EMPHASIS

D6.3: Report on services tested and potential KPIs (key performance indicators)

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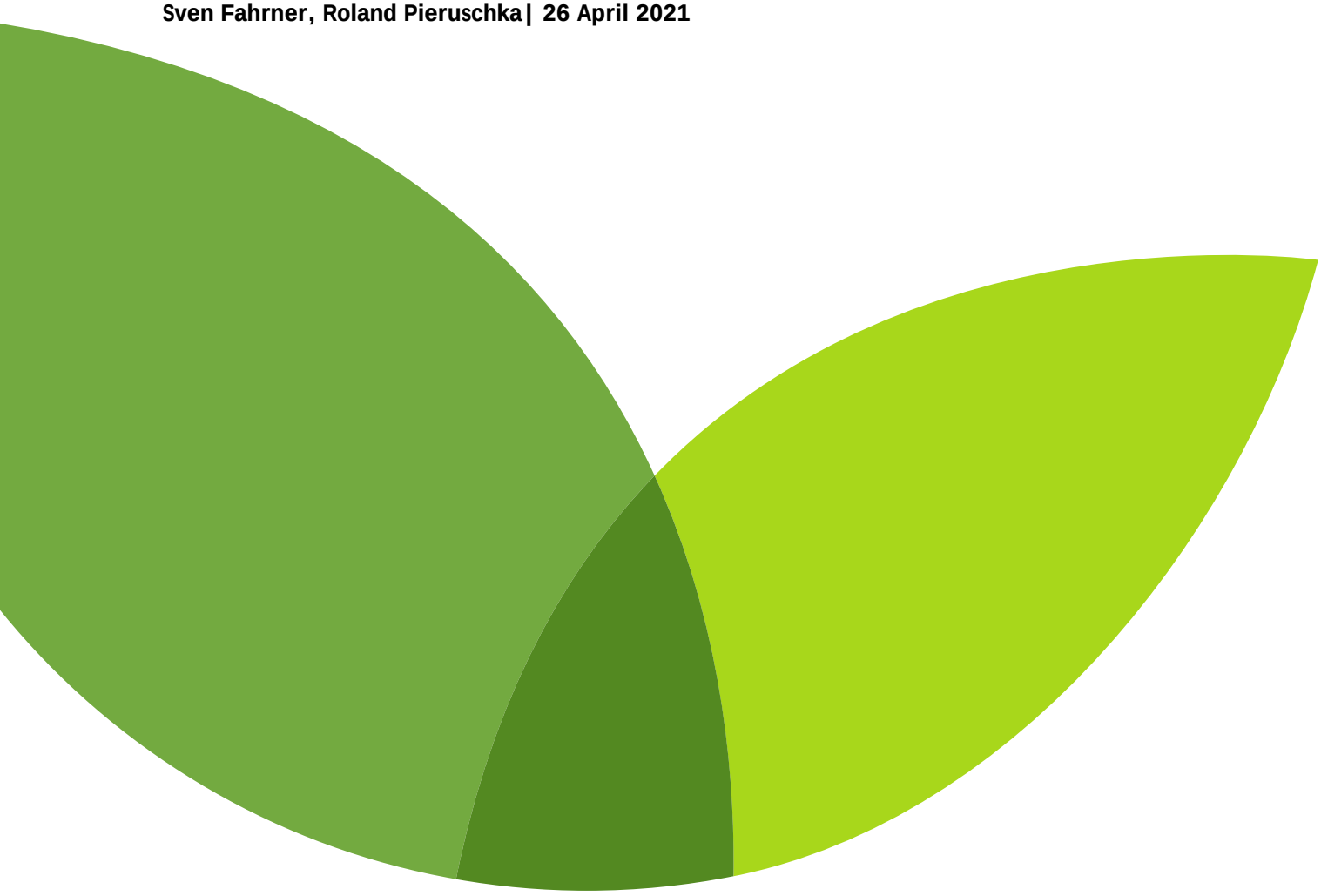

EUROPEAN INFRASTRUCTURE FOR PLANT PHENOTYPING

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Content

Documents used in the preparation of this deliverable:

- ESFRI Working Group Report "Monitoring of Research Infrastructure Performance (https://www.esfri.eu/sites/default/files/ESFRI_WG_Monitoring_Report.pdf)
- ERIC Forum Position Paper on the Development of KPIs for Research Infrastructures (https://www.eric-forum.eu/2019/07/09/eric-forum-position-paper-on-the-development-of-kpis-for-research-infrastructures/)
- OECD Reference framework for assessing the scientific and socio-economic impact of research infrastructures (https://community.oecd.org/docs/DOC-156270)
- RI PATHS Guidebook for socio-economic impact assessment of research infrastructures 8https://ri-paths-tool.eu/files/RI-PATHS_Guidebook.pdf)
- Minutes of the 1st EMPHASIS Interim General Assembly Meeting (confidential)
- Preparatory documents of the 2nd EMPHASIS Interim General Assembly Meeting (confidential)
- Minutes of the 2nd EMPHASIS Interim General Assembly Meeting (confidential)
- Preparatory documents of the 3rd EMPHASIS Interim General Assembly Meeting (confidential)
- Minutes of the 3rd EMPHASIS Interim General Assembly Meeting (confidential)

1. Executive Summary

Scope of this deliverable

This Deliverable summarises the concepts and evaluation approach to EMPHASIS pilot services which have been developed and conceptualised in the framework of the EMPHASIS-Prep project and represent a subset of the final service protfolio. These services will be delivered to the user community already within the Implementation Phase in order to (1) help further increase visibility of EMPHASIS with its stakeholders, (2) illustrate that EMPHASIS can deliver benefits, and (3) test feasibility and learn "operational procedures" in pan-European service provision. The success of the pilot services will be evaluated at the end of the Implementation Phase, and experiences gained used in service provision in the Operational Phase.

Main results of the deliverable

The pilot services address user demand identified in the EMPHASIS-Prep mapping activities in the first project period including fields of :

- Field phenotyping,
- Innovation,
- Harmonisation,
- Data management,
- Modelling, and
- Training.

The objectives and work plan of each pilot service as well as key performance indicators needed for their evaluation are presented in this deliverable.

2. Role and concept of pilot services

Scope

EMPHASIS-Prep did conceptualise pilot services based on the user demand mapping which has taken place mainly in the first years of the project. Delivering these pilot services will be a major activity for the Implementation Phase, helping to bridge preparation to the Operational Phase.
The pilot services:

- Are Intended to
    - Help further increase visibility of EMPHASIS with its stakeholders, specifically with its users,
    - illustrate that EMPHASIS can deliver benefits and thus help build trust with EMPHASIS services at an early stage of its life cycle,
    - test feasibility and learn "operational procedures" in pan-European service provision integrating different plant phenotyping facilities (controlled conditions, field, data, modelling);
- represent SOME selected services from the full Operational Phase service portfolio, but do not intend to meet full user demand as identified by constant mapping activities;
- Have been conceptualised as part of the EMPHASIS-Prep project; pilot delivery will take place as part of EMPHASIS implementation starting 2021 and thus requires additional funding (e.g. third-party funding or direct funding by EMPHASIS Interim General Assembly member countries);

The pilot service concepts have been agreed on by the EMPHASIS Interim General Assembly and will be financially supported by IGA member countries. They will start in 2021 and be operated throughout the Implementation Phase (according to the current planning ending December 2021). Each pilot will be evaluated in line with its specific key performance indicators (chapter "Key performance indicators of pilot services" on page 7 ff), and optimised accordingly towards the Operational Phase. The experiences gained by the pilot services will be integrated into the Operational Phase service provision.

Objectives and work plan of each pilot service

Field pilot service

EMPHASIS will facilitate standardized and interoperable plant phenotyping in multi-environment field experiments through co-ordinated services. Field phenotyping is highly demanded by the scientific community and regarded as very challenging. In this pilot, first steps will be taken to enable multi-environmental field experiments across field phenotyping infrastructures. The pilot will identify suitable field infrastructures, draft services, level agreements with participating countries including minimal requirements, equipment, logistics, data- and protocol management and access models.

