D5.3 - Community-Centred Assessment Plan

Agro-climatic Modelling

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ACRONYMS LIST

Acronym	Description
FAIR	Findable, Accessible, Interoperable, Reusable, as set of principles acting as an international guideline for high quality data stewardship
RFC	Request for Change
VRE	Virtual Research Environment
WOFOST	World Food Studies (crop growth simulation model)
YAML	Yet Another Markup Language, a human-readable data serialization language.

EXECUTIVE SUMMARY

This Community-centred Assessment Plan describes the detailed plan regarding the work to be carried out for assessing the effectiveness of the AGINFRA PLUS paradigm for research in the agro-climatic modelling community.

The assessment plan defines the envisaged user community and its different user profiles as well as the way to involve the community in the projects' activities, and select evaluators for the pilot assessments to be performed. It describes the objectives of the planned pilot trials and their assessment and the specifics of the different pilots defined in the iterative piloting scheme. Starting from that, the assessment objectives for the selected use cases (crop modelling, crop phenology estimation, AgroDataCube) are outlined and the associated assessment indicators, the method of assessment per indicator and the planning of the assessment of indicators over the iterative piloting scheme are defined.

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1 INTRODUCTION

This document presents the community centred assessment plan for the pilot applications to be developed, deployed and evaluated as part of the AGINFRA PLUS VRE pilots defined for the agro-climatic modelling community.

It describes how the community and the different user profiles within the community will be involved and how evaluators will be selected and recruited. It also presents the iterative set up of the piloting scheme for the selected use cases and the specific objectives for the pilot trials and the associated pilot assessments and their key performance indicators (KPIs). This also includes a detailed planning of the activities required to prepare the assessments (e.g. testing of the pilots, recruitment of evaluators, and preparation of the detailed assessment procedures).

As the three foreseen pilots look upon the use case from different angles (e.g. they face different maturity of the applications tested in the pilot, with also a more development-oriented perspective versus a usage perspective), the assessment methodology and planning are aligned to these stages. In this plan, the specifics of every pilot are defined and the targeted types of evaluators from the community that are required to assess the pilots in the specific stage are identified. Moreover, the plan describes the different levels of assessment that will be performed to evaluate the heterogeneous set of indicators that serve as KPIs to assess the pilots.

Finally, the plan also further clarifies the assessment objectives for the selected use cases: crop modelling, crop phenology estimation and AgroDataCube. From these objectives, a set of evaluation indicators is derived that will provide a broad view on the effectiveness of the use of VRE's for these use cases. For every indicator, the level of assessment and the specific pilot in the overall piloting scheme of the AGINFRA PLUS project is specified.

2 ASSESMENT METHODOLOGY

This chapter describes the methodology for the assessment of the identified AGINFRA PLUS use cases targeted at the agro-climatic modelling community, and its relation to the phases defined in project. It defines how the project intends to expose the use case through the VRE, how it interacts with the community in the various phases of the project through targeted assessment sessions and events and how the evaluators involved in each pilot evaluation will be selected and recruited and match the objectives of every individual pilot. Moreover, it defines the setup of the trials and the associated evaluation procedures and metrics used to measure the effectiveness of the AGINFRA PLUS paradigm for research in the targeted research community.

2.1   INTERACTION WITH COMMUNITIES

To assess the effectiveness of the AGINFRA PLUS paradigm for research in the agro-climatic modelling community, an iterative approach of assessments, in parallel with the proposed three-stage piloting scheme, will be performed. Following the concept of gradual extension of functionality, intended audience and the assessment of this scheme, the pilot will interact with the agro-climatic modelling community and the pilot evaluators accordingly.

First Pilot (intermediate phase, M13-18)

