M13 – Sustainability and Upscaling Plan

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Contents

1   Introduction

This report describes the sustainability plan, for the information currently available, of the SEBASTIEN project's products - namely data, algorithms, software, services, platforms (for both processing and exploitation), and other documentation or material - after project completion (October 2024). The sustainability plan aims, on the one side, to foster and enable further exploitation, update, upgrade or in-depth development of the above-mentioned products by identifying and describing the possibilities of promoting, using and accessing them; and, on the other side, to identify specific actions to be carried out by project partners which may foster further developments.

Towards these directions, the sustainability plan's main objectives are:

1.   to summarize SEBASTIEN products and how they will remain available after project completion, including licensing and IPR issues;

2.   to identify possible enablers or barriers for the future further development of the non-commercial demonstrators to pre-operational services produced within the framework of the project as a set of illustrative or pre-operational services for different users.

In particular, key elements will be synthetized for the exploitation and sustainability of SEBASTIEN products, taking into account access, the target groups, the possible financing sources etc.

2   Sebastien services

In the following sections, an overview of SEBASTIEN services is provided.

2.1. Service 1

The general scope of this Service is to support livestock farming to contrast climate change, in the short and long term. The service was split into three sub-Services, with the objective of responding to multiple possible stakeholders' needs.

-        Service 1.a formulated and implemented a Machine Learning (ML) model of heat stress effects on livestock production (quantitative and qualitative characteristics of the milk). Short-term (2-days) weather forecasts (using COSMO-2I data) and long-term climate projections (using VHR-PRO data available over HIGHLANDER and CMCC delivery systems) were used.

-        Service 1.b aimed at identifying animals more genetically resilient to adverse environmental conditions which could transmit this characteristic to future generations. In these terms, the adaptation of different cattle breeds in stressful environmental conditions, in terms of THI (inside and outside the barn) has been evaluated using future climate projections.

2.2. Service 2

This service was devoted to the evaluation of the THI computed inside stables. The results were also used in Service 1.a to evaluate the heat stress of the cattle inside stables. Artificial Intelligence (AI) was exploited to evaluate the THI by implementing the relationship between some input parameters and the related THI value. Specifically, the considered predictors are: i) the latitude and longitude of the stable, ii) the altitude of the stable, iii) the external THI considered at the location (latitude, longitude) nearest to the stable. The service is composed of two sub-services.

-        Service 2.a had the objective to estimate the variation of THI inside a stable for the next two days, with an hourly temporal resolution. Given the latitude, longitude and altitude of the stable and the external THI value, the developed ML approach can extract the possible THI inside the stable.

-        Service 2.b aimed at projecting the likely variations of THI inside a stable due to climate change under RCP4.5 and RCP8.5 scenarios for near- and long-term time horizons, as difference between 30-years future periods and a specific baseline (1981-2010). By implementing different countermeasures (e.g., types of conditioning systems and stable arrangements), users could plan adaptation actions and design the optimal setup of new stables in a climate-proof concept, reducing then the stress on animals due to the expected future increases in temperature. The possible THI inside the stable is evaluated by exploiting the same ML approach developed for Service 2.a.

2.3. Service 3

The management of an extensive farm is not easy as it is not possible to monitor the animals constantly and the feed availability (in terms of quantity and quality). To monitor the surrounding environments of extensive livestock farming, satellite data were used to observe vegetation conditions. This will allow the user to schedule and update grazing availability and detect possible overgrazing effects. Satellite data were combined in a statistical model with pasture field data, to evaluate pasture productivity and characteristics.

2.4. Service 4

Service 4 will help farmers and decision makers to contrast the spread of diseases from parasites (i.e. bluetongue in sheep) or health conditions (i.e. mastitis in bovine). Literature information about the environmental, climatic, farm management, geographical conditions, which can potentially favor or trigger them, were used in training models, then used under climate projections. The results of this service will be risk maps for parasites and diseases' spreads. The service is composed of two sub-Services.

-       Service 4.a used ML approaches to produce future maps of the probability of developing Blue Tongue in sheep in Sardinia.
-       Service 4.b aimed at assessing the effect of environmental stressful conditions (heat stress) on the somatic cell count (SCC) that are normally present in milk and represent an index to estimate mammary gland health and milk quality and it is affected by different factors (e.g. the animal's health, lactation stage, breed) by changes in the environmental conditions and stress conditions.

3   Project assets

3.1 Overview

A categorization of assets has been arranged here as a framework to initiate reflections on project sustainability within the partnership and design strategies and proposing tools to promote its future developments.