Task 2.1 Identifying suitable field infrastructures, including:

- access models: what sites are available for access;
- available equipment, both for phenotyping and for environmental- and physiological monitoring;
- specific logistics such as agronomic management of qualifying field sites;
- training requirements;

Task 2.2 Drafting service level agreement (SLA) for participating facilities, including:

- defining minimum requirement to qualify for plant phenotyping field sites (in cooperation with the harmonisation and the data pilot);
- minimum requirements for data management (e.g. FAIR principles, open source repository of data, in cooperation with the data pilot);
- quality policies (e.g. cost models, protocol handling, data and statistical design);

Task 2.3 Supporting for researchers involved in multi-environment field trial experiment, including:

- identifying funding opportunities, e.g. ERA-Net like project (link to WP1);
- developing procedures for access calls for field experiments;
- training researchers for e.g. setting up field experiments (Link to WP7);

Innovation pilot service

EMPHASIS builds upon the significant advances in plant phenotyping technology, infrastructure and methods that have taken place across Europe over the last decade. These provide a solid basis for the construction and operation of a pan-European research infrastructure. However, the continuing, rapid developments seen in core technology areas of sensors, robotics and artificial intelligence present both an opportunity and a challenge. Monitoring and exploiting research and development in appropriate areas will allow EMPHASIS to remain at the forefront of plant phenotyping into the future. Constant (re-)development is needed to ensure that EMPHASIS facilities employ the best available technologies and methods, and continue to provide a high quality of service. EMPHASIS facilities represent a valuable testbed for those developing new approaches and, more importantly, confidence in EMPHASIS' internal market will allow public research agencies and SMEs to justify investment in the development of plant phenotyping tools, supporting mission-oriented innovation policy (Mazzucato 2017). For this to occur, EMPHASIS must develop procedures to identify relevant key and common challenges, and processes to coordinate and adopt new methods as they appear.

The aims of the EMPHASIS Innovation Services are therefore:

- to ensure the long-term sustainable excellence of the infrastructure
- to support and drive innovation in plant phenotyping technologies, tools and methods by the wider industrial and academic communities.

A key role for EMPHASIS' Innovation Services will also be to act as a broker between infrastructure operators/users and technology developers/suppliers.

Task 3.1. Engage with Key Sectors and Actors.

- Create a register of academic experts in key areas of phenotyping and associated technologies.
- Create a register of industrial contacts and bodies, identifying their areas of technical expertise and product development.
- Establish an innovation board in collaboration with the IGA that will draw on the above registers to evaluate and create and implement innovative tools and methods.

Task 3.2. Innovation services for EMPHASIS infrastructures and users.

- Poll the IGA members and users for i) technical challenges and ii) emerging technologies they require guidance on, produce and distribute briefing papers on those topics

- Make members that registered as experts to provide individual advice on available tools and methods, monitor level of interest and nature of queries.
- Establishment of a processes continuing innovation actions for the Operational Phase

Task 3.3. Innovation services for industrial and academic developers especially with respect to imaging and AI/machine learning. EPPN2020 has demonstrated a mechanism for the provision of 'development access' to phenotyping facilities to support in-situ evaluation of emerging methods. The development of AI/machine learning based solutions, however, relies more heavily on access to annotated image and sensor data.

- Review annotated image datasets i) currently available for use in developing AI-based phenotyping technology, ii) desired by members of the industrial and academic registers, iii) potentially available with EMPHASIS facilities.
- Create and make available online (e.g. via the Nottingham Annotated Crop Image Database, https://plantimages.nottingham.ac.uk/) a sample EMPHASIS annotated image dataset

Harmonisation pilot service

The harmonisation pilot will evaluate how to establish EMPHASIS as a central point of information on how to perform plant phenotyping experiments according to state of the art procedures. The aim is to develop and communicate with the plant phenotyping community on best practices (Good Phenotyping Practice). This will be a prerequisite to allow experimental reproducibility between infrastructures and reusability of the obtained data (e.g. by defining standards. Minimum requirements for plant phenotyping experiments under controlled and field conditions will be defined and guidelines on use and calibration of sensors will be communicated.

