconsistency in data collection and monitoring solutions across different pilot sites. Variations in methodologies and the use of diverse drought indices created difficulties in harmonizing monitoring and assessment processes. The primary drought problem identified in this category is "agro-meteorological droughts," which considers both the impact of rainfall deficiency and low soil water availability on vegetation status and productivity. Addressing this issue involved standardizing data collection methods and developing a unified approach to drought hazard indexing.

Problem 2. Identification and impact of Drought in specific MED ecosystems

The project aimed to identify and assess the impact of drought problems in ecosystems, territories and domains having general characteristics close to those tested in the Germ of Life project. Four pilot cases were identified:



- Reduced grape yields and irrigation needs: Highlighting the impact of drought on viticulture and the necessity for efficient water management.
- Water scarcity and vegetation stress: Emphasizing the broader ecological impacts of drought on plant health and ecosystem stability.
- Biodiversity loss and invasive species: Addressing the long-term consequences of drought on biodiversity and the proliferation of non-native species.
- Frequent short drought cycles: Recognizing the increasing frequency of short-term drought events and their cumulative effects on the environment.

Problem 3. Need for ecosystem-specific Vulnerability Indicators and assessment process

To assess the drought impact accurately and propose effective mitigation and ecosystem restoration plans, it was essential to identify suitable vulnerability indicators. While existing literature provides indicators for economic, social, and environmental impacts at macro scales, the Germ of Life project focused on identifying micro-meso scale indicators. These indicators are tailored to short-medium temporal and spatial scales, providing a more precise assessment of drought impacts in specific regions.

Problem 4. Establishment of a Seamless Process to help Policymakers looking for mitigation strategies and solutions.

The project also aimed to establish a seamless process and workflow to support policymakers in identifying mitigation plans. This involves:

- Identifying Natural Based Solutions (NBS): Developing a framework for selecting and implementing NBS to address drought-related challenges.
- Pre-procurement process: Creating a streamlined process for identifying and engaging suppliers, ensuring the timely and efficient implementation of mitigation strategies.



An established structured method for the Germ of Life solutions' **ideas generation** have been implemented in 2024 following the internal objectives and milestones :

- Q1 2024: Formation of technical partner teams and initial technical brainstorming sessions.



- Q2 2024: Development of initial solutions and collaborative meetings with Pilots' representatives.
- Q3 2024: Online and physical meetings (e.g. Marseille meeting) with Pilots representatives, presentation of solutions, and feedback collection for ideas refinements.

Solutions and Addressed Problems

Solution 1: Drought Hazard Prediction

Problem Addressed: Monitoring Data and Drought Hazard Indexes Harmonization

Approach:

- Data collection methods have been standardized across pilot sites.
- A unified approach to drought hazard indexing has been proposed, focusing on agro-meteorological droughts.
- A centralized platform for real-time data collection, sharing, analysis and forecast has been designed.

Solution 2: Vulnerability Assessment Tool

Problem Addressed: Identification and Vulnerability Impact of Drought in Specific MED Ecosystems

Approach:

- The technical team generated the initial idea and presented a digital workflow (UML) to pilot sites representatives. The idea was consequently refined and adapted to use cases aiming at assessing the vulnerability impact of drought on specific pilots' ecosystems, such as viticulture, vegetation, and biodiversity
- A first set of orientative indicators for Vulnerability risk dimensions have been assessed by the technical team using the JRC's Global Drought Observatory (GDO) and United Nations University (UNU-EHS).

The outcomes of joint consultations and analysis of requirements led to the design of the **Vulnerability Assessment Tool (VAT)**, an integrated platform aiming to identify and assess ecosystem-specific vulnerability indicators at micro-meso scales, as well as provide a holistic view of cooperative work among pilot use cases and functions to assist in their awareness and decision making process in the years ahead for drought consequences.



A survey took place with a questionnaire that was distributed among partners and experts in the field in countries participating in the project. The questionnaire was based on the following work document from JRC:

“drought vulnerability indicators for global-scale-KJNA29824ENN.pdf”

The analysis of the survey lead to a prioritisation of the following FACTORS:

- **FARMING PRACTICES**
- **ENVIRONMENTAL FACTORS**
- **GOVERNANCE**
- **ECONOMIC FACTORS**
- **SOCIAL FACTORS**
- **INFRASTRUCTURE**

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Social Factors						
Population undernourished (%)	43	27	13	10	7	43,3
Population with ill-health (%)	23	37	20	17	3	36,7
Out-of-pocket expenditure on health (%)	21	17	38	24	0	37,9
Rural population (% of total population)	3	31	31	24	10	31,0
Age dependency ratio (% of working-age population)	13	13	37	33	3	36,7
Risk perception (% of population who has experienced droughts in the past 10 years)	7	17	20	40	17	40,0
Availability of a drought early warning system (yes/no)	13	10	20	23	33	33,3
Households/farmers with access to information (radio/TV/internet) (%)	13	3	3	43	37	43,3
Economic Factors						
Dependency on agriculture for livelihood (%)	0	20	27	23	30	30,0
High dependence on tourism for income and employment (% of GDP)	3	10	21	31	34	34,5
Agriculture (% of GDP)	7	23	27	20	23	26,7
Population below the national poverty line (%)	27	33	23	17	0	33,3
Unemployment rate (%)	13	33	27	27	0	33,3
Farmers/labourers without savings (%)	7	17	34	34	7	34,5
Distance to closest market (km)	33	37	23	7	0	36,7
Market fragility	7	15	44	30	4	44,4
Farmers with crop, livestock or drought insurance (%)	21	7	36	32	4	35,7
Infrastructure						
Population without access to (improved) sanitation (%)	48	16	16	13	6	48,4
Population without access to clean water (%)	48	13	16	6	16	48,4
Poor water quality	26	19	23	13	19	25,8
Total dam capacity	7	14	32	18	29	32,1
% of retained renewable water	7	30	11	33	19	33,3
Electricity production from hydroelectric sources (% of total)	23	20	17	30	10	30,0



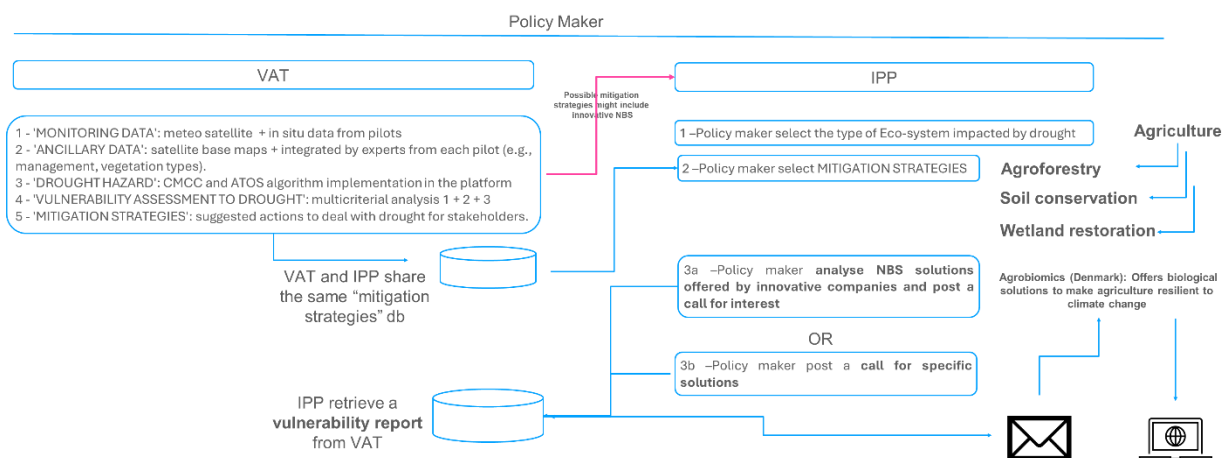
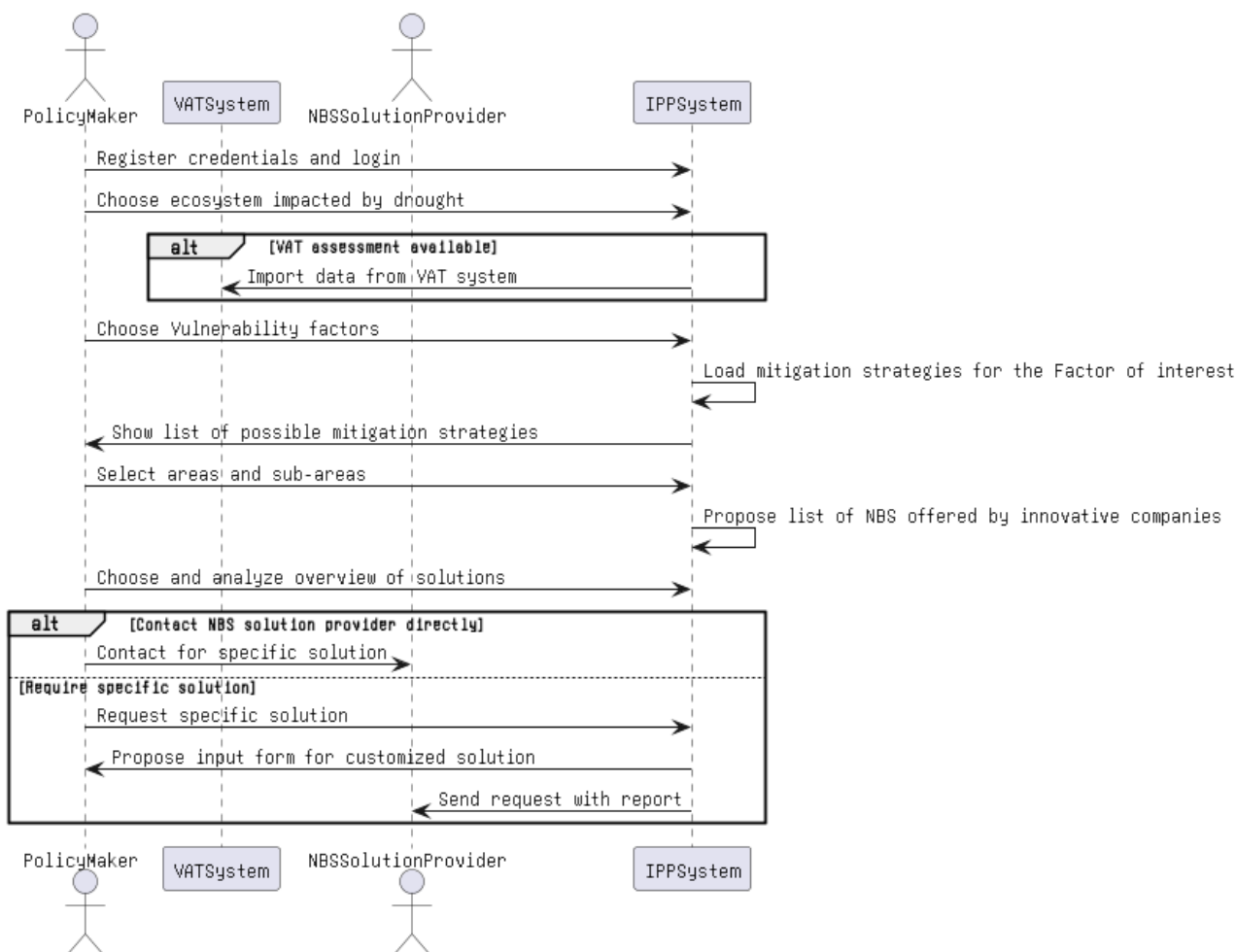
	1	2	3	4	5	
Governance						
Disaster risk taken into account in public investment and planning decisions (yes/no)	3	13	26	32	26	32,3
National investment in disaster prevention & preparedness (US\$/Year/capita)	10	27	23	13	27	26,7
Existence of national adaptation policies/plans (yes/no)	10	13	17	23	37	36,7
Government effectiveness	10	17	30	27	17	30,0
Number of (drought-related) adaptation projects in the past 10 years	15	22	33	15	15	33,3
Food aid (US\$ per capita)	20	30	30	17	3	30,0
Research and development expenditure (% of GDP)	21	14	31	17	17	31,0
Environmental Factors						
Soil organic matter (g*kg)	4	4	44	16	32	44,0
Soil depth (mm)	0	8	29	25	38	37,5
Degree of land degradation and desertification	7	7	14	31	41	41,4
Area protected and designated for the conservation of biodiversity (%)	0	14	28	41	17	41,4
Livestock health	4	21	11	46	18	46,4
Water stress	0	0	14	34	52	51,7
Farming Practices						
Irrigated land (% total arable)	4	14	14	29	39	39,3
Use of fertilizer (ton)	4	4	31	38	23	38,5
Access to fodder (kg purchased per year)	8	4	40	40	8	40,0
Tonnes of active ingredients of insecticides and pesticides used	4	4	38	38	17	37,5
Cultivation of drought-resistant crops (%)	7	21	21	18	32	32,1
Farmers use different crop varieties (%)	8	8	42	15	27	42,3

Solution 3: Innovation Procurement Platform

Problem Addressed: Facilitate the selection and implementation of drought mitigation strategies, mainly based on Natural Based Solutions (NBS).