Although the final aim of SEBASTIEN is the delivery of 4 services (see Sect. 2), these are composed of: data; algorithms for data pre-processing, processing/inclusion into models, post-processing; elaboration workflow to make input, intermediate and output data available to users (in terms of digital products through the Service platform, but also for user-friendly dissemination through the website e.g. by mean of graphical products); as well as the platform and web site and portals enabling the execution of all the workflows and the exploitation of results, respectively.

After summarizing all SEBASTIEN categories of products (Table 1), three criteria which are related to sustainability have been used to categorize them:

- the regular update or maintenance of the asset after project completion;
- the possibility of exploitation by stakeholders external to the project partnership;
- the responsibility of such update/maintenance.

Table 1 - List of SEBASTIEN products and associated licenses and owners.

ID	Products	License	Owner
1	Datasets	Open	SEBASTIEN
2	Algorithms (from pre- to post-processing)	Open	SEBASTIEN
3	Dissemination products/elaborations	Open	SEBASTIEN
4	Platform	Open/Apache 2.0 license	SEBASTIEN
5	Website/Exploitation portals/tools	Open	SEBASTIEN

We refer mostly to Milestone 4 for the description of datasets, algorithms and services.

These criteria led to the definition of two products categories described below:

- *internally maintained*: assets will be maintained updated by project partners;
- *exploitable/open to sustainable external exploitation*: assets which are exploitable by external stakeholders interested in the topic and item. These products will not necessarily be updated/maintained by project partners, as this category also includes "ready to use" items, such as reports, maps, images, leaflets.

Each service's lead partner or contributor has been asked to focus on the elements provided for the Services according to the proposed categories with ID 1-2-3 of Table 1 and to answer to a set of questions aimed at identifying needs, barriers and enablers of future sustainability. The Questionnaires are reported in Annex 1 and obtained answers are analyzed in Section 3.2. Section 3.3 is about the platform and exploitations portals (website, other).

3.2 Services components' sustainability

In total, 19 respondents to questionaries ensured that the Services are represented in a balanced way, with a slight dominance of Service 2 and then 3 (Figure 1).

Figure 1: Share of respondents among Services

Concerning the type of products (Figure 2; note that more than one selection was possible among type of products due to numerosity of them), datasets will be mostly internally maintained (8), e.g. climate simulations will be regularly updated, some (7) will continue to be available but without upgrades/updates, and a limited part (5) available to be sustained externally. The last option (external maintenance) is the one dominating (14) for further elaborations from available datasets, that are numerous also beyond SEBASTIEN and can serve additional sectors; thanks to the updates of most of datasets produced directly by partners, also maintenance of elaborations (10) can be kept aligned, while a minor part (8) will remain available for consultation without new releases. Coming to algorithms, the partners will continue to fine tune most part of them (15), many (12) will remain exploitable while a very small part (3) could be exploited externally, probably due to peculiarities in formats and languages that could require specific competencies.
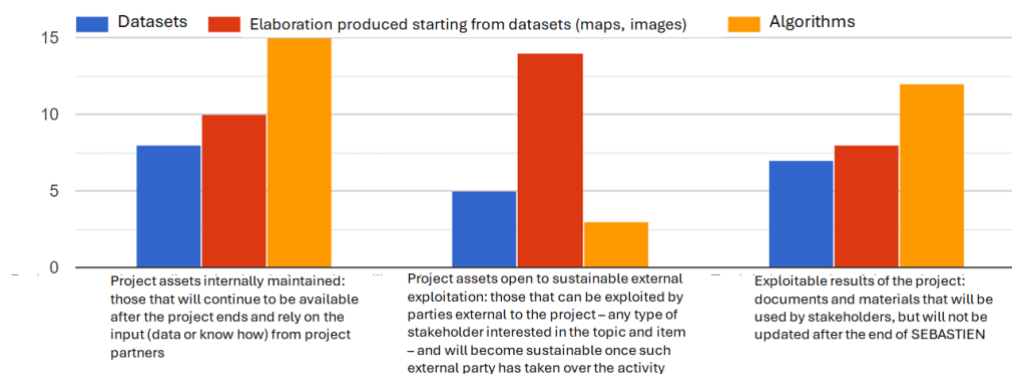

