Document de travail : Conception and aim of the INRAE information web-portal on impacts and adaptation to climate change in agriculture, forestry and water resources management

Title[1]: Conception and aim of the INRAE information web-portal on impacts and adaptation to climate change in agriculture, forestry and water resources management

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Short abstract :

The information web-portal aims to present the results of scientific projects conducted at INRAE, on impacts and adaptation to climate change in agriculture, forestry and water resources management. The target audience is researchers involved in interdisciplinary works and research partners such as extension services, NGOs, consultancies, public institutions etc., who are interested to understand the consequences of climate change and to evaluate adaptation and mitigation scenarios. This paper presents the methodology approach and the concepts we developed. In particular, we put efforts on the harmonization of data coming from the different projects in order to make useful available data to illustrate the impacts of climate change and it helps inform the climate change adaptation or mitigation strategies. This paper also presents the technical environment, combining a processing chain developed with R, GIS oriented open source tools and a free, modular and interoperable Spatial Data Infrastructure software. The resulting web-portal is an operational demonstrator. It will be deploy progressively at the scale of the institute.

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1. Purpose

This paper describes the design and development of the INRAE web portal for information on climate change impacts and adaptation in agriculture, forestry and water resources management. Its objective is to make climate services available. We define here “Climate services” as easily accessible, timely and relevant scientific information for decision-making on climate change mitigation, adaptation, and disaster risk management. In a broad sense, this includes the development, application, and transfer of climate-related knowledge, including knowledge for understanding climate, climate change, and its

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impacts on agriculture, forestry, water management, as well as guidance on its use by researchers and political and economic decision makers on this topic.
There are several portals that provide climate services such as the European portal Copernicus https://climate.copernicus.eu/, Climate impacts explorer (https://agmip.org/impacts-explorer-2/), the CLAIRE (Centre for Climate Action and Innovation. Research and Engineering) initiative (https://www.ufz.de/index.php?en=33573), the webAtlas project at European scale (https://www.atlas.impact2c.eu/en/), and the Canari portal (https://canari-agri.fr/) intended for French agricultural actors wishing to calculate directly online, simply and quickly, local agro-climatic indicators from climate projections.
The portal presented here is original in that it provides information focused on making useful available data to illustrate the impacts of climate change and it helps inform the climate change adaptation or mitigation strategies, using results produced by different research projects conducted by INRAE and partners. These results come from calculations, very often linked to computer simulation of models. The main target audience is researchers involved in interdisciplinary works, synthesis or expertise activities, but the portal addresses to partners such as extension services, NGOs, consultancies, public institutions for land use planning or management, local authorities, etc., who are interested to understand the consequences of climate change and to evaluate adaptation scenarios. The target audience, and this is a choice, is a well-informed public, rather postgraduate level (which does not exclude other audiences that will have to be warned about the proper use).

2. Methodology

We designed and developed the portal in three steps. The first one consisted in a project opportunity study and the specifications of the portal's objectives. The second step concerned the fulfilment of a demonstrator to make the proof of concept. The third step, currently underway, concerns the progressive deployment of the portal.

2.1. Organization

We organized a working group, composed of researchers and engineers from four main thematic areas (plant production, animal production, forestry, water) and including people with crosscutting skills related to the production and management of data, their readability to facilitate their use. Five workshops were organized. The first one was devoted to defining the precise framework of the group missions, and we decided to work on two structuring components. The first one concerned a survey of a panel of portals to develop arguments on three levels, namely, how creating such a portal will bring existing knowledge to the target audience, facilitate the use of data, and make existing data and tools more reliable. The second one was an inventory of current services or those close to completion, for each of these four areas (crop production, animal production, forestry, water). What services are available? What are the strengths and weaknesses of these services? Which users? What are the interests of integration? What computer and human resources are necessary for the creation but also for the perpetuation of the service? What priority data sets and what resources are necessary. The group also collected the expectations of end-users.
The group's work as a whole, led to a set of proposals that were summarized in the report (Gascuel et al. 2021). We made the choice not to try to meet all of the expectations immediately, but to build a demonstrator in a realistic and systematic manner that would constitute a proof of concept for the INRAE information portal on the impacts and adaptation of agriculture, forestry and water management to climate change. We have also decided to select three scientific projects as pilot projects, in order to guide and test the integration of their results into the portal: i) Phenology indicators for vineyards and their evolution with respect to climate change, produced with the tool SICLIMA (https://agroclim.inrae.fr/siclima/), ii) Heat stress indicators for livestock (Graux et al. 2022)

and iii) Study 4p1000: Storing carbon in French soils. What is the potential with regard to the 4 per 1000 objective and at what cost? (Pellerin et al. 2020)