Approach:

The technical team generated the initial idea and presented a digital workflow (UML) to pilot sites representatives. The idea was defined by taking into consideration either policies and strategies aiming at stimulating the application of innovative solutions in Europe. The European Commission Guidance of Innovation (Brussels, 18.6.2021 C(2021) 4320 final) has been studied and shared with the pilots' representatives to clarify the context of application. Some of the pilots have already implemented Innovation Procurement documented strategies (e.g. Andalusia CPI strategy) that facilitate the introduction of Germ of Life IPP applied to drought management innovation strategies and solutions.





C

Evaluation Phase: The evaluation phase occurred at the end of Period 2 (M7-M12). During this phase, online workshops were conducted with representatives from PTAs. These workshops aimed to assess the refinement of solutions based on structured feedback. Invitations were extended to other relevant stakeholders within the pilot organizations to ensure comprehensive input. The key activities included:

1. **Assessment of Refinement:** Solutions were evaluated and refined based on feedback gathered during the structured online workshops.
2. **Stakeholder Engagement:** Invitations were extended to additional stakeholders within the pilot organizations to broaden the scope of feedback and ensure diverse perspectives.
3. **Preparation for Implementation:** Preparatory steps were taken to ready the solutions for the upcoming implementation phase.

This thorough evaluation process ensured that the solutions were well-vetted and tailored to meet the specific needs of the pilot projects, setting a solid foundation for successful implementation in the subsequent periods.

D

Selection and implementation

Selection Phase: Following the evaluation process, which took place at the end of Period 2 (M7-M12), partners have meticulously chosen several services and features from the Germ of Life solutions. These selections are documented in Chapter 5 of this Deliverable. The criteria for selection were based on relevant indexes and indicators that will be utilized in the application implementation, user interfaces, workflows, data model, and data flow.

Implementation Phase: The implementation phase is scheduled for Period 3 and Period 4. During this phase, technical partners and PTAs will collaborate to refine the current selections and tailor them to the specific purposes and scopes of the pilots. This collaboration will encompass the following activities:

- **Activity 1.4:** Adapting existing solutions for Drought risk prediction
- **Activity 1.5:** Newly developed Collaborative Vulnerability Assessment tool
- **Activity 1.6:** Innovation Procurement Platform for technologies and NBS for drought risk mitigation

All these activities are expected to be completed by the end of Period 4 (M24). This structured approach ensures that the implementation is thorough, well-coordinated, and aligned with the project's goals.



3.2 Role of PP5 in leading the process

The Germ of Life project has a significant collaborative work component, as it unites partners with scientific and technical backgrounds, who must work collaboratively to design and create a technological system that addresses a real need based on diverse scientific content. For this collaborative work to be fruitful, it is necessary to have a global interlocutor who connects with all project members and ensures an optimal flow of knowledge among all partners. All this collaborative work has been extensive and has been developed from the very beginning of the project. Conceptually, the project's idea was clear in its definition, but it was necessary to substantiate and define it precisely, thanks to the contributions of each and every one of the Germ of Life project partners—those with scientific backgrounds, those with technological backgrounds, and the various pilots—who are globally part of this project.

Numerous internal and external meetings have been held to define the entire Germ of Life technology. Regarding internal meetings, focusing on the technical aspect, meetings with all partners were held on April 8, 2024, June 3, 2024, July 19, 2024, and July 20, 2024, during which all aspects of the three platforms were discussed. Furthermore, from the beginning of 2025 until the conclusion of this deliverable, numerous technical meetings have been held to finalize all the necessary aspects. It is important to highlight the three in-person meetings, held in Seville (March 7-8, 2024), Marseille (September 16-17, 2024), and Cyprus (February 6-7, 2025), where the technical concepts of the project were strongly discussed. Also important were the workshops, following the co-design methodology, held on November 8, 2024, November 15, 2024, and November 22, 2024. Additionally, meetings have been held with entities external to Germ of Life to understand the needs of potential stakeholders, such as those held in Croatia (June 26-27, 2024), Malaga (November 28-29, 2024), and we have also held meetings with projects on similar topics, such as the meeting we had with the Danube project on March 12, 2024.

3.3 Inputs and contributions from stakeholders

As previously highlighted, the Germ of Life project relies on the effective collaboration of partners with diverse backgrounds. We include university experts in drought-related topics, experts from organizations with similar scientific expertise in drought-related sensors, experts in Artificial Intelligence applied to water management, companies with a clear technological profile, and pilot projects with distinct but complementary characteristics. The success of the Germ of Life project relies on the union of all this complementary knowledge, since, if properly led, it will lead to the design of a system that truly solves a real problem affecting all of Europe.



Co-design methodologies have been used to foster effective collaboration between partners with different backgrounds. At first, the language between scientific and technological backgrounds may seem different, but when the starting point and the desired results are clear, using the right channels of collaborative communication, knowledge sharing and effective interaction among all partners with diverse backgrounds flows. To this end, Ubitel has engaged experts in this type of work, and the actual result applied to our project has been highly effective and appreciated by all partners.



4 Co-design approach

4.1 Methodology for co-design

Co-design is a design methodology focused on the active participation of all interested parties in the creation process. It is based on the idea that the best results are obtained when designers, users and other actors collaborate on equal terms, combining technical knowledge with real experiences and needs. In our specific project we have developed the following phases:

1. Exploration and Definition of the Problem

Objective: Understand the context, identify needs and define the problem.

□ Activities:

- Interviews and surveys: Compilation of experiences, expectations and difficulties of the participants.
- Mapping of key actors: Identification of users, experts, organizations and other relevant groups.
- Analysis of problems and opportunities: Identification of gaps and critical points to improve.

Expected results:

- A clear diagnosis of the problem.
- A deep understanding of users and their needs.
- An initial roadmap for solution development.

2. Generation of Ideas and Conceptualization

Objective: Create solutions in collaboration with participants.

□ Activities:

- Ideation workshops: Use of techniques such as brainstorming to generate ideas.
- Co-creation with users: Joint design of concepts and preliminary solutions.
- Prioritization of ideas: Evaluation of proposals according to impact, feasibility and alignment with needs.

Expected results:

- Innovative ideas based on real user experience.
- Initial concepts to develop prototypes.
- A consensus on the best solutions to explore.



3. Prototype Development

Objective: Convert ideas into tangible models for validation.

□ Activities:

- Rapid prototyping: Creation of initial versions using accessible materials (paper, cardboard, digital tools).
- User testing: Early interaction with prototypes to obtain feedback.
- Iteration and improvements: Adjustments based on the comments and learnings obtained in the tests.

Expected results:

- First functional prototypes of the solution.
- Early validation with real users.
- Key data to improve and refine the design.

4.2 Involvement of PTA stakeholders

The pilot stakeholders within the GERM OF LIFE project play a key role in the co-design process of the Vulnerability Assessment Tool (VAT) and Innovation Procurement Platform (IPP), as they provide contextualized information and validate the development of the tool in real scenarios. Below, its role in each of the first phases of co-design is analyzed.

Problem Exploration and Definition

Role of pilot stakeholders:

- They act as primary sources of information, providing data on the impact of drought on their regions.
- They identify the social, economic, and environmental factors relevant to their specific contexts (e.g., crops in Greece, river parks in Italy, temporary ponds in Portugal).
- They collaborate in the selection of indicators, balancing qualitative and quantitative data.

□ Concrete examples:

- In the first workshop (15/11/24), the pilot leaders defined key indicators such as vineyard yield in Greece, forest health in Spain or water availability in Portugal
- The importance of customizing the indicators according to the area of study was established, avoiding overly general approaches



2. Idea Generation and Conceptualization

Role of pilot stakeholders:

- They participate in ideation workshops to define the user flow and functionalities of the VAT and IPP.
- They contribute their experience on the practical use of the tool to ensure its real usefulness.
- They evaluate the feasibility of different methods of visualizing results (maps, graphs, indexes)

□ Concrete examples:

- In the second workshop (22/11/24), stakeholders discussed how to present the vulnerability index: a numerical scale (1-10) was preferred for its clarity.
- The integration of VAT with an innovation platform for the acquisition of mitigation solutions was analyzed

3. Prototype Development

Role of pilot stakeholders:

- They validate the first VAT and IPP prototypes in their respective environments.
- Provide feedback on the user interface and data flow
- They help to adjust the algorithms for normalization and calculation of the vulnerability index

□ Concrete examples:

- At the session on 8/11/24, it was agreed that pilots would use historical Copernicus data and local sensors to test the system
- Challenges such as the need to balance granularity and usability in indicators were highlighted

Conclusion

Pilot stakeholders are active actors in the VAT and IPP co-design process. Their participation ensures that the tool reflects local realities and is effective in managing drought risk. From problem definition to prototype validation, their applied knowledge and empirical data enrich the development of a contextualized and operational solution



5 Case Studies

5.1 Drought Risk Monitoring and Prediction services

5.1.1 Introduction

The Drought Risk Monitoring and Prediction service will include:

- the selected key drought indicators for near real time drought monitoring of the PTAs in a dashboard.
- Proof of Concept predictive services for these indicators.

A workshop has been organised between the PTAs and the technical partners of WP1 to further assess operational needs related to drought risk management, confirm the initial choices of indicators, and agree on parameters for machine learning models (such as relevant scales). The detailed minutes of this workshop (Workshop 3, held on December 10th, 2024) are provided in Annex 3.

5.1.2 Requirements

The requirements from predictive models for end users of the platform were co-defined between partners of Activity 1.4, and participants of workshop 3, in particular the pilot sites.

- Drought Indicators
 - For predictive models

The priority indicator is **Standardized Precipitation and Evapotranspiration Index (SPEI)**, which is commonly used and is particularly appropriate when both precipitation deficits and high temperatures contribute to drought severity (e.g., in arid or semi-arid regions), such as countries in the Mediterranean context (compared with Standardised Precipitation Index – SPI- which can have limitations) **SPEI is a Must Have**. It is the target for the Minimum Viable Product (MVP).

Additional indicators can be considered if time allows (**Could Have**):

- **SPI** is already used for some pilot sites and a second meteorological drought index.
- An index reflecting agricultural drought such as **Crop Water Stress Index (CWSI)**, with a preliminary model already explored within the framework of the project.