Figure 2: Type of products and exploitation horizon/level

In terms of licenses (Figure 3), for almost 70% of respondents it is not yet defined. For the rest, for more than 20% they were already defined, and it is always CC BY 4.0, while for 10% of respondents they have been already defined only for some products within the Service.
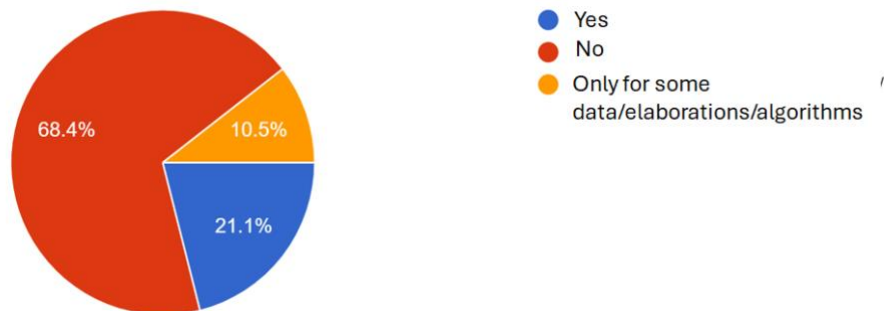

Figure 3: License definition for services

Concerning the possibility to further develop/advance/upgrade the Services (Figure 4), no Agreement is already in place, but most of respondent (84%) wants to continue collaboration by establishing agreements. In very few cases (slightly more than 5% each) there is no interest or possibility (because of future data lack), or the Service will continue to be developed regardless of agreements or new projects. In case of Agreement needed, for 90% of respondent (not shown) it is required among all the partners contributing to the Service development, not only with the leader. The possibility to work on agreements for specific Service' continuation will be discussed at the end of the project among interested partners.

Figure 4: Requirements for next development of the Services

For now, continuation of the specific services under a newly funded project is not expected, except continuing thanks to PNRR funds under Agritech project.

In terms of scientific outputs linked to the above products, that are and will remain available even without any continuation of technological (data, algorithms, platforms) components of the project, dissemination material as scientific papers and associated datasets will be accessible via open repositories or via partners' facilities such as CMCC, following the principles of Open Science. Some partners will keep promoting their scientific output through their social media channels after the end of the project to foster their circulation to a broader audience.

3.3 Platform and web service portal sustainability

The platform hosting SEBASTIEN's services represents an enhancement and adaptation of the platform available in the HIGHLANDER project, properly adapted and modified to better manage the livestock sector datasets and related services.

In these terms, the SEBASTIEN Data Delivery System (https://dds.sebastien-project.eu) is a service web portal that provides access to all the services developed in the context of the project and to the various visualization tools. It allows registered users to interact with the computational capability of the underlying system and to visualize the results as maps or graphs.

SEBASTIEN relies on four main types of input data: climate data, weather data, in situ sensor data and satellite imaging data exposing the related services using common international standards and formats to ensure broad interoperability and reusability (see also M17 - Compliance with the Metadata Quality Assurance (MQA) tool for datasets).

Access to the SEBASTIEN DDS is currently available upon registering procedure. Once logged in, users can request different maps or graphs by using various filters offered by the graphical user interface (e.g., RCP scenario, phenotype, livestock type, etc.).

It relies on a modular architecture made up of several components which can be updated independently. Each component can also be integrated with further existing services and shared with other projects supporting the sustainability of the platform reducing the cost of maintenance.

The resources needed to keep the SEBASTIEN platform operational after the project's completion involve maintaining the hardware and ensuring the availability of the HPC system. Additionally, it requires the ongoing involvement of expert personnel, measured in person/months, to support these efforts over time.

As mentioned above, the continuation of the specific services under a newly funded activities as follow up of SEBASTIEN is not expected (except the PNRR funds under Agritech project). However, the platform, and in particular the underlying processing system, will be maintained and updated as they represent a CMCC effort and product that can be adapted and exploited in subsequent initiatives. In particular, initiatives that currently support the development and maintenance of the DDS platform include:

- SDGs-EYES – Sustainable Development Goals – Enhanced monitoring through the family of copErnicus Services - HORIZON-CL4-2021-SPACE-01 – which aims to boost the European capacity for monitoring the SDGs based on Copernicus, building a portfolio of decision-making tools to monitor those SDG indicators related to the environment from an inter-sectoral perspective, aligning with the EU Green Deal priorities and challenges (end date 31 December 2025).
- SILVANUS – Integrated Technological and Information Platform for wildfire Management - H2020-EU.3.5. - SOCIETAL CHALLENGES – which envisages to deliver an environmentally sustainable and climate resilient forest management platform through innovative capabilities to prevent and combat against the ignition and spread of forest fires (end date 31 March 2025).

These projects, despite their different scope, are based on a processing platform that exploits many of the components used in SEBASTIEN and will support the continuity of the DDS both by maintaining the platform and by continuing its development.

4 Sustainability enablers and barriers

This Section lists the main factors which may enable, or limit, future developments of SEBASTIEN products, as well as actions undertaken by SEBASTIEN partners to reduce such barriers while maximizing enablers. As already mentioned, the Services are more at demonstrators to pre-operational stage and not intended to be services to the market within the project scope. Identified licenses for all products are already mentioned in Section 2.