Task 4.1 Community exchange on harmonisation

- Organize workshops and round table discussions with operators of plant phenotyping facilities and users on Good Phenotyping Practice in all infrastructure categories:
  i) controlled environment,
  ii) intense field,
  iii) lean field (Link to WP2),
  iv) data and computational services (Link to WP5),
  v) modelling (Link to WP6)

Task 4.2 Requirements for Good Phenotyping Practice

- Evaluate and define experimental procedures required to enable comparability of experiments with focus on experimental design and analysis for single and multiple installation experiments, environmental monitoring, sensor calibration and application etc. (here we will use preliminary work from EPPN/EPPN2020 and extend it to EMPHASIS members)
- Map, evaluate and extend existing repositories hosting plant phenotyping protocols and their accessibility for the user community;
- Develop an EMPHASIS repository integrating information from existing repositories as well as new protocols and quality measures required for Good Phenotyping practice in plant phenotyping.
- Establishment of a processes continuing quality assurance for the Operational Phase

Data management pilot service

The objective of this pilot is to implement FAIR principles (findable, accessible, interoperable, reusable) to ensure that the datasets that are and will be collected in EMPHASIS installations are available to a large community of plant scientists. Such 'open science' approaches are increasingly required by most journals, on national and European level. Three levels of data management are defined to graduate the efforts needed in order to have the best practices:

Level 1: Data Identification and organization ('Reusable')

- Improve the quality of data: identifiers, spatial positions, events and variables, metadata.

Level 2: Local information system for environmental and phenotypic datasets

- Improve the quality of access to the data using information systems.

Level 3: A multi local information system facilitating meta-analyses

- Multi-site access through EMPHASIS-Layer.

Task 5.1: Providing support to reach level 1-2 compliance

- Helping partners to reach minimum requirements guidelines level 1&2 based on the implementation of those requirements in EPPN2020
- Developing information systems that can handle datasets obtained in both controlled condition and field conditions, with common ontologies of events, objects and traits
- Ensuring the compatibility of information systems deployed in different nodes (with WP communication)

- Organizing workshops and training to support the implementation of level 1&2 in EMPHASIS IGA countries (Link to WP7)
- Help local infrastructures to implement information systems, in particular with ontologies of objects, events and traits not considered in other local information systems, with the help of selected European SMEs

Task 5.2: Implementing the EMPHASIS-layer

- Establishing the strategy for an integrated European Phenotypic Information System including common ontologies and Web Services across platforms in controlled and field conditions (EMPHASIS-Layer)
- Providing a "use case" to demonstrate the use of Emphasis-Layer, including three local infrastructures connected to the layer from different countries.
- Implement further local infrastructures into the EMPHASIS-Layer by providing support and consulting

Task 5.3: Establish Data Management Policy for EMPHASIS

- Develop and implement rules on data property, sharing and right of the first use, including necessary metadata for FAIR sharing in accordance to the EU policy of open data.
- Establishment of a processes for data management towards the Operational Phase

Modelling pilot service

The plant phenotyping space is too immense to observe all aspects of the phenotype in all combinations of genotypes by growth stage by environmental conditions. Mathematical modelling offers many opportunities to enlarge the phenotypic space of phenotyping experiments through the computation of novel traits that are not directly accessible to available sensors. In addition, modelling also helps capturing the essence of observed phenomics data to predict integrated (e.g. yield) or functional traits (e.g. plant root system architecture) for new genotypes across a wide range of target environments or management practices. Leveraging the power of mathematical modelling in plant phenotyping depends on our ability to feed phenome data into structural plant models (SPMs), functional-structural plant models (FSPMs) and process-based crop simulation models (CSMs). This goes beyond the data management challenge, as it depends on the ability of the plant phenotyping community to design experiments and platforms that yield suitable data for modelling, and reversely. It is one of the objectives of EMPHASIS to improve the connectivity between the phenomics and the modelling communities.

Task 6.1: Get and keep the plant phenomics community aware of model applications

- Maintain and update the online portal (quantitative-plant.org, developed by EMPHASIS-PREP) referencing plant and crop simulation models.
- Promote the interest to modelling by advertising this website within the phenomics community.