- An index reflecting vegetation status from remote sensing data such as **Disease Water Stress Index -4 (DSWI-4)**, provided exploration of forecasts based on datasets trained on remote sensing data using meteorological variables from SEAS5 are conclusive.
- Additionally, an **aggregated indicator** summarizing the aforementioned indicators could be added based on a weighted sum for example (Could Have).
- o For current drought conditions (Near real time)
 - The priority indicator is common with the predictive model: **Standardized Precipitation and Evapotranspiration Index (SPEI)** but calculated using the ground station data from the PTAs. (**Must Have**)
 - **NDVI – (Must Have)** from remote sensing and from ground station.
 - Could have: DSWI-4

- Temporal scale for predictive models

The priority scale is the subseasonal temporal scale (a few months ahead), matching the 7-months possibility provided by SEAS5 Copernicus dataset. The models could forecast **6 to 7 months ahead** with an update every month (as this dataset is updated monthly with expected meteorological variables). This would be a **Must Have** requirement following the MosCoW matrix.

Two pilot sites also mentioned that the **long term trends** would be relevant to take decisions around ecosystems preservation and management. The current understanding of feasibility is that there is enough historical data from Copernicus to build a model for long term forecast, using as input the RCPs scenarios, however there are additional tasks around downscaling and bias correction. So this task might be classified as a **Could Have**, and more technical explorations should be carried to assess if this feature can be delivered. Outputs would be the static graphs of expected range of evolution for selected points.

- Geospatial scale

- o For predictive models

The priority scale is very local (less than 1° wide) as pilot sites target specific ecosystems and areas. For predictive models the target is consequently a single time series generated for the pixel/ tile considered (11 km side for ERA5Land and 33 km wide for SEAS5). Hence the primary target is a single **point located at the ground station coordinates (Must Have)** with a single time series.



However, two pilot sites expressed interest in assessing drought conditions on larger areas. It is also relevant in terms of transferability and scalability of the project to be able to map larger areas. As a consequence, exploring generation of **forecasts for several tiles/ pixels** covering for example a relevant watershed / sub-basin could be explored if time allows (**Could Have**).

As a conclusion, partners decided to use as primary drought indices the SPEI and NDVI. The SPEI will be calculated based on sensor data that is collected from pilot's based meteorological stations as well as from Satellite datagridded databases (e.g. Copernicus ERA 5 of the COPERNICUS Climate Data Store) and from ECMWF forecasted data. The NDVI will be calculated based on satellite data. Both SPEI and NDVI are to be used to calculate the VAI (Vulnerability Assessment Index) which is part one of the outputs of the VAT tool platform. Last but not least all three indices (SPEI, NDVI and VAI) will be graphically presented in a simple, concise and useful way to end users of the pilots so they can see valuable information that will help them derive decisions.

5.1.3 Data inputs

The data required for (1) the predictive models training and inference is listed below followed by the data available and required for calculation of indicators in near real time. The predictive models require a large amount of historical data to be trained with sufficient performance. The data from the ground station started to be collected in period 2 of the project and can serve only as a validation set not a training set. As a consequence, datasets from GCM models have been prioritised to train the models

- **Data inputs for predictive model training**

Data	Source	Comment
ERA5-Land hourly data (reanalysis) for cumulative variables (P, PET)	Copernicus Data Store	To calculate PET, compare with the simplified version from dataset, to calculate SPEI, and other relevant indicators (CWSI, DSWI)



ERA5-Land daily statistics (reanalysis) for all other variables	Copernicus Data Store	To calculate PET, compare with the simplified version from dataset, to calculate SPEI, and other relevant indicators (CWSI, DSWI)
Data from PTAs ground stations	Ground Stations of the project	For comparison, validation, performance criteria, downscaling if required,, uncertainty assessment
SPEI historical	ECMWF database	To validate model outputs / assess bias

- **Data inputs for predictive model inference in production**

Data	Source	Comment
Forecasted meteorological variables from SEAS5	Copernicus Data Store (ECMWF)	Updated monthly
Data from ground station	Ground Stations of the project	To calculate performance criteria and detect drift

- **Data inputs for near real time calculation of indicators**

Data	Source	Comment
Data from PTAs ground stations	Ground Stations of the project	Priority
Remote Sensing: NDVI	Sentinel 2 (via Google Earth Engine)	

5.1.4 Planned Data Outputs

The planned outputs are listed as below (for the Must Have indicator):



For current drought assessment:

- **SPEI indicator (Standardized Precipitation Evapotranspiration Index)**
- **NDVI map (Normalized Difference Vegetation Index) and NDVI value from ground station sensors**

For predictive models:

- **six values for SPEI-1 for the following 6 months**
- **two values for SPEI-3**
- the performance criteria and relevant uncertainty information

Additional outputs defined as Could Have from the collaborative sessions are:

- Crop Water Stress Index (for current drought assessment and drought forecast)
- SPI (Standardised Precipitation Index)
- DSWI4 (Disease Stress Water Index 4)
- Other satellite products such as soil moisture
- A final indicator combining a selection of indicators from the first two and the additional to be explored. This combined indicator would represent more precisely all components of drought (meteorological, agro-ecological, vegetation stress) .

5.2 Collaborative Vulnerability Assessment Tool

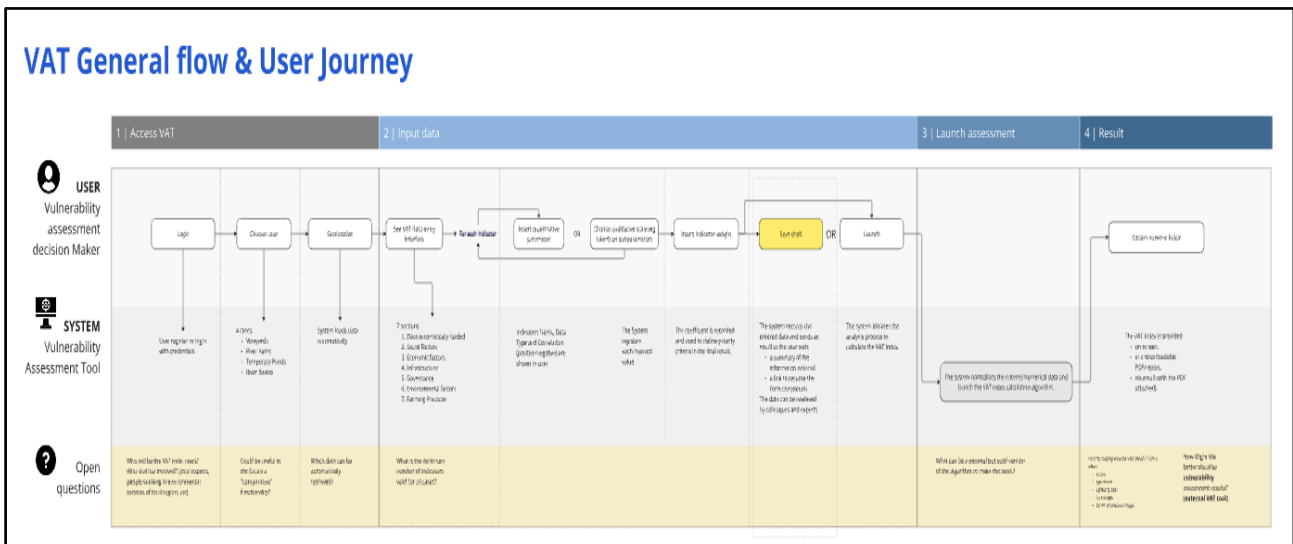
5.2.1 Introduction

Fed by the outputs of the Drouth Risk prediction, a Vulnerability Assessment Tool – better platform - is proposed as an integral part of GERM OF LIFE system, that is in the form of a visual informative system about drought risk per area of interest coupled with decision making function and a collaborative work space.

It will be built on open-source technologies, implementing a web based and mobile application for improving decision-making capabilities based on data collected and processed from various sources. It receives risk prediction information (AI based) in the form of indices, calculates risk based scores either from historical data or real time sensor data and includes a dashboard for risk visualization based on the KPIs identified. As said it will also encompass a collaborative space where the assessment from different stakeholders can take place on the specific drought risk area, produce structured reports available for decisions and mitigation actions functional requirements, and include geo-spatial information of various types and in several operative layers.



5.2.2 VAT Macro requirements



5.2.2.1 Tool Access (Access VAT)

- a. The system will allow users to log in with credentials (username and password).
- b. Optional to design a 2F authentication
- c. Users will be able to select one of the following cases:
 - i. **Vineyards | Greece**
 - ii. **River Parks | Italy**
 - iii. **River Basins | Spain**
 - iv. **Temporary Ponds | Portugal**
- d. Once a case is selected, the system will automatically load the contextual data related to the selected case (e.g., predefined vulnerability indicators), GIS related data, .
- e. Platform will be able to show:



- ❖ GIS geographical layers for pilot areas
 - ❖ data based on questionnaires related to indicators for: Social Factors, Economic Factors, Infrastructure, Governance, Environmental factors, Farming practices.
 - ❖ data per pilot obtained from past Copernicus data sources.
 - ❖ data from real time sensors
 - ❖ calculated indices - SPEI and NDVI and VAI - graphically presented.
 - ❖ reports per pilot based on calculation of indices.
 - ❖ collaborative platform for exchanging information.
- f. collaborative platform for exchanging information

5.2.2.2 Data Input (Input Data)

- a. The system will provide users with a structured interface to view and edit input data. The screen will display some data automatically loaded from the system based on previous selections, as well as a form for manually entering additional data.
- b. These additional data – PER PILOT - may potentially refer to different indicators in the following areas (Indicators paragraph):
- Social factors
 - Economic factors
 - Infrastructure
 - Governance
 - Environmental factors
 - Farming practices
- c. Users will be able to input quantitative parameters for each indicator if required.
- d. Users will be able to select a qualitative scale (e.g., from a predefined list) for additional parameters.
- e. Users will be able to manually assign a weight to each indicator to influence the overall calculation.
- f. Users will be able to save a draft of the input configuration for later review or collaboration with other colleagues/experts.
- g. Data from questionnaires answered will also be displayed



- h. Data from Copernicus about the pilot areas will also be displayed
- i. Indices to be used for current drought assessment:
 - **SPEI**: one that will be calculated based on past Copernicus data using gridded past or quasi-real time data (e.g. ERA 5 from the COPERNICUS Climate Data Store database), ECMWF forecasted data and one from real time sensors data
 - **NDVI**: one that will be based on current satellite data
 - As a second step of development, the following indexes can be added:
 - **SPI**: one that will be based on past Copernicus data and one from real time sensor data.
 - **CWSI**: one that will be based on past Copernicus data and one from real time sensor data.

5.2.2.3 Assessment Launch (Launch assessment)

- a. The system will allow users to launch the VAT index calculation based on the input data and configured weights.
- b. The system will normalize numerical and qualitative data to process them through a predefined assessment algorithm.
- c. The system will support the display of calculation details in a transparent manner (e.g., logic applied visible to advanced users).

5.2.2.4 Results

- a. The system will provide a numerical value as the main outcome of the VAT index calculation.
- b. Results will be presented in the form of:
 - Summary reports
 - Interactive graphical dashboards
 - Exportable standard formats (PDF, CSV).
- c. Results will be stored for subsequent analysis and traceability.



5.2.3 Indicators

For each case study, various indicators associated with different areas have been identified. In some cases, certain areas are not to be considered (there are no elements). The data are summarized in the four tables below.