- Available components that have been developed in the first stage of the piloting will be used and evaluated by an independent agro-climatic modeller employed at Wageningen Environmental Research to acquire first impressions regarding data accessibility, opportunities to support open science based modelling and user experience. The main objectives are to (1) evaluate the main pilot components developed and deployed on the VRE and the general usability of the VRE for modelling and (2) to collect issues and RFC's that feed into the further refinement of the components and the full prototype(s) to be developed in the next stage. The researcher selected for the evaluation process will be a person that is not involved in the development of modelling components and their deployment on the VRE.
- The profile of the researcher that will run these trials is that of a senior modeller, highly experienced in modelling and model development and with a broad knowledge of ICT. He/she will have capacities in modelling in the broad sense and experience in areas like the required data and data fusion for modelling, the configuration of models and the assessment of model output. Besides, he/she will have previous experience with running models in alternative cloud and high performance computing environments.
- A VRE developer will join the pilot evaluation. This person will have previous experience with model implementation in the D4Science VRE and thus will be able to assess some of the indicators that require a deeper and more technical insight into the VRE.
- The number of evaluators in the first evaluation will be two: one senior modeller and one VRE/model developer. Their user profile (see annex personas) is that of a researcher.
- The evaluators will be recruited from the broader modelling community at Wageningen Environmental Research.

Second Pilot (summative phase, M22-M27)

- The full range of VRE based prototypes developed for the agro-climatic modelling use cases within AGINFRA PLUS will be in first instance trialled by a small group of researchers from the AGINFRA PLUS consortium. The principal objective will be to collect a comprehensive set of indicator data and user experiences for the pilot evaluation. Moreover, it provides an excellent opportunity to thoroughly test the prototype, and signal and resolve issues before deploying it to the broader agro-climatic modelling community in the third piloting trial.

- The evaluators that will run these trials will ideally have a range of expertise levels, from junior modeller to expert-modeller, to account for a broad range of potential end users. While most obviously these will include modellers from Wageningen University & Research, we will extend the group with researchers from other project partners (e.g. INRA) and from our international networks where possible, to incorporate a broader and more independent perspective.
- The number of evaluators in the second evaluation will be approximately 10, varying from senior to less experiences modellers and data analysts. The main user profile (see annex personas) will be researchers.
- The recruitment process will be organized in collaboration with the AGINFRA+ project partners
  o Approximately 5 will be recruited from the partners (WUR, INRA) internal modelling groups
  o Approximately 5 will be recruited from peer research organizations and European and global partnerships around agricultural modelling and monitoring

Third Pilot (summative phase, M30-M36)

- In the third pilot trial, the final version of the prototype(s) for the use case will be exposed to and trialled by the broader scientific community of agro-climatic modellers through a dedicated piloting event. The main objective is to complement the set of indicator data and user experiences collected in the second pilot in order to perform a full evaluation of the developed prototype and its efficacy for end users.
- Additionally, the trial will be run with a group of evaluators from the other stakeholder groups that have been identified. Information providers and service intermediaries will be requested to experiment with some of the data, data analytics and visualization components. Business analysts will be requested to examine specifically the analytics and visualization functions that are relevant for them.
- The number of evaluators will be approximately 30. A broad group of about 10 - 15 international modellers (researcher profile) will be involved, through a side or back-to-back event with a major international conference or workshop that attracts the foreseen audience. Besides, we aim at approaching a group of approximately 15 - 20 information providers and service intermediaries and business analysts through one or more hackathon-like events.
- The recruitment process will be organized in collaboration with the AGINFRA+ project partners
  o Approximately 5-10 researchers will be recruited from the partners (WUR, INRA) internal modelling groups
  o Approximately 5-10 researchers will be recruited from peer research organizations and European and global partnerships around agricultural modelling and monitoring
  o 15 – 20 evaluators from the groups of information providers and service intermediaries and business analysts (from SMEs, NGOs, governmental) will be recruited through the partners' networks and through advertisement in agro-ICT events, like hackathons. Pilots Trials

First Pilot (intermediate phase, M13-18)

The first pilot trial will focus on the crop modelling use case and more specifically the assessment of some of the major components being developed for the agro-climatic modelling use cases. This pilot can be regarded as a form of "module testing", where the emphasis will be on the accessibility of the components from the VRE and the required connectivity for further integration of these modules into use case specific workflows to build a full workflow. It will also be a more generic assessment of the ease of use and usability of the VRE as an environment for effective collaborative modelling.

- The evaluation of the accessibility and connectivity (with regard to the foreseen prototype and its application) of data sources required for the use case on the VRE. This includes the assessment of how the FAIR principles are complied with through the VRE.

- The assessment of accessibility, usability of the main application components of the use cases.
- The global assessment of ease of use and expected learning curve of the VRE to develop and deploy modelling components like data access, models, data analytics.