2.2. The demonstrator

During the design and development of the demonstrator, two processes were combined and conducted in parallel: the harmonization of the scientific results and the technical environment.

- Harmonization of scientific results:

By scientific harmonization, we mean that it is necessary to present in a consistent way the results from different projects, published in different publications, with different formats. Furthermore, it is important to present them in a simple and understandable way, as they are often the result of complex and multidimensional projects. In addition, the majority of the data to be integrated in the portal have temporal and spatial dimensions, and we have to take into account these two dimensions in the portal. These temporal and spatial dimensions are linked to the fact that they are derived from calculations or computer simulations accounting for spatial and temporal variations. As far as the climate is concerned, there are inter-annual differences to which are added the trend evolutions linked to climate change, and this is why the data are in fact time series observed over a period of several decades. In order to present the data in a harmonized way, we have designed a first editorial charter to present the salient results of a scientific project and we have designed a second one to facilitate the multidimensional and complete exploration of the dataset.

- Technical environment:

The challenges for the design of the technical environment were to fit as well as possible into the current digital ecosystem at INRAE, and to respect the Open source, FAIR and data standards frameworks (e.g.Standard OGC https://www.ogc.org/standards/) in order to facilitate data reuse and interoperability with other tools, other partners and their initiatives.

3. Findings

The portal is online (https://ccsafe.hub.inrae.fr/) . It includes three levels of information. The first one concerns general information (e.g. modelling approaches to assess the impacts of climate change on agriculture, modelling approaches to test adaptation scenarios...). The other two levels concern i) the presentation of each project and its salient results, and ii) the multidimensional exploration of the data sets. Each of these last two levels respect an editorial charter.

For the editorial charter aiming at presenting the salient elements of a dataset, we have chosen a graphical approach, based on three types of graphs: i) boxplot to give a synthetic indication of the variability of the indicator presented, ii) time series to give the temporal trend of the indicator, and iii) geographical map to give the spatial representation of the indicator. On each of these graphs the median, the 10 and 90 percentiles of the indicator are mentioned. The editorial charter also imposes a temporal division into three periods, based on a division classically used in climate change impact studies. Recent past (1991-2022), near future (2036-2065), far future (2071-2100). Furthermore, the editorial charter invites to specify the climate scenario(s) (RCP 2.5, 4.5, 8.5 ...) based on which the dataset has been produced, as well as the GCM model with which the climate data mobilized in the study have been produced. Figure 1 gives an illustration of the application of the editorial charter on a dataset produced in the framework of a study on the impact of climate change on the stress of dairy cows.

Figure 1: Results illustrating the number of days of heat stress for dairy cows for the near time horizon: 2021-2050 and for the climate scenario 8.5.

Figure 1a: Distribution of the number of days under severe stress for all 30 years and for all spatial grid cells.

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Figure 1b : Temporal evolution of the number of days per year when we are in a severe stress situation, for the entire spatial grid cells (in red the median, the blue envelope corresponds to the upper and lower percentiles, respectively 10 and 90)
Figure 1c: The map shows the median of the values calculated over the 30 years of the H1 time horizon: 2021-2050, for each spatial grid cell.