Vineyards Greece	
Social Factors	Not applicable
Economic Factors	Not defined
Infrastructure	Not defined
Governance	Not applicable
Environmental factors	<p>Indicator: Water Stress</p> <ul style="list-style-type: none"> • Data Type: number (measuring soil humidity with sensors) • Correlation: positive • Data source: direct (quantitative)
Farming practices	Not defined

River Parks Italy	
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<p>Social Factors</p>	<p>Indicator: Number of awareness-raising actions addressed to farmers</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Positive (Greater awareness generates more conscious behaviors) • Data Source: Direct (quantitative) <p>Indicator: Number of awareness-raising actions addressed to citizens (for example training activities in schools, awareness-raising meetings with citizens...)</p> <ul style="list-style-type: none"> • Data type: Number of education activities, Number or participants • Correlation: Positive (Greater awareness generates more conscious behaviours) • Data Source: Direct (quantitative)
<p>Economic Factors</p>	<p>Indicator: Production capacity of cultivated areas / Hectares of Cultivated areas (forage crops) / number of different crops</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Positive or neutral • Data Source: Direct (quantitative)
<p>Infrastructure</p>	<p>Presence of water storage works (artificial reservoirs, including small and medium-sized ones, technologically simple)</p> <ul style="list-style-type: none"> • Data type: Number (from ARPA Piemonte) • Correlation: Positive • Data Source: Direct (quantitative)
<p>Governance</p>	<p>Indicator: Plans/Decisions at a regional/local level for pressure management</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Positive



	<ul style="list-style-type: none"> • Data Source: Direct (quantitative) <p>Indicator: Interventions to increase the resilience of territories to climate change (Funding and Calls...)</p> <ul style="list-style-type: none"> • Data type: Number / Number of calls/Number of beneficiaries • Correlation: Positive • Data Source: Direct (quantitative)
<p>Environmental factors</p>	<p>Indicator: Extent of protected areas (hectares) in order to estimate the degree of conservation of natural areas</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Positive • Data Source: Direct (quantitative) <p>Indicator: Average precipitation (mm/year) - data from the ARPA (Regional Agency for Environmental Protection) meteorological station</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Negative (Less precipitation will lead to increased vulnerability to drought) • Data Source: Direct (quantitative) <p>Indicator: Total snow cover (cm) and number of snowy days (days)</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Negative (Less precipitation will lead to increased vulnerability to drought) • Data Source: Direct (quantitative)



	<p>Indicator: Soil water content (soil moisture)</p> <ul style="list-style-type: none"> • Data type: Percentage (GoL Sensors) • Correlation: Negative • Data Source: Direct (quantitative)
Farming practices	<p>Indicator: Quantity of fertilizers and pesticides distributed for agricultural use (tons)</p> <ul style="list-style-type: none"> • Data type: Number • Correlation: Negative (It can deteriorate the quality of available water) • Data Source: Direct (quantitative) <p>Indicator: Use of sustainable irrigation practices</p> <ul style="list-style-type: none"> • Data type: TBD • Correlation: TBD • Data Source:TBD

River Basins Spain	
Social Factors	<p>Indicator: Availability of a drought early warning system (yes/no)</p> <ul style="list-style-type: none"> • Data Type: Y/N • Correlation: negative • Data source: Likert (qualitative) <ul style="list-style-type: none"> ◦ Qualitative parameters: TBD
Economic Factors	Not applicable
Infrastructure	<p>Indicator: Total dam capacity</p> <ul style="list-style-type: none"> • Data Type: percentage



	<ul style="list-style-type: none"> • Correlation: negative • Data source: direct (quantitative)
Governance	<p>Indicator: Existence of national adaptation policies/plans</p> <ul style="list-style-type: none"> • Data Type: Y/N • Correlation: negative • Data source: Likert (qualitative) <ul style="list-style-type: none"> ◦ Qualitative parameters: TBD
Environmental factors	<p>Indicator: Area protected and designated for the conservation of biodiversity (%)</p> <ul style="list-style-type: none"> • Data Type: percentage • Correlation: negative • Data source: direct (quantitative)
Farming practices	Not applicable

Temporary Ponds Portugal	
Social Factors	<p>Indicator: Number of awareness campaigns held per year in the local community</p> <ul style="list-style-type: none"> • Data Type: number (reactions to the campaign, institutions taking part to the program, people taking part to events/activities) • Correlation: Positive (more awareness-raising actions promote greater awareness) • Data source: direct (quantitative) • Qualitative parameters



Economic Factors	Not applicable
Infrastructure	Not applicable
Governance	Not applicable
Environmental factors	<p>Indicator: Number of months per year with water in the pond</p> <ul style="list-style-type: none"> • Data Type: number • Correlation: positive • Data source: direct (quantitative)
Farming practices	<p>Indicator: Use of sustainable irrigation techniques</p> <ul style="list-style-type: none"> • Data Type: percentage / direct report from farmers and landowners • Correlation: positive • Data source: direct (quantitative)

5.2.7 VAI concept and calculation

Following analyses and several discussions we concluded the following concepts:
The Vulnerability Assessment Index, defined as:

$$VAI = (F + D) / A$$

with



- F: the frequency with which the area experiences a specific DCI category (e.g., % of occurrence of the specific DCI category over the last 30 years - the time basis is to be decided),
- D: the dependence of the area on the specific activity (e.g., % of agriculture in GDP).
- A: the ability to cope with drought (e.g., % of area that can be irrigated).

This index can be interpreted as follows:

- VAI > 1: Area vulnerable to drought.
- VAI < 1 Less vulnerable, better adaptive capacity.

Here comes a calculation example:

- F = 60% (specific DCI category occurred in 18 out of --- depends on the time basis)
- D = 70% (Agriculture contributes 70% of GDP)
- A = 50% (50% of the area can be irrigated)

Then: VAI = (60 + 70) / 50 = 2.6

In order to add better flexibility and ease the Policy makers Vulnerability assessment process the GoL technical partners and PTAs agreed to follow a questionnaire based assessment to calculate the parameter **D** (Dependence) and **A** (Ability to cope with drought)

Since quantitative data are needed to feed the VAI , the answers to questionnaires will be provided by the use of quantitative scales, to be selected during the implementation and according to the questions provided by the PTAs. Example of scales to be used are:

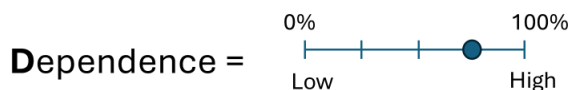
- **Likert Scales:** to quantify subjective opinions, making it easier to analyze and interpret responses statistically.
- **Slider Scales** : let respondents drag a slider along a continuum to indicate their response. This method can provide a more precise measurement of attitudes or feelings, often represented as a percentage e.g. 0% to 100%
- **Numeric Rating Scale (NRS):** Respondents rate their response on a numeric scale, such as 0 to 10 or 0 to 100. This method is straightforward and allows for fine-grained analysis of responses.

Let's take the following assessment example:



Example River Parks-Italy

- **Factor: SOCIAL**
- **Indicator: Expected Impact level from awareness-raising actions addressed to farmers**



Ability=

Q1: How much farming practices improved after participating in the awareness-raising activities?



Q2: Level of benefits observed in farming operations since adopting the practices promoted through the awareness-raising actions



Q3: Quantity of awareness-raising actions addressed to farmers



- **F:** Combine the SPEI and NVDI in a single index and provide an algorithm for the calculation of parameter F.
- **D:** the dependence of the area on the specific activity is considered as static or semi-static **objective parameter** and depend by the policy makers' strategy on the specific indicator in a specific area/territory.
- **A:** the ability to cope with drought is a **Variable/Subjective parameter**, it can vary and can change in a specific timeframe, based on decisions taken by decision makers and actions undertaken to cope with drought management.

In the following table a synthesis of key indicators for each vulnerability dimensions indicated by PTAs during the co-design session and the number of questions required for each indicator.



	River Parks	River Basins	Temporary Ponds	Vineyards
D Dependence Indicators selected	Key indicator/s 1 Key indicator for each Vulnerability dimension 2 for SOCIAL 1 for INFRA 4 for ENV 2 for FARMING 2 for GOV	Key Indicator/s 1 Key indicator for each Vulnerability dimension 1 for SOCIAL 1 for INFRA 1 for ENV 1 for FARMING	Key Indicator/s 1 Key indicator for each Vulnerability dimension 1 for SOCIAL 1 for ENV 1 for FARMING	Key indicator/s Agriculture
A Ability to cope with drought (to be assessed when drought happens, by questionnaires)	2 for SOCIAL (3 questions x 2) 1 for INFRA 4 for ENV (3 questions x 4) 2 for FARMING (3 questions x 2) 2 for GOV (3 questions x2)	SOCIAL (3 questions) INFRASTRUCTURE (3 questions) ENVIRONMENTAL (3 questions) FARMING (3 questions)	SOCIAL (3 questions) ENVIRONMENTAL (3 questions) FARMING (3 questions)	INFRASTRUCTURE e.g area that can be irrigated

5.2.4 UI/UX Mock-ups of the VAT system

5.2.4.1 Technological and UX constraints

- The system will be developed with a simple and intuitive interface, following UI/UX principles for maximum accessibility.
- Calculation and result visualization will be optimized for quick response times.



5.2.4.2 UI/UX Methodology followed

The design of User Interface (UI) and User Experience (UX) for a Vulnerability Assessment Tool (VAT) should focus on streamlining the processes involving the user and the system. The objective is to enhance functionality and deliver a seamless user experience that aligns with the core workflows.

The initial phase involves user registration and login to the system. The design must emphasize creating a secure and user-friendly environment. The VAT supports various user roles, such as decision-makers, who require quick and efficient access to the platform.

Next, users can select from different scenarios, such as vineyards, river parks, temporary ponds, and river basins. Each scenario must be supported by a clear and straightforward navigation guide that allows quick access to available data or manual data entry. The data input sections include parameters such as quantitative data and indicator weights, while optional inputs may include qualitative scales (e.g., Likert scale).

Data management requires special attention. The system automatically normalizes numerical data entered by the user. Each value is recorded, and the user is provided with the option to save drafts for later continuation or submit the data definitively. After submission, the VAT sends a confirmation message that includes a summary of the entered data and a link for resuming the process.

Launching the assessment process is a critical moment for the user. The interface design should include an intuitive and clearly visible button to activate the calculation algorithm. The results are presented through interactive graphics and reports, offering a clear visual understanding of vulnerability levels. Users can export their data as PDFs or share it via email with colleagues for further evaluation.

The assessment results include the visualization of indicators using color-coded scales that denote risk levels. For instance, indicators may be displayed on a visual scale ranging from green (low vulnerability) to red (high vulnerability), providing immediate insight into intervention priorities.

The overall user experience (UX) is supported by engagement elements, such as real-time feedback during data entry, interactive visualization, and personalization features. Accessibility is paramount for VAT to ensure equality in user experience, regardless of limitations.