In this stage of piloting only a very limited set of specific integration aspects, e.g. data analytics, data fusion, post-processing etc., will be considered. Components will be individually tested, e.g. data sources will be tested by querying them for typical (raw) data required for pre-processing, models and algorithms will be tested using available, ready-for-use datasets.

Where feasible, we will also have evaluators assess the ease of use of the VRE by having them develop a simple (proxy of) a model, with data feeds and data outputs. This might give them additional insights in the potential use and future opportunities of the D4Science VRE and could provide a broader evaluation perspective.

Second Pilot (summative phase, M22-M27)

In this second evaluation, we re-evaluate the crop modelling use case with a subgroup of experienced modellers, assessing the full crop modelling workflow, from data collection to analysis and visualisation. Moreover, with a second group we will test and evaluate the crop phenology estimation use case, which is more oriented on explorative modelling. This case is suitable for less experienced modellers and scientists that do not perform modelling work, but are involved in other areas of agro climatic data science.

A smaller group of more experienced scientists will evaluate the crop modelling use case. Thus, there will be opportunities for a more in-depth evaluation of specific aspects of VRE usage that either require larger efforts and/or a high level of expertise. These pilots will emphasize the assessment of complete scientific agro-modelling workflows on the D4Science VRE. We foresee that this evaluation will include both the assessment of a pre-configured modelling workflow, as well as evaluation from the model and workflow development perspective, where specific components could be configured in real-time by evaluators. It seeks to assess the defined agro-climatic workflows in a more integrated manner, looking specifically at linkage between the input data, computing and analytics elements through data fusion, data wrangling, post processing etc. As far as feasible, in-depth experiments will be performed that require amounts of effort and expertise that cannot be expected to be broadly available in the 3rd pilot that will reach out to a larger and more diverse group of evaluators.

Besides the indicators that were already subject of the first evaluation, the following additional aspects will be assessed in the trials:
- Performance of components and pre-configured workflows.
- Scalability of workflows, through the assessment of a large-scale modelling experiment that mimics massive modelling exercises that are required e.g. in climate modelling or robust decision-making scenarios.

Secondly, a group of community members will evaluate the VRE facilities for explorative modelling through the crop phenology estimation use case. While the former part of the evaluation is rather specialist , this use case concerns a concept that can be much broader applied by different groups of users (researchers, but also information & service providers, business analysts) within and outside of the agro-climatic domain.

The evaluation will assess a limited amount of evaluation indicators, and will be focusing less on the technical and more on the specific open science related capabilities of the VRE.

Third Pilot (summative phase, M30-M36)

The third pilot assessment will be performed by a group of international modellers, complemented with representatives from information intermediaries & service providers and business analysts (e.g. from SMEs and/or NGOs). Consequently, the group is broader and more diverse than the evaluators that were involved in the previous two stages of the pilot. As AGINFRA PLUS will have less control on the composition of this final group of evaluators, the performed assessment will be limited to aspects that can be evaluated uniformly by a relatively heterogeneous group of scientists, information and service providers and business analysts.

This pilot will thus focus on indicators that can be more easily assessed in a limited period and with the heterogeneity of expertise levels that can be expected in international community events. It will therefore focus in first instance on assessing ease of use of pre-configured workflows and working with its output data, with some attention to perform specific associated analytics and visualization functions. Moreover, the evaluation will cover the Open Science related capabilities of the VRE, testing how it support sharing and reusing of scientific resources in order to support co-development.

The following aspects will be assessed in the trials:
- Usefulness the VRE for (explorative) modelling and of pre-configured workflows and workflow components, e.g. components for data analytics and visualization.
- The open science related aspects of openness and FAIRness, e.g. options for sharing and reuse and the assessment of the accessibility, discoverability and reusability of data and algorithms.
- Uptake potential of the pilot VRE, assessing if users of the pilot VRE plan to use a VRE in their future research.

2.2   PILOTS EVALUATION

The evaluation of the pilots will be performed along a set of assessment indicators and evaluation questions that are targeted to the specifics of that use case. Due to the difference in the scale, setup and number and type of involved evaluators in each of the pilots (as described in the previous section), only the indicators fitting the objectives of the specific pilot will be evaluated. Moreover, the way in which indicators and metrics are measured will differ over the three evaluations. This is inevitable, because of the type and complexity of the components and workflows to be evaluated and their maturity, as well as because of the different profiles of the evaluators that are involved in every single stage. Evaluations will vary from the assessment of expert functions required for developing and deploying components and setting up workflows, to more Open Science oriented indicators like openness and FAIR-ness and the future uptake potential of VREs. While for some indicators it is expected feasible to perform quantitative evaluations, the character of most of the indicators, and of the group of evaluators involved, will result in qualitative evaluations.