Task 6.2: Help users, platform managers and model developers to design model-based data analysis pipelines to improve phenotypic output

- Develop an interactive web companion to explore possible connections between phenotyping platforms outputs, models inputs and models outputs. This online tool would serve different purpose:
  - identify possible model outputs (e.g. yield, root system architecture…) for a given phenotype dataset.
  - reversely, identify the phenotyping platforms that are suitable to feed data into a given model.
  - allow platform managers to adjust their output capabilities to support modelling, and allow model developers to adjust their input to available phenotype variables.
  - show a clear view of platforms outputs, models inputs and models outputs and allow users to design a data analysis graph linking phenotypic data and models to get to their variables of interest.

Task 6.3: Simplify the translation from phenomics datasets to model inputs

- Map existing initiatives from modelling communities (e.g. ICASA) and identify clusters of model parameters that are likely to have synonyms of like equivalents in phenotyping outputs.
- Use Implementation Phase partners to build a list of variables from phenotyping platforms and create clusters of variables that can be aligned on the clusters of model inputs.
- Express these informations in a hierarchical ontologies allowing to create graphs of output-to-input at different granularities. Create a graph linking the different clusters and identify simple models (based on simple function, regression, expert knowledge) that can be used to translate similar variables from both sides. This will be feedback into Task 6.2.

Training pilot service

The training pilot, to be tested during the implementation phase, is intended to implement innovative methods of training in plant phenotyping, with emphasis on technological methods allowing remote transfer of knowledge during the COVID-19 emergency and post-emergency. EMPHASIS will coordinate and support the user training activities in plant phenotyping according to the needs and expectations of the plant phenotyping community, already identified by EMPHASIS-

PREP and further developed by pilots 2-6 of EMPHASIS implementation phase. The Training pilot aims at performing as a guidance about what competencies are required in plant phenotyping in order to coordinate, design and execute training courses for different target groups, facilitating access to training material and supplying updated training and transfer of knowledge offer, especially aimed at remote, on-line access. The Training WP would closely interact with other WPs to specifically address the training needs that may be required by specific services.

The training pilot service will also promote and stimulate the collaboration with other training institutions such as universities, research centers, ESFRI projects, end-users, stakeholders, and the civil society.

Task 7.1 Coordination of EMPHASIS training activities on plant phenotyping:

- Identify specialized training topics and ToK activities [with the support of the other WPs (pilot services)] for already identified training target groups (researchers, technology developers, modelers,..)
- Develop an EMPHASIS training network among IGA participants
- Stimulate collaboration and communication with universities research centres, other ESFRI projects and clusters regarding training activities
- Support EMPHASIS national nodes in organizing training initiatives and coordination for practical implementation of EMPHASIS conference.
- Identify and propose funding opportunities aimed at supporting training and ToK activities (e.g. ITN, ETN);

Task 7.2 Planning of training activities

- Plan, propose and implement training activities along the implementation phase, including activities that may allow continuous and efficient transfer of knowledge under limitation of traveling because of COVID-19 emergency and post-emergency.
- Identify quality criteria and policies for high quality training activities (minimum requirement, training KPIs,..)
- Develop a trainer/trainee register
- Develop, implement and maintain an online course catalogue and quality indicators
- Disseminate the EMPHASIS training offer with the support of WP1

3. Key performance indicators

The pilot services represent a test case for services in the Operational Phase and provide a framework for the Operational Phase KPIs to evaluate the effectiveness of these services. As such, the pilot services provide a sound bases to develop a number of key performance indicators, based upon KPIs for the Operational Phase can be developed. KPIs have an central role for the evaluation of services and a basis to evaluate if specific services will be continued, adapted to changing demand or stopped.

Field pilot service

- Identification of at least 10 field installations representative of the range of European climate and soil conditions until Jan 2022.
- Run 1 training course on multisite experiment setup best practice before the end of the implementation phase, with positive response from the user on the training. (in collaboration with Training pilot)
- 1 minimal requirement list created using a scientifically driven approach with a majority of the institutes, within the IGA.
- 4 templates of services level agreements drafted, adjusted to different scenarios to ensure user access to field sites.
- Develop a database of at least 20 field sites potentially available for access, including local equipment, environmental conditions and agreed protocols.
- Development of 1 web page within the Emphasis site dedicated to field experiments performed under the Emphasis umbrella