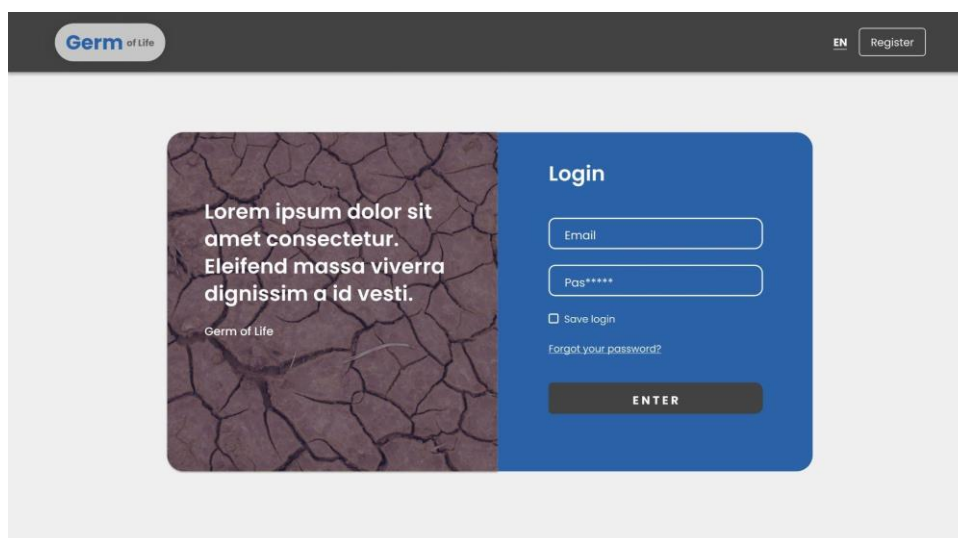
The UI/UX design of VAT is not just about achieving an aesthetically pleasing interface but also about providing tools that promote understanding of complex data and



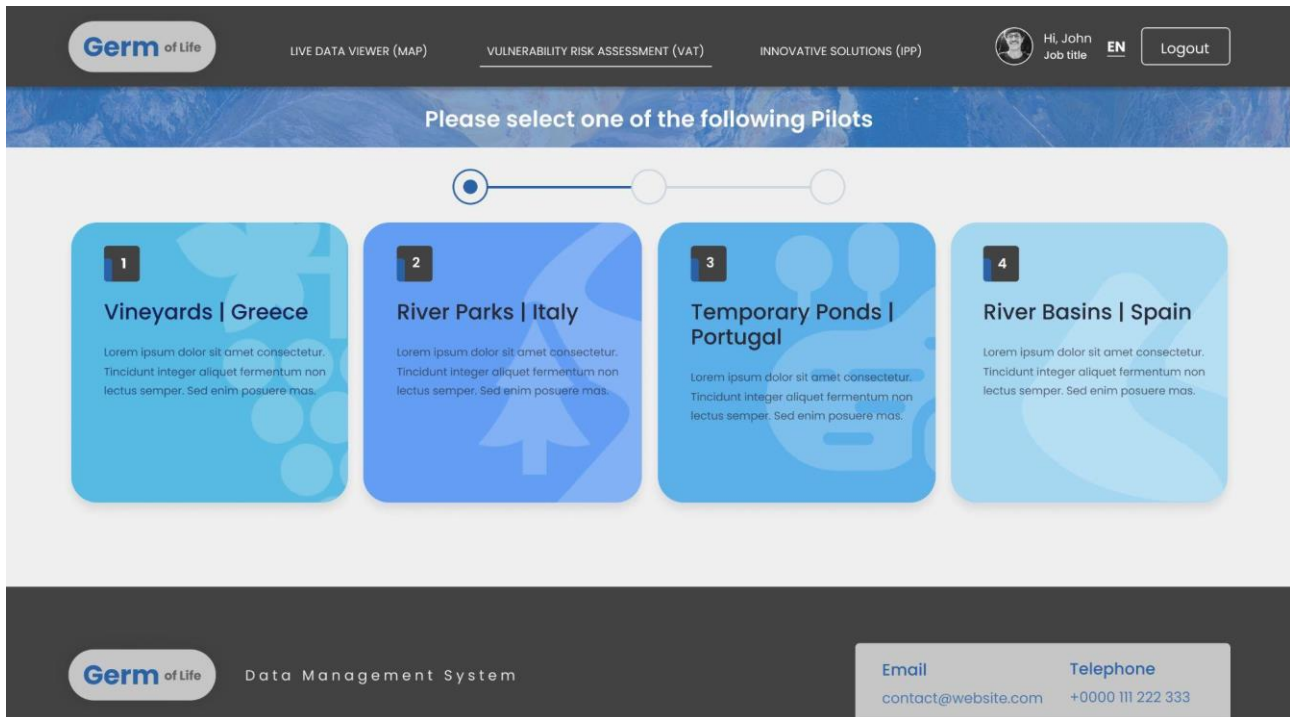
support critical decision-making. These tools bridge the complexity of analysis with human intuition, enhancing their value as indispensable advisors.

5.2.4.3 UI/UX Mock-ups

This login page follows a modern and clean UI/UX approach with a split-screen design. On the left, a visually engaging background image adds context, while the right side presents the login form in a structured and intuitive layout. The form includes clearly labeled input fields, a "Save login" checkbox for user convenience, and a "Forgot password?" link for easy recovery. The CTA button ("ENTER") is prominently styled to draw attention. The overall design ensures accessibility, with high contrast, readable fonts, and a straightforward flow for a seamless user experience.



This screen appears after logging in and selecting "Vulnerability Risk Assessment (VAT)" from the menu. The interface guides users to choose one of the available pilot projects, presented as interactive cards with clear numbering and country-specific labels. The progress indicator at the top suggests a multi-step process. Each card is visually distinct, using subtle background illustrations and a consistent layout for readability. The design ensures an intuitive selection process, supporting user engagement through a structured and visually appealing UI. In this case, we will proceed by selecting the first option, "Vineyards | Greece."



Vineyards | Greece

This screen appears after selecting the pilot "**Vineyards | Greece**" and corresponds to the "**Environmental Factors**" stage of the **Vulnerability Risk Assessment (VAI)** process. The user inputs values that contribute to the VAI calculation:

1. **D Input:** The user selects a value within a predefined range using a slider.
2. **A: Social Factor Indicators:**
 - o If the Social Factor has only **one indicator (A1)**, the user answers three questions using a **0-5 scale** (via sliders).
 - o If there are **multiple indicators (A2, A3, etc.)**, each indicator has its own set of three questions.
3. **F: Environmental Factor:** This value is **not directly input by the user** but is automatically calculated based on an algorithm (a combination of **SPEI & NDVI**, as provided).



VAI Calculation Formula:

$$VAI = (F + D) / A$$

where:

- **F** is automatically calculated,
- **D** is the user-defined input,
- **A** is derived from the **average score of the Social Factor indicator questions**.

The screen follows a **structured, user-friendly flow**, with a **visual progress bar** at the top indicating the current step. After completing the input fields, the user can proceed with the calculation by clicking the **"Calculation"** button.

The screenshot displays the 'Environmental Factors' section of the VAI calculation tool. At the top, a navigation bar includes the 'Germ of Life' logo, 'LIVE DATA VIEWER (MAP)', 'VULNERABILITY RISK ASSESSMENT (VAT)', 'INNOVATIVE SOLUTIONS (IPP)', a user profile for 'Hi, John Job title', and an 'EN' language selector with a 'Logout' button. The main header reads 'Vineyards | Greece'. A progress bar below the header shows three steps, with the first step, 'Environmental Factors', being the current active step. The main content area is titled '1 Environmental Factors' and contains a form for entering 'D' (input) and 'A' (indicator). The 'D' input is a slider with a value of 2. The 'A' indicator is 'Water Stress'. Below this, there are three questions, each with a slider from 0 to 5. The first question has a value of 2. A 'Calculation' button is located at the bottom right of the form area. The footer contains the 'Germ of Life' logo, 'Data Management System', and contact information for Email (contact@website.com) and Telephone (+0000 111 222 333).



Vulnerability Assessment TOOL (VAT)

This screen appears after completing the "**Environmental Factors**" stage and selecting "**Calculation**" in the **Vulnerability Risk Assessment (VAI)** process. It presents **drought assessment and NDVI monitoring results** through a structured, interactive, and visually intuitive interface.

Key UI/UX Features:

1. Clear Data Visualization

- **Gauges** for **Current & Expected Drought Assessment (SPEI values)** provide an **instant understanding of risk levels**.
- **Interactive NDVI maps** display real-time and forecasted conditions.

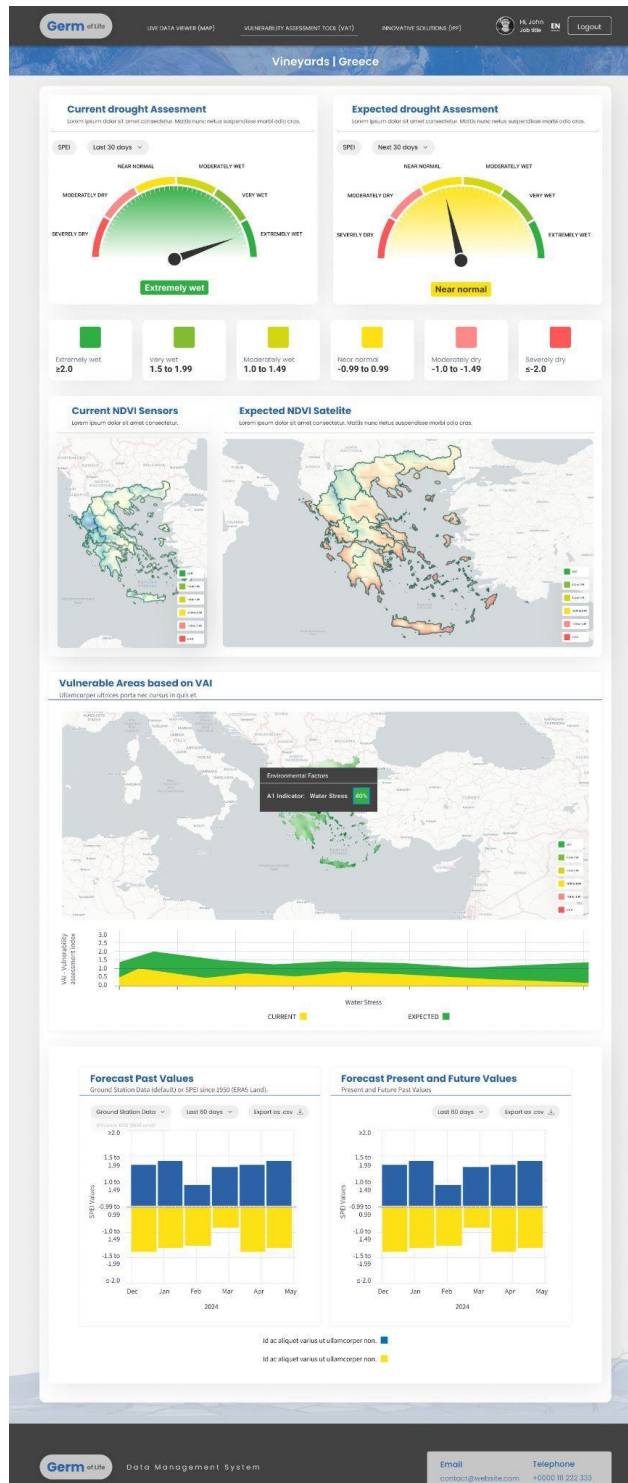
2. User-Centered Design

- **Color-coded indicators** enhance readability of risk levels.
- **Hover tooltips** provide additional data without overwhelming the interface.
- **Logical workflow** ensures smooth navigation from input to results.

3. Interactivity & Accessibility

- Users can **explore risk areas dynamically** via the interactive map.
- **Historical & forecast SPEI charts** allow trend analysis at a glance.
- **CSV export** enables further offline data analysis.

The **intuitive layout, responsive design, and seamless transition from input to results** ensure an efficient and user-friendly experience.