To facilitate the overall evaluation process, we will survey individual indicators in different ways, depending on the specific character of the indicator and the involved evaluators:

- *Qualitative scoring*: Quite some indicators will not be suitable for quantitative assessment. In these cases, at least a qualitative evaluation metric, for example though ordinal scoring, will be developed. In such cases, we will also add the option to provide an additional explanation in the form of a short expert review, if required. This will allow getting better insight in the motivation of the individual reviewer.
- *Quantitative benchmarking*: for a limited set of indicators, quantitative measurements can be performed, for example for the indicator "performance" by measuring "computation time" in a "conventional" modelling environment compared to a VRE environment.

- *Expert review*: For indicators that cannot be easily benchmarked or where quantitative assessment alone does not provide sufficient insight, an expert review will be requested. The expert review will allow experts to (1) explain the motivation for their quantitative scoring of indicators, (2) assess indicators, using their experiences with non-VRE environments and (3) allow evaluators to give their opinion on a VRE for modelling through an interview with open questions after an evaluation session.
- *End user survey*: The broader trials in the third pilot, the associated character and heterogeneity of the group of evaluators, the end user oriented setup of the trial and the limited time available in events will require a targeted approach. The indicators can in that case be assessed through an end user survey that can be completed in a relatively short time, also by less experienced evaluators. The format will be an on-line survey.

The following table summarizes the indicators from which a selection will be assessed for each of the use cases. It also indicates the method of assessment, the relevant user profiles and use cases and the stage(s) in the piloting scheme where the evaluation of these indicators will be performed.

Indicator	Rationale and evaluation questions	Assessment method	User groups and use cases	VRE pilot
Usefulness of the VRE pilot for the use case	The pilot VRE should support researchers to perform their work "in the cloud" in a collaborative environment that allows co-development by remote researchers and research teams and that offers performance and scalability in performing open science. Questions: *How do you assess the usefulness of the pilot VRE with regard to the following aspects:* - *Collaboration and communication* - *Data analytics* - *Modelling* - *Visualisation* *Do you think that a VRE like D4Science can help to perform your work "in the cloud" and support co-development by remote researcher and research teams?*	Qualitative scoring Expert review End user survey	User group(s): Researchers Use case(s): Crop modelling; Crop phenology estimation	1, 2, 3
Learning Curve	How much time is needed to learn the pilot VRE concepts, new pilot functionalities and to master underlying technology and functionality, before the pilot VRE can be used? Questions: *How do you estimate the effort to make an existing analytical procedure or model run on the pilot VRE?* *How do you estimate the effort to configure and run a model and analyse its outputs?*	Qualitative scoring Expert review End user survey	User group(s): Researchers, intermediaries & service providers, business analysts Use case(s): Crop modelling; Crop phenology estimation	1, 2, 3

Performance and Scalability	A VRE and VRE applications should support collaborative research in such a way that performance is (at least) comparable with "traditional research environments". They should also offer scalability, meaning that the resources available (for computing, storage etc.) should be able to adapt to the amount and size of the research jobs, the amount of concurrent users etc. Questions: *How do you rate the performance of the pilot VRE compared to the platform(s) you are used to work with? How do you rate the scalability of the pilot VRE?*	Expert review, Benchmarking	User group(s): Researchers, intermediaries & service providers, business analysts Use case(s): Crop modelling;	2
Openness and FAIRness	Openness is an important asset of any environment related to the European Open Science Cloud. It means that is should be easy to find and use data and applications, to add new data and analytics to the pilot VRE and to publish and share resulting workflows, components, and data with other researchers. This relates to how the pilot VRE supports researchers in making research data and algorithms FAIR (Findable, Accessible, Interoperable, Reusable). Questions: *How open do you think the pilot VRE and its applications are from the following perspectives?* - *Ease of finding and accessing and reusing datasets* - *Ease of finding and assessing and reusing analytics and models* - *Ease of registering and sharing datasets* - *Ease of registering and sharing analytics and models* *Are the data and algorithms available through the pilot VRE well documented?* *Do you think that the pilot VRE offers the functions to store and describe data and algorithms in such a way that fellow researchers would be able to reuse them?*	Qualitative scoring Expert review End user survey	User group(s): Researchers Use case(s): Crop modelling; Crop phenology estimation; AgroDataCube	1, 2, 3
Uptake potential	VREs could be a means to implement future open science, and therefore it is important that they are considered useful and that researchers show interest to keep using a VRE after the end of the AGINFRA PLUS project. Questions: What is the likelihood that you would use a system as the one demonstrated in the pilot VRE in the future for your work?	Qualitative scoring End user survey	User group(s): Researchers, intermediaries & service providers, business analysts Use case(s): Crop modelling; Crop phenology estimation	3