Innovation pilot service

- Identify and recruit 6-8 members of an Innovation Board by March 1st 2021
- Poll IGA and support group to identify technological challenge facing the community and emerging technologies of interest
- Produce and disseminate 1 Technology Briefing paper
- Produce and disseminate 1 Challenge Briefing paper
- Release 1 annotated dataset

- Develop 1 webpage within the Emphasis site dedicated to innovation (to be loosely based on the https://konfer.online model)

Data management pilot service

1. Number of European installations that reach level 1 for data management (URIs, variables, storage). Objective by end 2021: 20
2. Number of scientists who participated to trainings and/or performed on-line case studies to reach level 2. Objective by end 2021: 50
3. Number of European installations with a local information system. Objective by end 2021: 8
4. Number of European installations connected with Emphasis Layer. Objective by end 2021 : 3

Modelling pilot service

- Number of models and scientific publications referenced per year on the website
- Number of visitors on the website (with the diversity and geographic spread of visitors)
- Number of webpages visited on the website
- Number of models downloaded
- Number of visitors on the website (the website hosting the interactive web companion)
- Number of model and phenotyping platform webpages/homepages visited thank to the website
- Number of connexions perform between phenotyping database and the models by the interactive web companion.
- Number of models, plant image analysis software and phenotyping platforms referenced on the ontology
- Number of models' inputs (parameters and variables) and models 'outputs (plant traits) referenced on the ontology
- Number of phenotyping outputs (plant traits) referenced on the ontology
- Number of possible connexions between phenotyping outputs and plant models referenced on the ontology

Training pilot service

1) Quantitative

NUMBER	Expected in 2021	Expected in 2022
Number of trainees/participants (totally)	50-100	> 100
Number of participants per topic proposed within EMPHASIS pillars and pilots.	5- >30	5- >30
Number of participants per format proposed (hand-on/webinar/f2f)	5-10/>30/5-10	5-10/>30/5-10
Number of collaborations with other entities, research institutions, projects, Emphasis pilots, etc.	3-5	>5
Number of trainers	8-15	>15
Number of stakeholders involved	5-10	>10

2) Qualitative[1]

The qualitative KPIs will be assessed by surveys before and after the training sessions.

Before the training session:

[1] These KPIs are based on the Kirkpatrick Model (Kirikpatrick (1994), Evaluating Training Programs: The Four Levels)

- the survey is intended to record the preliminary participant expectations.

After the training session, the survey intends to explore four main aspects:

- **Reaction**
  How did the participants react or respond to the training?
- **Learning**
  What did participants learn from the training?
- **Behaviour**
  Did the participants put it into practice what they learnt on their activities?
- **Results**
  Did the training meet the participant and stakeholder* expectations? What was the return on these expectations?

  **Here the term "stakeholder" identifies institution, entities, research infrastructures, companies etc. which the participant is affiliated to.*

Annex 1: Check list

Deliverable Check list (to be checked by the "Deliverable leader")

	Check list		Comments
Before	I have checked the due date and have planned completion in due time		*Please inform Management Team of any foreseen delays*
	The title corresponds to the title in the DOW		
	The dissemination level corresponds to that indicated in the DOW		*If not please inform the Management Team with justification*
	The contributors (authors) correspond to those indicated in the DOW		
	The Table of Contents has been validated with the Activity Leader		*Please validate the Table of Content with your Activity Leader before drafting the deliverable*
	I am using the EMPHASIS deliverable template (title page, styles etc.)		*Available in "New EMPHASIS Logo, Templates, CI" on the collaborative workspace*
The draft is ready			
After	I have written a good summary at the beginning of the Deliverable		*A 1-2 pages max. summary is mandatory (not formal but really informative on the content of the Deliverable)*
	The deliverable has been reviewed by all contributors (authors)		*Make sure all contributors have reviewed and approved the final version of the deliverable. You should leave sufficient time for this validation.*
	I have done a spell check and verified the English		
	I have sent the final version to the WP Leader and to the Project coordinator (cc to the project manager) for approval		*Send the final draft to your WPLeader and the coordinator with cc to the project manager on the 1st day of the due month and leave 2 weeks for feedback. Inform the reviewer of the changes (if any) you have made to address their comments. Once validated by the 2 reviewers and the coordinator, send the final version to the Project Manager who will then submit it to the EC.*