5.2.5 Next Steps

- ❖ VMs have been designed and are currently working on the main GERM OF LIFE Server infrastructure
- ❖ API to connect VAT platform with MLOps platform is to be developed
- ❖ SPEI and NDVI indices algorithms have been set and will be software programmed.
- ❖ a database for storing pilot related sensors data is to be built
- ❖ SPEI and NDVI will also be stored in the database
- ❖ VAI index has been determined and will be software programmed.
- ❖ VAT software platform related modules like: login, GIS layers, collaboration platform, questionnaire answers visually presented, etc has started been constructed

5.3 Innovation Procurement Platform for NBS (IPP)

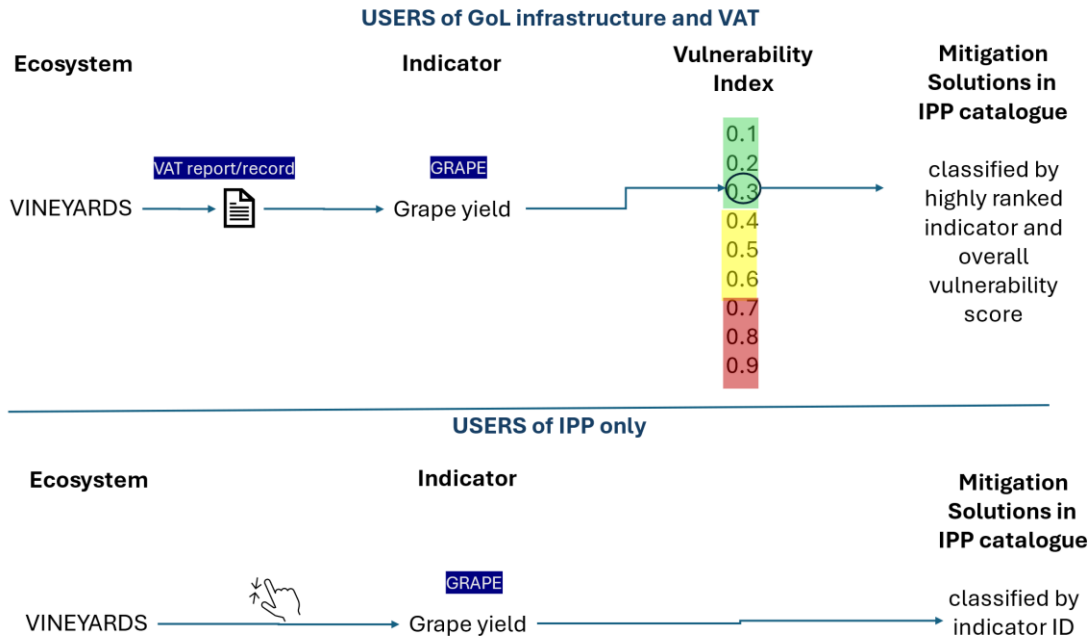
5.3.1 Introduction

The purpose of IPP is to guide public procurers in guiding pre-procurement specifications for Drought mitigating Innovative Solutions” and support NBS suppliers in matching the request by a data-driven evidence of:

- a. The type of Ecosystem impacted by drought
- b. The type of Drought Risk (categorization)
- c. Ecosystem Vulnerability indicators (from VAT)

IPP is proposed as an integral part of the GERM OF LIFE system, that is in the form of a workflow fed by data and indicators retrieved by the VAT to be used to define ecosystems drought impact profiles and call or match for mitigation NBS.

IPP is also proposed to procurers belonging to public organisations that are not users of the overall GERM of LIFE infrastructure and services, so in this case the IPP can be used as Market Consultation catalogue of NBS solutions published by suppliers.



5.3.2.2 Data Input (Input Data)

Currently from available requirements, no additional data input is needed by the users.

5.3.2.3 Results

The system will provide a list of prioritized NBS solutions based on the main outcome of the VAT index calculation.

Results will be presented in the form of:

- Catalogue of Existing Solutions (prioritized) and information about the suppliers
- Contact of (prioritized) NBS Suppliers to be contacted for on demand innovative solutions

Results will be stored for subsequent analysis and traceability.



5.3.2.4 UX/UI Mockups



The purpose of this platform is to GUIDE PUBLIC PROCURERS IN FORMALIZING Pre-procurement specifications for Drought mitigating Innovative Solutions” and support NBS suppliers in matching the request by a data-driven evidence of:

- The type of Eco-system impacted by drought
- The type of Drought Risk (categorization)
- Ecosystem Vulnerability indicators (from VAT)



Germ of Life

Interreg
Euro-MED



Co-funded by
the European Union





Innovation Procurement Platform

BUSINESS INFO

* Registration Type

-Please select-



* Full Name of Company

* Registration No. / Organization No.

E.g. 201903124587

Old Registration No. / Organization No.

* No. of Employees

-Please select-



Company Website

E.g. https://...





PRIMARY ADDRESS

Address Line 1

Address Line 2

Address Line 3

* City

State

-Please select-

* Postal Code

* I have read and agreed to the [Terms of Use](#) and [Privacy Policy](#)



I'm not a robot





* Salutation

USER / SIGN IN INFO

-Please select-

* First Name

* Last Name

* Contact Number

+32

E.g. 11325665

* Username

* Email

E.g. example@domain.com

* Re-enter Email

* Job Title





Innovation Procurement Platform

1

Vineyards

Lorem ipsum dolor sit amet consectetur. Tincidunt integer aliquet fermentum non lectus semper. Sed enim posuere mas.

2

River Parks

Lorem ipsum dolor sit amet consectetur. Tincidunt integer aliquet fermentum non lectus semper. Sed enim posuere mas.

3

Temporary Ponds

Lorem ipsum dolor sit amet consectetur. Tincidunt integer aliquet fermentum non lectus semper. Sed enim posuere mas.

4

River Basins

Lorem ipsum dolor sit amet consectetur. Tincidunt integer aliquet fermentum non lectus semper. Sed enim posuere mas.





Germ of Life solution users: *i*

VAT record : Retrieve

 Upload

Independent assessment: *i*

NEW VAT ASSESSMENT

SKIP





Germ of Life HOME ECOSYSTEMS MARKET CONSULTATION Hi, John Job title EN Logout

Retrieve Vulnerability Assessment Report/Records

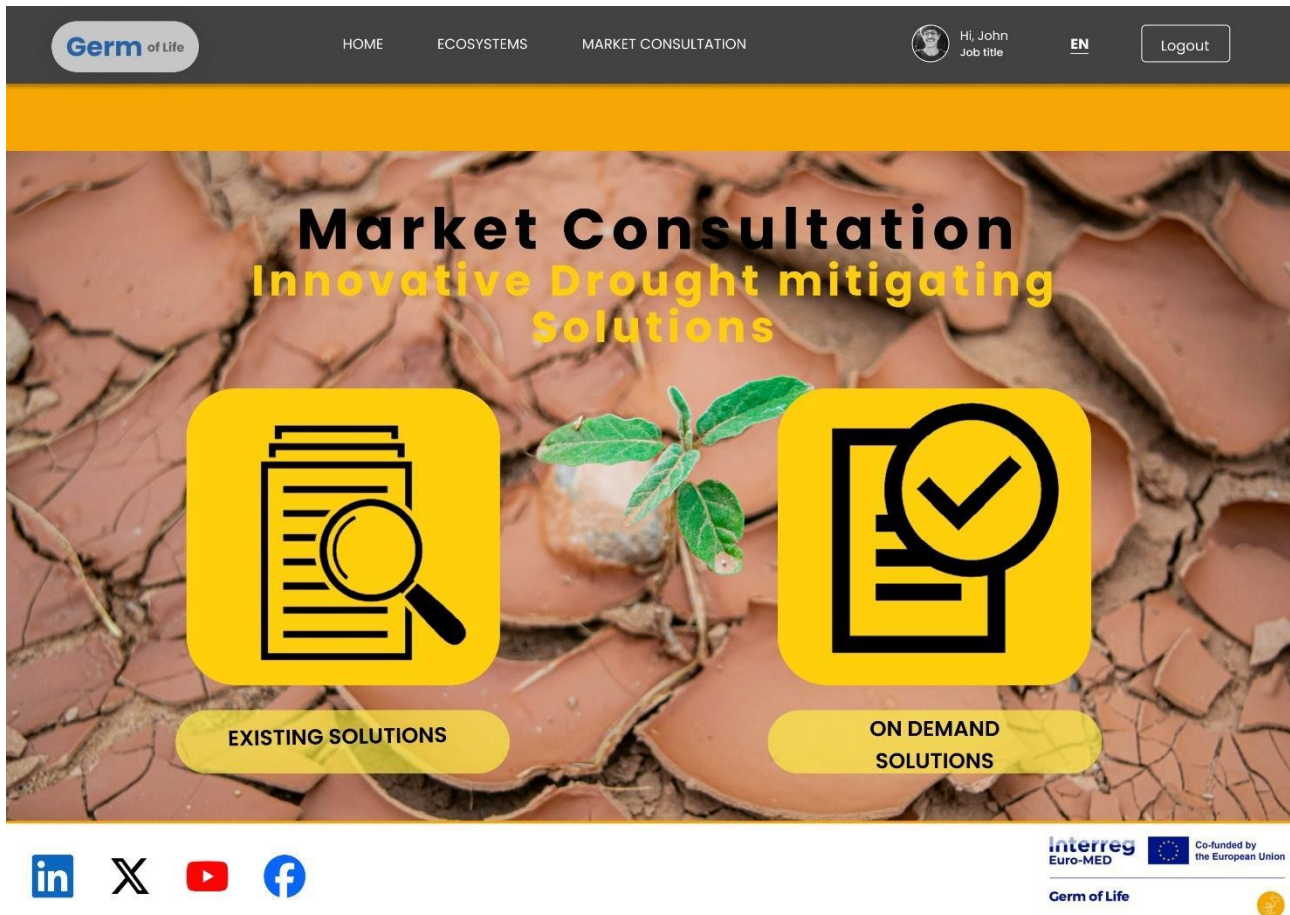
Please enter VAT ID (mail, ?):

Please enter VAT report code:

SUBMIT

SKIP





Based on the information provided by the procurer in the previous steps of the IPP workflow, a catalogue of NBS is proposed depending on the Ecosystem impacted as defined in the project.

For each NBS solution a list of suppliers, already registered in the platform and profiled according to the NBS relevant expertise, is presented and an internal workflow to initiate the innovation pre-procurement process.

Here is an example of NBS categorization currently identified and to be extended by PTAs within the Activity 1.6 by the end of Period 4:

Agriculture

- **Composting:** Enhances soil fertility and moisture retention.
- **Soil improvement:** Techniques to improve soil health and water-holding capacity.
- **Systems for erosion control:** Prevents soil erosion and maintains soil structure.
- **Create and preserve habitats and shelters for biodiversity:** Supports beneficial species that enhance agricultural productivity.



River Parks

- **Infiltration basin:** Enhances water infiltration and reduces runoff.
- **Swale:** Channels water and promotes infiltration.
- **Constructed wetland:** Improves water quality and provides habitat.
- **River engineering:** Techniques to manage river flow and reduce erosion.
- **Rivers or streams, including re-meandering, re-opening Blue corridors:** Restores natural river dynamics and enhances water retention.
- **Reprofiling/Extending flood plain area:** Increases floodplain capacity and reduces flood risk.
- **Diverting and deflecting elements:** Manages water flow and reduces erosion.

Water Ponds

- **(Wet) Retention Pond:** Stores water and reduces runoff.
- **Rain garden:** Captures and infiltrates rainwater.
- **Constructed wetland:** Provides water storage and improves water quality.
- **Vegetated grid pave:** Enhances water infiltration and reduces runoff.

River Basins:

1. **Infiltration basin:** Enhances water infiltration and reduces runoff.
2. **(Wet) Retention Pond:** Stores water and reduces runoff.
3. **Rain garden:** Captures and infiltrates rainwater.
4. **Swale:** Channels water and promotes infiltration.
5. **Constructed wetland:** Improves water quality and provides habitat.
6. **Create and preserve habitats and shelters for biodiversity:** Supports biodiversity and ecosystem health.
7. **Green Corridors:** Connects habitats and enhances biodiversity.
8. **Use of preexisting vegetation:** Preserves natural habitats and reduces implementation costs.
9. **Composting:** Enhances soil fertility and moisture retention.
10. **Soil improvement:** Improves soil health and water-holding capacity.
11. **Systems for erosion control:** Prevents soil erosion and maintains soil structure.
12. **River engineering:** Techniques to manage river flow and reduce erosion.
13. **Rivers or streams, including re-meandering, re-opening Blue corridors:** Restores natural river dynamics and enhances water retention.
14. **Reprofiling/Extending flood plain area:** Increases floodplain capacity and reduces flood risk.
15. **Diverting and deflecting elements:** Manages water flow and reduces erosion.