Table 1 - Evaluation indicators for agro-climatic modelling

In general, the evaluation questions will be defined in such a way that the evaluator will at least provide a qualitative or quantitative rating. Besides, in relevant cases, additional comments will be requested to explain the scoring of the evaluation questions and the indicator in general.

A typical format would be as in the following example evaluation question:

Indicator - <Indicator name>

< Short explanation / rationale of the indicator, see also table above >

<Evaluation question 1>

1- insufficient	2	3- sufficient	4	5 - very good	Not applicable

Further explanation and comments on question 1:

……………………………………………………………………...

<Evaluation question 2>

1- very low	2	3- moderate	4	5 - very high	Not applicable

Further explanation and comments on question 2:

……………………………………………………………………...

Further explanation and comments regarding <Indicator> in general:

3 ACTIVITY PLANNING

The following table describes the planning of the VRE evaluation activities to be executed with the members of the agro-climatic modelling community. For every pilot it distinguishes between the pilot evaluations and the preceding preparation activities.

Activity	Start	End
Preparation of first pilot evaluation - Recruitment of evaluators - Testing of components to be included in the pilot evaluations - Development of detailed evaluation programme and evaluation questionnaires	Mar 2018 (M15)	Jun 2018 (M18)
First pilot evaluation - One day evaluation event (crop modelling use case) - Reporting and feedback of RFC's	Jul 2018 (M19)	Jul 2018 (M19)
Preparation of second pilot evaluation	Oct 2019 (M25)	Feb 2019 (M26)
- Recruitment of evaluators	Oct 2018 (M22)	Jan 2019 (M25)
- Testing of components and workflows to be included in the evaluations - Development of detailed evaluation programme and evaluation questionnaires	Jan 2019 (M25)	Feb 2019 (M26)
Second pilot evaluation - One or two half day evaluation events (explorative modelling use cases crop phenology estimation, AgroDataCube) - One full day evaluation event (crop modelling) - Reporting and feedback of RFC's	Feb 2019 (M26)	Mar 2019 (M27)
Preparation of third pilot evaluation	Mar 2019 (M27)	Jun 2019 (M30)
- Recruitment of evaluators	Mar 2018 (M27)	May 2019 (M29)
- Testing of components and workflows to be included in the evaluations - Development of detailed evaluation programme and questionnaires	May 2019 (M29)	Jun 2019 (M30)
Third pilot evaluation - One or two side events to modelling conferences and workshops (crop modelling) - One to three half day evaluation events (explorative modelling use cases crop phenology estimation, AgroDataCube) - Reporting and feedback of RFC's	Jun 2019 (M30)	Oct 2019 (M34)

Table 2 – Activity planning for pilot evaluations

Note that in case of the second and third pilot, the amount of evaluation sessions is flexible and depends on how we can most effectively involve a larger group of evaluators. Moreover, the periods reserved for

the second, and specifically the third evaluation are rather long, to allow for some flexibility in the planning of sessions along events that attract larger parts of the community and where more participants are expected to attend AGINFRA PLUS evaluation sessions. It also accounts for the fact that the third evaluation period is planned over the summer of 2019, which limits the options substantially if a smaller time window would be reserved.

4 USE CASE 1 - CROP MODELLING

The use case "crop modelling" is defined in deliverable D5.1 (User-driven Requirements & Use Cases - Agro-climatic and Economic Modelling) as a use case where researchers perform large-scale regional crop model simulations. Besides, it also includes some of the elements that have been specifically mentioned in the use case specified for information intermediaries and service providers, focusing on the accessibility, the data provisioning and data wrangling of data from the AgroDataCube for its use in agro-climatic models.