Figure 1a

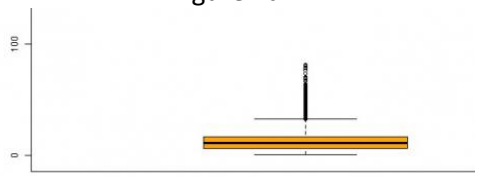


Figure 1b

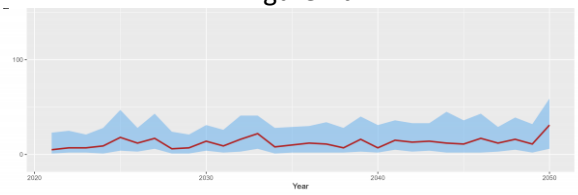
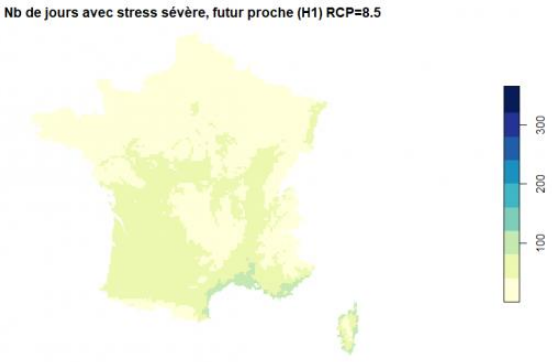
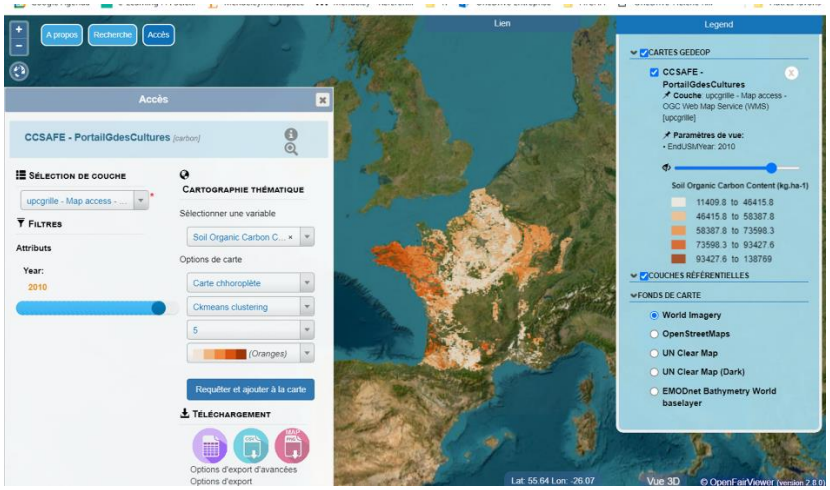


Figure 1c



For the multidimensional exploration of the data, we have chosen an approach based on an online graphical interface allowing to dynamically exploring the dataset via drop-down menus. Figure 2 illustrates the exploration of the dataset concerning the evolution of organic carbon in soil taking (soil can be a major actor in Carbon sequestration) into account climate change and different scenarios of crop rotations and management practices. The user can select on the lower left corner of the web interface i) the specific set of results to explore, ii) the variable he wants to visualize, iii) the time horizon and iv) the type of representation. In this example, the map concerns the median of the simulated values of the Soil Carbon Content, for a specific horizon time. The tool has automatically calculated the different classes (here five), and attributed a class value to each geographical location.

Figure 2: Multi-dimensional exploration of results coming from the 4p1000 project (Pellerin et al. 2020)



The technical environment is based on a processing chain allowing going from datasets stored in the INRAE data warehouse (https://entrepot.recherche.data.gouv.fr/dataverse/inrae) to data published on the INRAE geographic data infrastructure. We developed the different modules of the chain by using the R software (https://www.r-project.org/) which is commonly used in our community. The chain uses the open source tool Geoflow (https://github.com/r-geoflow/geoflow), which is an R engine dedicated to orchestrate and run data (and metadata) workflows. The data are published on modular and interoperable Spatial Data Infrastructure software based on an instance of Georchestra (https://www.georchestra.org/). It also uses the open source tool Openfairviewer (https://github.com/eblondel/OpenFairViewer) which is a FAIR, ISO and OGC (meta)data compliant GIS data viewer for browsing, accessing and sharing geo-referenced statistics.

4. Practical Implications

The resulting demonstrator (finalized at the end of December 2022) is now an open access information tool designed to enable the dissemination of scientific projects on climate change. The demonstrator includes the results of three scientific projects. We are in the process of scaling up with a progressive deployment at the scale of INRAE.

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