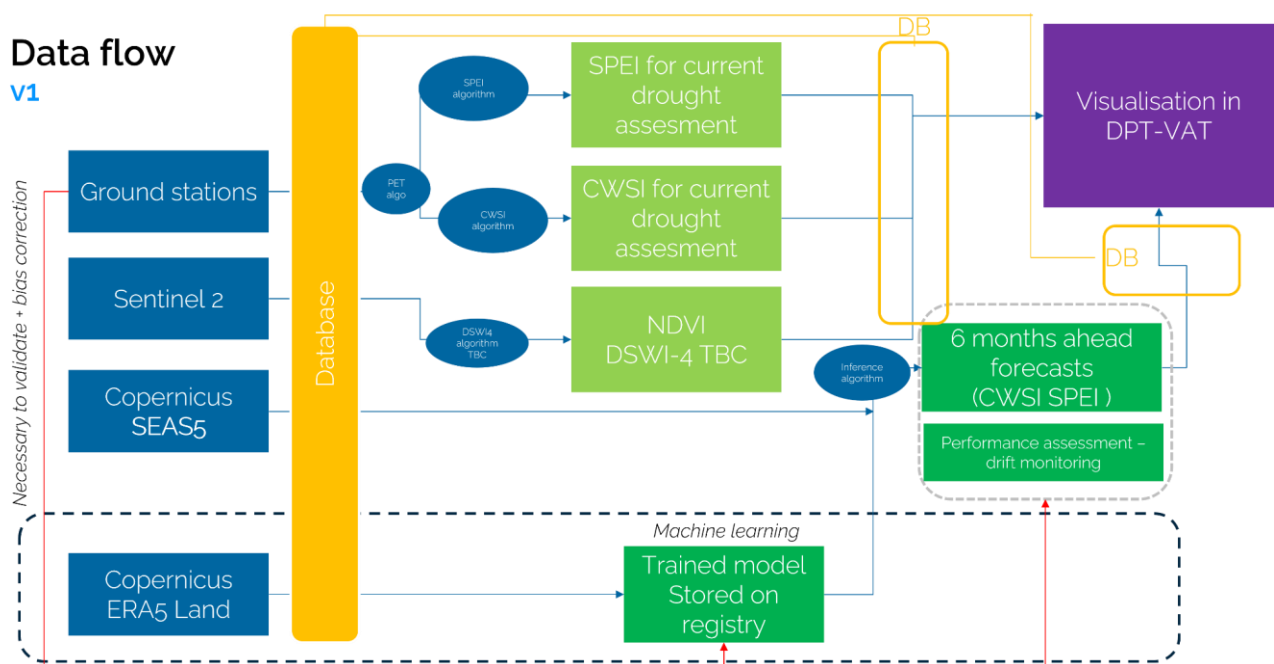
6 Back-end Data flow model

6.1.1 Introduction

The back-end data flow model is designed to manage and streamline the movement of data between various applications of Germ of Life solution. This model ensures that data is efficiently processed, stored, and retrieved, enabling seamless integration and communication across different parts of a system. By defining clear pathways for data, a back-end data flow model we aim at maintaining data integrity, enhancing performance, and supports scalability.

6.1.2 Data flow

The initial data flow in the Drought Prediction Tool (DPT) is defined in the following figure :

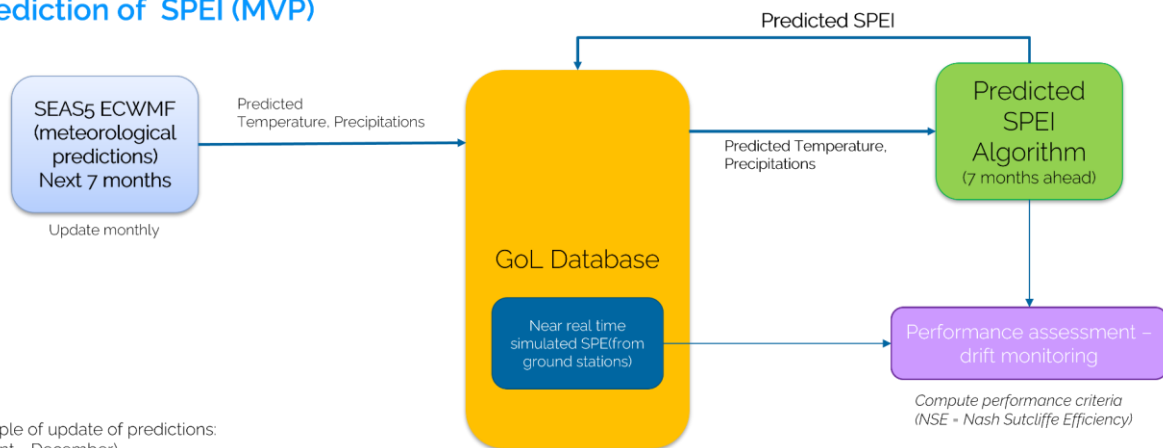


The Minimum Viable Product focuses on the Standardised Precipitation Evapotranspiration Index (SPEI), and the Normalised Difference Vegetation Index (NDVI). The two of them are to be plotted in near real time. The following two figures provide the general dataflow of those two pipelines for current drought assessment, and the detailed computation of SPEI.



Figure : Calculations of SPEI for current assessment

Data flow Prediction of SPEI (MVP)



Example of update of predictions:
Present - December)

Iteration 1 T - 0 (Dec)	SPEI jan	SPEI Feb	SPEI Mar	SPEI Apr	SPEI May	SPEI Jun	SPEI Jul		
Iteration 2 T + 1m (Jan)	Check perf of SPEI Jan	SPEI Feb 2	SPEI Mar 2	SPEI Apr 2	SPEI May 2	SPEI Jun 2	SPEI Jul 2	SPEI Aug	
Iteration 3 T + 2m (Feb)		Check perf Of SPEI Feb	SPEI Mar 3	SPEI Apr 3	SPEI May 3	SPEI Jun 3	SPEI Jul 3	SPEI Aug 2	SPEI Sep

Figure : Dataflow to generate SPEI forecast, assess performance of forecast and update logic



7 CONCLUSIONS

7.1 Summary of key findings

The GERM OF LIFE project has successfully developed a comprehensive approach to drought management in the Mediterranean region, integrating scientific and technological expertise to create three key platforms: a drought risk detection platform, a vulnerability assessment tool, and an innovation procurement platform. Through collaborative efforts, the project has addressed critical challenges such as data harmonization, ecosystem-specific vulnerability assessment, and the facilitation of drought mitigation strategies. The pilot studies in Greece, Italy, Portugal, and Spain have provided valuable insights into the impacts of drought on various ecosystems, highlighting the need for tailored solutions. The project's innovative approach will be tested starting from Period 5 to demonstrate the accuracy and effectiveness of drought management. The co-design approach has ensured that the tools developed are practical and user-friendly, reflecting the real needs of stakeholders. Moving forward, the continued refinement and implementation of these solutions in Period 3 and Period 4 will play a crucial role.

7.2 Future steps and recommendations

To ensure the successful implementation and refinement of the GERM OF LIFE project's solutions, future steps and recommendations are:

Questionnaires to Implement and Test the VAI:

PTAs to elaborate on questionnaires to gather quantitative and qualitative data necessary for calculating the Vulnerability Assessment Index (VAI). These questionnaires should be designed to capture essential information on social, economic, environmental, governance, and farming practices indicators.

Conduct pilot tests with stakeholders to validate the effectiveness and accuracy of the VAI calculation. Feedback from these tests will be crucial for refining the assessment tool and ensuring it meets the needs of various ecosystems.

Selection and Integration of NBS in the Database:

Identify and select appropriate nature-based solutions (NBS) that address drought mitigation and ecosystem restoration. This involves evaluating existing solutions and suppliers, ensuring they align with the specific requirements of the pilot areas.



Integrate the selected NBS into the project's database, creating a comprehensive catalogue that can be accessed by public procurers and stakeholders. This database should include detailed information on each solution, its applicability, and supplier contacts.

Maintaining Periodical Meetings Among Technical Partners and PTAs:

Continue regular meetings between technical partners and Pilot Test Areas (PTAs) during activities A1.4, A1.5, and A1.6. These meetings are essential for ensuring consistency in the implementation of requirements and facilitating effective communication and collaboration.

Use these meetings to review progress, address challenges, and make necessary adjustments to the project plan. This collaborative approach will help maintain alignment with project goals and ensure the successful deployment of the developed solutions



8 Appendices

8.1 Supporting documents

Throughout this collaborative creation process among all partners, where knowledge sharing has been key to the success of this work, as supporting material for all those interested in this document, we have uploaded to the Basecamp repository important documentation from all the workshops held that shaped the co-design methodology, which has been fundamental throughout this process. We will include material from an initial internal preparatory workshop among partners, and three additional workshops where work was done jointly on the three platforms that shape this project: risk prediction, vulnerability, and bidding.

1. Internal Workshop

The meeting took place on November 25th online and started at 14.00 CET. After Ubitel's presentation of the main characteristics of the workshops, the partners discussed the concrete details of those workshops, especially which concrete indicators should be used connected with the specific characteristic of the 4 pilots of Germ of Life project.

2. 1st Workshop

This first online workshop with project partners and local stakeholders focussed on the Vulnerability Assessment Tool and had two main sections:

1. review of general flow and use cases for the VAT
2. discussing and identify socioeconomic indicators relevant for local pilots

No critical issues were identified, although each Pilot lead committed to define a set of priorities to select their indicators among the highly ranked options emerged with the survey done in July 2024.

The focus of the VAT platform is to assess vulnerability at local level and not just to identify hazard or drought risk using regional or national dataset. Indicators need to be site specific and mix qualitative information and quantitative data.

The tasks assigned after the workshop:

- each pilot lead will review on miro their key indicators
- tech partners will draft some mockups to test the skeleton of the VAT application



- workshop facilitators will reorganize miro board and prepare for second workshop on IPP

3. 2nd Workshop

This second online workshop with project partners and local stakeholders focussed on the indicators for the Vulnerability Assessment Tool and the flow of the Innovation Procurement Platform.

The working group discussed the importance of stakeholders' engagement and the development of a vulnerability assessment tool, focusing on the transition from hazard and drought risk to vulnerability. They also discussed the integration of indicators into the index for vulnerability assessment, the potential for a third-party platform for accreditation, and the need for guidelines on procurement systems for public entities and solution providers. The conversation ended with discussions on the final report's content and format, considering its use in procurement processes.

4. 3rd Workshop

This workshop was facilitated by Atos in order to clarify requirements for Activity 1.4, such as optimal predictive time horizons, spatial scale, how the outputs would be used. The different activities enabled to identify priorities and to list elements yet to clarify.



5. MIRO screenshots of the co-design process

Project Background



Germ of Life

Germ of Life expects to build and technologically evolve an existing practice tested in the Interreg project DiDaDraze where an operational mode for the implementation of a proactive drought management has been established in Danube regions.

Germ of Life will make a **step forward in the automation and precision of the state of soil and vegetation risk assessment** thanks to advances in analysis and actionable knowledge from the monitoring and data-driven solutions in place.

Prediction will be based on the identification of drought events performed by analysing their key characteristics: magnitude and duration (combined to quantify the intensity), frequency, timing, co-occurrence/fluctuation dynamics and spatial extent.