4.1 Input data availability

For the assets which are open to sustainable external exploitation for future developments, it is relevant to note that the requirement of a regular and constant update of input data is the main constraint cited by SEBASTIEN partners involved in the Services, also to support further algorithms and elaborations. Given the increasingly availability of – even improved - climate reanalyses and projections and satellite imagery through Copernicus services (especially C3S and CLMS) and given the CMCC effort in maintaining the very-high resolution downscaling for both reanalysis and projections, we expect that most of fundamental data will continue to be available. New local or sectoral data can be facilitated by the consolidated collaboration of partners with key stakeholders like farmers'/breeders' association.

4.2 Financial resources

Among the enablers for the infrastructure and human resources' side, the main funding opportunities under the next Work Programme 2025 in Horizon Europe were preliminarily identified and will be discussed among partners in the following months. Table 2 report a summary of them. Moreover, new forthcoming national and international funding opportunities will be also pursued.

Table 2 – Possible calls in the Horizon Europe Work Programme 2025 allowing follow-on of SEBASTIEN

Cluster 6 - Food, Bioeconomy, Natural Resources, Agriculture and Environment	Type	M€	N. expected projects	Note
HORIZON-CL6-2025-02-FARM2FORK-02: Additional activities for the European partnership on animal health and welfare	RIA	12	2	50% cofin; The proposal must be submitted by the coordinator of the consortium funded under HORIZON-CL6-2023-FARM2FORK-01-2 (where partner UNITUS is involved)
HORIZON-CL6-2025-02-FARM2FORK-08: Fostering animal breeding and genetics for climate change adaptation and mitigation, improved robustness and resilience	RIA	12	2	
HORIZON-CL6-2025-02-FARM2FORK-07: Improving grassland management in European livestock farming systems	RIA	16	2	

Annex 1 - Questionnaire

a) Which Service are you filling out this form? If, as an organization, you are involved in more than one Service, we kindly ask you to fill out a form for each of the Services.

Service 1 - Coping with environmental stressors for breeds to support livestock farming towards breed adaptation to environmental conditions and production needs.

Service 2 - Intensive farming risk management under climate extremes to alert about approaching or projected dangerous environmental circumstances for cattle.

Service 3 - Extensive farming management and feed availability based on indicators/indices about the phenological stage and greening of the naturally vegetated or managed areas used to feed livestock heads when conducted outdoors.

Service 4 - Livestock farming under risks from combined abiotic and biotic factors to provide updated risk maps of parasites and diseases spread.

b) Indicate, with reference to the Service for which you are filling out the form, how you would classify the outputs of the Service based on the three types of assets identified.

	Datasets	Elaborations produced from datasets (maps, images)	Algorithms
Project assets internally maintained: those that will continue to be available after the project ends and rely on the input (data or know how) from project partners			
Project assets open to sustainable external exploitation: those that can be exploited by parties external to the project – any type of stakeholder interested in the topic and item – and will become sustainable once such external party has taken over the activity			
Exploitable results of the project: documents and materials that will be used by stakeholders, but will not be updated after the end of SEBASTIEN			

c) Has a license been defined for the data/processing/algorithm output from the Service?

1. Yes
2. No
3. Only for some data/processing/algorithms

d) Only if you have indicated that a license has been defined for all or some datasets/processing/algorithms output from the Service, can you tell us which type of license?

(open answer)

e) Select the option that most applies to the Service with reference to its potential development from the perspective of your organization (only one possible choice)

1. We are not interested in further developing the Service
2. The future development of the Service is limited by the need to have a regular and constant updating of the input data
3. We are willing to develop collaboration agreements for further development of the Service
4. Agreements are already in place for the further development of the Service
5. The Service will be further developed directly by the partners involved

f) For a further development of the service starting from the Service carried out in SEBASTIEN it is necessary:

1. Sign a collaboration agreement with all the partners involved in the implementation of the Service
2. Sign a collaboration agreement with the Service lead

g) Is the further development of the Service envisaged, even if only partially, in a new European project (even if only "submitted"/"in preparation")?

1. Yes
2. No

h) We ask you to include in this section some information on European projects in which it is planned to further develop the Service. The project is (if there are multiple projects in different categories below, you can select more than one category):

1. 1) in preparation

2. 2) "submitted" pending evaluation

3. 3) financed (under negotiation or ongoing)

4. 4) nothing in preparation

i) Only if you have indicated 1), 2) or 3) to the previous question, could you give us some more brief information for each project or proposal? (e.g. funding program, project title/acronym, duration, partner, budget, if in preparation, submitted or approved/ongoing?)

(open answer)