4.1 TARGET USERS

Associated persona's (see Annex 1) for this use case are: researcher, information intermediary & service provider

Typical users of this use case will be:
- Researchers in various scientific domains (e.g. agronomy, agro-economy, climate change) that use agro-climatic crop modelling as part of their research.
- Information intermediary & service providers (e.g. extension services, ICT service providers) that either use crop models or the output of crop models as a resource to provide added value services for farm advisory and farm management support.

4.2 ASSESSMENT OBJECTIVES

The principal objective of this use case is to deploy and implement a full crop modelling workflow on a virtual research environment and to be able to run it in an explorative way as well as operationally. Based on the foreseen data availability, the focus will be on regional yield forecasting (specifically looking at simulating crop growth and yields at agricultural parcels in the Netherlands). To accomplish that, a comprehensive set of functional, integrative and technical "sub-objectives" needs to be accomplished. The following are potential functional and technical features that could be part of the pilot VRE for this use case:

- Development and deployment of a version of the WOFOST (World Food Studies) crop model on the VRE. There are several implementations of WOFOST, and the most suitable candidate at the moment is the recently developed Java implementation of this model.
- Findability and accessibility of required (raw) input data through the VRE. This includes access to data from the AgroDataCube (a PostGIS spatial/relational database), and sets of (crop) parameter files (currently in YAML format).
- FAIR publication of generated output files (from model, analytics components etc.) through the VRE for reuse by third parties and for data analysis.
- Development of data integration functions to process the mentioned (raw) input data to usable data formats for the WOFOST crop model.
- Data analytics and data visualization options (both for input and output data), particularly focused on handling and analysing spatial datasets. E.g., display simulated yields per crop per parcel as a geographic map.
- Explorative use (e.g. through the use of a Notebook environment such as Jupyter) of components and assembling them into documented workflows.
- Deployment of modelling workflows on the VRE so that less experienced users can operate crop model configurations.
- Performance – the option to access high performance hardware through the VRE so that crop model simulation runs can be executed quicker compared to regular workstations and laptops used by researchers.

- Scalability – the option to distribute crop modelling runs effortlessly over a variable number of computing nodes through the VRE. E.g., running model simulations for a certain crop for all relevant parcels in the Netherlands for multiple years in parallel and combining the results.

4.3 EVALUATION

The development of the evaluation procedures for the use case will, aligned with the iterative approach of the pilot trials, be developed in a phased way. The relevant indicators from the set described in section 4.3 and the methods of assessment in the different pilots will then be further specified.

5 USE CASE 2 - CROP PHENOLOGY ESTIMATION

The use case "crop phenology estimation" is defined in deliverable D5.1 (User-driven Requirements & Use Cases - Agro-climatic and Economic Modelling) as the use case targeting business analysist working on crop phenology estimation, combining various heterogeneous data sources to generate policy advice and decision support. Moreover, it includes elements that have been specifically mentioned in the use case for information intermediaries and service providers, focusing on the accessibility, the data provisioning and data wrangling of data from the AgroDataCube for data analytics required to provide farm advisory services.

5.1 TARGET USERS

Associated persona's (see Annex 1) for this use case are: business analyst, information intermediary & service provider

Typical users of this use case will be:
- Researchers that perform explorative modelling to develop and test crop phenology estimation or similar models and algorithms.
- Data analysts that aim at combining various data sources like satellite data, statistics etc. to generate policy advice and decision support.
- Intermediaries that either use crop models or the output of crop models as a resource to provide added value services for farm advisory and farm management support.

5.2 ASSESSMENT OBJECTIVES

The principal objective for the use case is to use the VRE for explorative modelling purposes, specifically to develop and test data science algorithms to determine crop phenology development. It also aims at deploying the AgroDataCube on the VRE, and making its data accessible and reusable for such explorative modelling exercises. This implies that a set of functional, integrative and technical "sub-objectives" are accomplished. The following are potential functional and technical features that could be implemented as part of the pilot VRE for this use case:

- Using the VRE for the explorative definition of algorithms (e.g. using a Notebook environment such as Jupyter) for assessing crop phenology development.
- Making the content of the AgroDataCube (a PostGIS spatial/relational database, containing agro-climatic data for the Netherlands) available (findable and accessible) on the VRE for this specific application and for further explorative research.
- Using the pilot VRE to define workflows for assessing larger scale crop phenology development based on data coming from the AgroDataCube, e.g. for different crops and all agricultural parcels in the Netherlands.
- Using the pilot VRE to train machine-learning algorithms using crop phenology development and other input data from the AgroDataCube, and subsequently use the trained model to predict yield per crop per parcel, based on forecasted weather.
- Performing data analytics and visualization for e.g. (spatio-temporal) input data, the crop phenology, derived crop growth curves, yield forecasting. Preferably in an easy to use and customizable dashboard.
- Performance improvements – the option to access high performance hardware through the VRE so that algorithms can be executed quicker compared to regular workstations and laptops used by researchers.
- Scalability improvements – the option to distribute algorithm calculations effortlessly over a variable number of computing nodes through the VRE. E.g., running machine-learning algorithms for yield

prediction for a certain crop for all relevant parcels in the Netherlands in parallel and combining the results.

5.3 EVALUATION

The development of the evaluation procedures for the use case will, aligned with the iterative approach of the pilot trials, be developed in a phased way. The relevant indicators from the set described in section 4.3 and the methods of assessment in the pilots will then be further specified.

6 USE CASE 3 - AGRODATACUBE

The use case AgroDataCube concerns the integration of a (Dutch) regional data source for agronomic research and farmer support services into the VRE to facilitate various agronomic research applications, among others the two use cases described previously. Although defined here as a separate use case (realization of the case will be able to facilitate a range of similar use cases), in practice this case will be implemented as part of the development of the functionality for regional crop modelling and crop phenology estimation. This implements a range of functions that are relevant for applications of all types of users (researchers, information intermediaries and service providers, business analysts) in the area of data accessibility, data provisioning and data wrangling for data analytics.

6.1 TARGET USERS

Associated persona's (see Annex 1) for this use case are: researcher, business analyst, information intermediary & service provider.

Typical users of this use case will be:
- Researchers that are collecting, preparing and pre-processing data feeds for modelling runs.
- Analysts that aim at combining various data sources like satellite data, statistics etc. to generate policy advice and decision support.
- Intermediaries that either use crop models or the output of crop models as a resource to provide added value services for farm advisory and farm management support.

6.2 ASSESSMENT OBJECTIVES

The principal objective for the use case is enabling the use of a resource like the AgroDataCube from a VRE and to make its data findable, accessible, interoperable and reusable (FAIR). The use case will not be independently implemented. It will be integrated in the previously described use cases on crop modelling and crop phenology estimation, as these will use the AgroDataCube as a main data provider. The use case implies that a set of functional, integrative and technical "sub-objectives" are accomplished. The following are potential functional and technical features that could be part of the pilot VRE for this use case:

- Making the content of the AgroDataCube (currently a PostGIS spatial/relational database, containing agro-climatic data for the Netherlands) available (findable and accessible) on the VRE for further processing.
- Using the VRE to implement a range of pre-processing, data analytics, visualisation and similar jobs that use (among others) the AgroDataCube data services.
- When needed, the implementation of the AgroDataCube on a scalable infrastructure, which could be the D4Science data infrastructure. This should allow resource-demanding applications, like mass scale modelling, to query the data without resource capacity or performance issues.

6.3 EVALUATION

The development of the evaluation procedures for the use case will, aligned with the iterative approach of the pilot trials, be developed in a phased way. The relevant indicators from the set described in section 4.3 and the methods of assessment in the different pilots will then be further specified.

ANNEX 1 – PERSONAS

Persona 1 - Researcher

The researcher's work is focussed at scientific and applied scientific definition and application of models. These could aim either at developing and applying innovative models and model applications or at configuring and applying existing models for innovative research on societal challenges like food security or climate change.

Alain Duvall - Senior Agronomic Researcher

"*I would like to find ways for me and my team to work more efficient and to **make it easier to share and reuse data and analytics**"*

Name: Alain
Position: senior-researcher at an agronomic research organisation
Age: 46
Education: University, PhD
Location: France
Archetype: Researcher

Biography

Alain has a PhD in Agronomy. He has worked as a researcher in France and the US for an NGO and several research organisations and he's been involved in developing simulation models and performing impact assessments for years. Since a few years, he is head of a small research team. Besides, he works on a strategy to better exploit big data and big data analytics in his domain.