In Germ of Life project, led by the outputs of the **Drought Risk prediction, a Vulnerability Assessment Tool** processed in the form of decision support system (DSS) built on open-source technologies, **implements a computer program application for improving decision making capabilities** based on data collected and processed.

It receives risk prediction information (AI-based) in processed forms and includes a dashboard for risks visualization based on the KPIs identified. **Introduce a collaborative space** where the assessment from different stakeholders can take place on the specific drought risk area, produce structured reports available for decisions and mitigation actions functional requirements, include geospatial information.

"Digital Drought Risk Management enabling the drought mitigation and adaptation strategies for the restoration of the ecosystem equilibrium in Mediterranean European Countries".

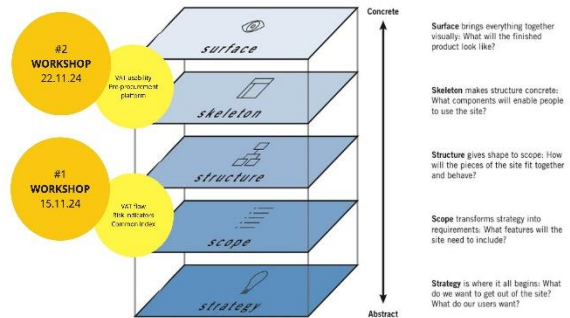
Drought risk = Vulnerability x Hazard x Exposure



Platforms & Requirements

The project aims to address identified challenges and leverage opportunities to provide **proactive drought risk management** through new and adaptable solutions that support various stakeholders in:

- Drought Risk Forecasting:** leveraging artificial intelligence and timely alert systems based on data; remote sensing and the use of new, potentially valuable data for identifying and quantifying the impact of drought.
- Vulnerability Risk Assessment:** enhancing cooperation for risk management and evaluation, and supporting decision-making processes regarding the planning, assessment, and sharing of results related to the performance and impact of nature-based solutions (NBS) through data monitoring and evaluation.
- Proposing Innovative Solutions:** supporting public authorities in the effective implementation of strategies and plans, including technologies and nature-based solutions (NBS) suitable for drought risk mitigation.



Requirements Gathering

Requirements | 3

- Drought Risk Forecasting
- Vulnerability Risk Assessment Tool
- Proposing Innovative Solutions

Prio 1: Must-Haves | 3

- Timely alert based on data
- Create vulnerability score/spectrum
- Input vulnerability score

Prio 2: Should-Haves | 3

- Leveraging artificial intelligence
- Adjust Indicators and select criteria
- Pre-procurement matching

Prio 3: Good-to-Haves | 3

- Quantify impact of Drought
- Download vulnerability report
- Suggest mitigation strategies



Social Factors

- Households/farmers with access to information (radio/WiFi/internet) (€)
- Risk perception (‰ of population who has experienced droughts in the past 10 years)
- Availability of a drought early warning system (yes/no)

- Population undernourished (%)
- Out of pocket expenditure on health (%)
- Age dependency ratio (% of working-age population)
- Population with ill-health (%)
- Rural population (% of total population)

Economic Factors

- Agriculture (% of GDP)
- Dependency on agriculture for livelihood (%)
- High dependence on tourism for income and employment (% of GDP)

- Population below the national poverty line (%)
- Farmers/labourers without savings (%)
- Market fragility
- Unemployment rate (%)
- Distance to closest market (km)
- Farmers with crop, livestock or drought insurance (%)

Infrastructure

- Total dam capacity
- Electricity production from hydroelectric sources (% of total)
- % of retained renewable water

- Population without access to (improved) sanitation (%)
- Poor water quality
- Population without access to clean water (%)

Are these indicators still relevant or adequate to assess vulnerability for local pilots? do they have the data to populate indicators?

Governance

- Disaster risk taken into account in public investment and planning decisions (yes/no)
- National investment in disaster prevention & preparedness (US\$/Year/capita)
- Existence of national adaptation policies/plans (yes/no)

- Number of (drought-related) adaptation projects in the past 10 years
- Government effectiveness
- Research and development expenditure (% of GDP)
- Food aid (US\$ per capita)

Environmental factors

- Water stress
- Soil depth (mm)
- Degree of land degradation and desertification

- Soil organic matter (g/kg)
- Livestock health
- Area protected and designated for the conservation of biodiversity (%)

Farming practices

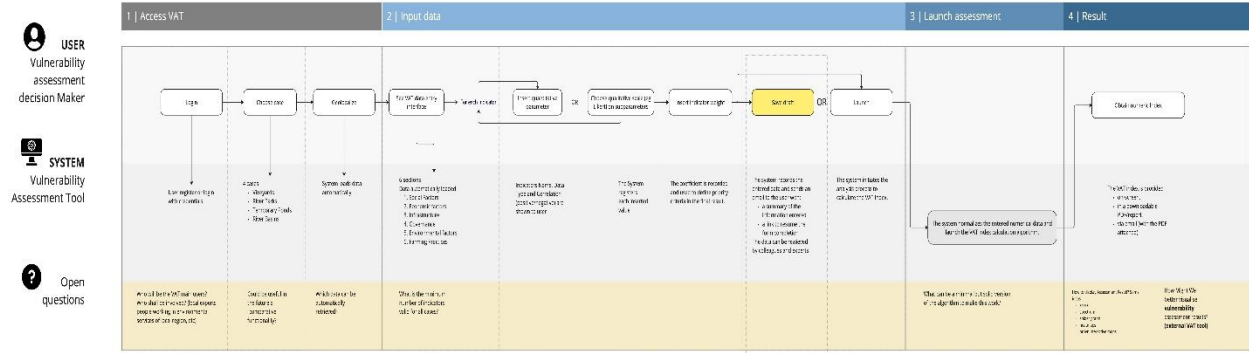
- Irrigated land (% total arable)
- Access to fodder (kg purchased per year)
- Use of fertilizer (ton)

- Tonnes of active ingredients of insecticides and pesticides used
- Farmers use different crop varieties (%)
- Cultivation of drought-resistant crops (%)





VAT General flow & User Journey



IPP > Innovation Procurement Platform

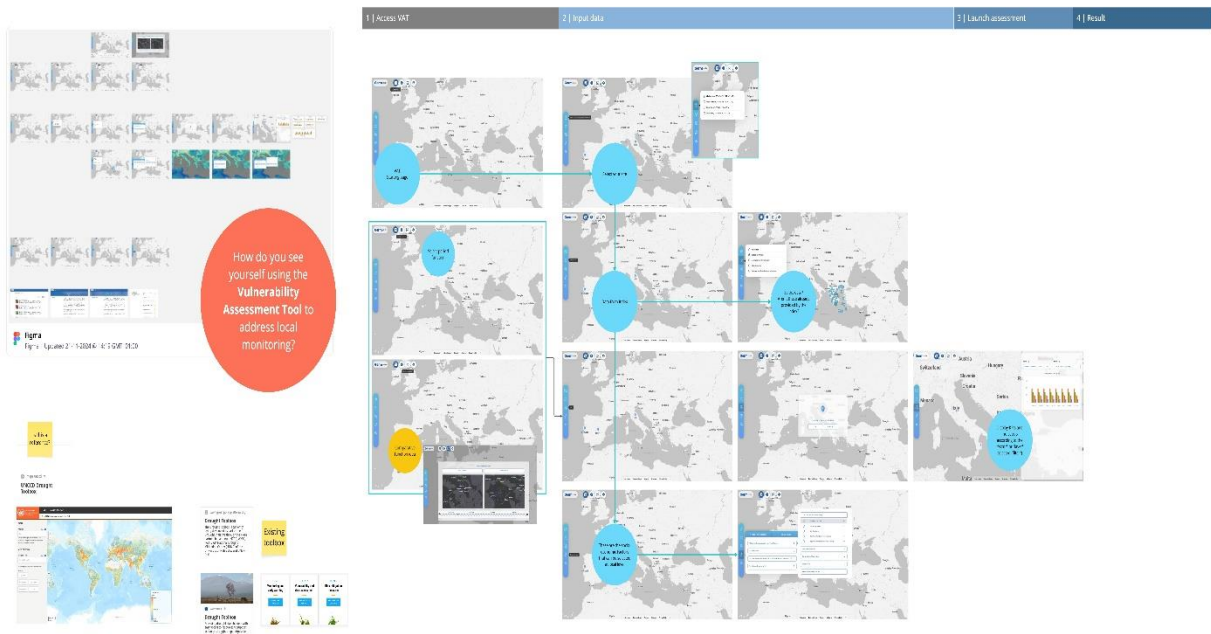
Hypothesis of GoL-DVI

Vulnerability Index Assessment

Vulnerability Index	Indicator	Indicator	Indicator	Indicator	Indicator
High	High	High	High	High	High
Medium	Medium	Medium	Medium	Medium	Medium
Low	Low	Low	Low	Low	Low

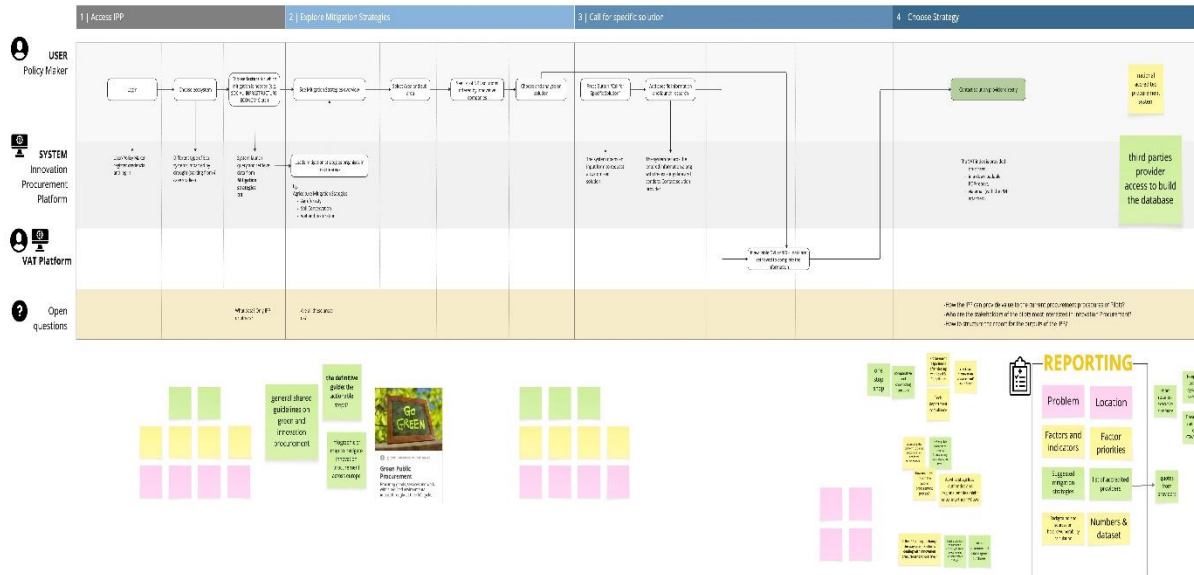
Key points to address in the 1st VAT workshop

- When are the "Vulnerability assessment decision maker", main users?
- What are the "use cases" for each of the pilot cases (Vulnerability Index, River Parks, etc., Temporary Parks, etc.)?
- When are the main stakeholders? (e.g., experts, organizations, etc.) that should be involved directly in the first pilot cases through "assessment sessions"?
- How to quantify such indicators and assessment (e.g. questions and/or tools)?
- Should we consider the assessment "Vulnerability Index" as a tool to allow the possibility to refer, using the Vulnerability Index, to the prioritization of mitigation strategies?





IPP General flow & User Journey



IPP > Innovation Procurement Platform