Daily Tasks
- Operational management of a small team of researchers and ICT professionals specialized in agro-climatic modelling and impact assessment.
- Coaching his team members in their daily work.
- Setting out directions for future research in the agronomic domain, with a focus on big data and data analytics.
- Scientific publication.
- Data curation.

Motivations
- Doing research that is being used and has impact.
- Progressing his scientific career.

Goals
- To provide good quality scientific outputs
- To extend his team's data analytics capacities
- To produce results that are fit-for-use for policymakers

Frustrations:
- Why is it still so hard to find the data I need for my research?
- All my team members are developing their own data analytics; there is too much redundancy and too little reuse.
- I cannot easily publish my data in a citable manner.

Persona 2 - Information intermediary / service provider

Information intermediaries and service providers usually aim to provide added value, like farm management advice, through the (re)use of existing data and (meta)models to support end users (for instance policy and decision makers or farmers). They aim at providing operational services, using trusted datasets and proven technologies.

<u>Kenneth Brown - ICT developer</u>

*"Despite all efforts it is still hard to **find trusted data and process it efficiently for modelling**"*

Name:	Kenneth
Position:	programmer and data-analyst at AgroTalk, a small ICT company
Age:	28
Education:	University, BSc
Location:	Uganda
Archetype:	Developer

Biography

Kenneth has finished his BSc in informatics in Uganda and has just joined AgroTalk. AgroTalk is a small ICT company that specializes in providing advice to farmers through among others mobile phone and smartphone apps. With his six colleagues, Kenneth is developing a service that provides farm management advice to smallholders through SMS services and through a farm management support system that is used by extension workers in the field. They are providing crop advice using a crop growth model that uses among others weather data. In the future, they plan to also develop a smartphone app for this purpose.

Daily Tasks
- Co-developing a software system that performs automated daily crop model runs and turns the results into advice.
- Manual and semi-automatic analysis of data sources like weather data, crop development data, soil data etc., to provide advice to farmers.
- Liaising with two colleagues, who are agronomists and advise him on his data analysis work and on the implementation of agronomic algorithms for the new IT system.

Motivations
- Programming reliable, robust software for smallholders.
- Using new technologies, with a special interest in big data and data analytics.

Goals
- To deliver a high-quality ICT solution that has added value and can be charged for.

Frustrations:
- The data I need to turn agronomy knowledge into working solutions is hard to find and get, e.g. weather data is available, but often too expensive, and the data I can get is not always of good quality.
- Data is provided in so many formats that are not compatible and there is no software to process the data easily.

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Persona 3 - Business Analyst

The business analyst is mainly interested in re(using) existing data sources and modelling outputs for commercial application. Some well-known examples are the use of combination of weather, soil and agronomic data for farm management or the use of yield forecasts and weather data for risk assessment for re-insurance activities.

<u>John Jackson - Policy advisor and analyst</u>

"I know there is scientific work on agricultural data analytics but I do not have access to scientific resources other than papers"

Name: John
Position: Data analyst at the Ghana Ministry of Agriculture
Age: 36
Education: University, BSc
Location: Ghana
Archetype: Data Scientist

Biography

John has been working at the Ministry of Agriculture for 12 years now. He started as a policy officer, but he has always had interest in data analysis and three years ago, he has been transferred to the new department for data analytics and data science. He is producing regional crop bulletins, using data collected in the different agricultural regions of Ghana and data provided through the national weather service. The results of his work are published through the open data platform that the government has just set up. Currently he is exploring the opportunities of satellite derived NDVI data that his department has been provided access to recently.

Daily Tasks
- Collecting the data for his work from different sources.
- Analysing, improving and post-processing the crop and weather data as input for his data analysis algorithms and specifically exploring the options of NDVI data streams.
- Publication of his output data on the open data platform and curation of the section on agricultural data.

Motivations
- Working on this new field of data science, using new technologies and analytics.
- Promoting open data and the use of open data by farmers and business.

Goals
- Make his work easier by improving the data flows.
- Operationalize the analysis of NDVI time series
- Becoming a senior data scientist.

Frustrations:
- Data is very scattered and it takes too much effort to collect and integrate it.
- I do not have access to scientific resources for my data analytics.
- Even though we are providing open data, I see that it is hardly used.

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