Adaptation of vegetable farmers to climate change in the Parisian region: a participatory approach using climate data

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Abstract

For vegetable farmers, climate change brings many issues and its impacts may vary by regions and crops. The objective of our exploratory study was to develop a participatory process to investigate collectively with vegetable farmers their priorities and needs to adapt to climate change based on climate data relevant to them. Our work relied on an iterative process involving workshops with agricultural experts and vegetable farmers on 3 contrasting territories of the Parisian Region and climate projections using DRIAS (Data on French Regionalized climate scenarios and Impacts on the environment and Adaptation of Societies). We first identified the relevant climate factors and thresholds to which specific vegetables are particularly sensitive. Simulations, downscaled at the local level (8*8km area) of the relevant climate factors were provided and discussed with farmers. This allowed us to refine the main climate factors that were judged relevant by farmers to support their strategic thinking about adaptation to climate change. This climate factors were presented at the temporal scales judged relevant by farmers: (i) comparison of reference years of the past 1990-2020, near future 2020-2040, far future 2040-2060, (ii) seasonal scale (winter, spring, summer, autumn). This information, explained to farmers on short videos, was used to carry out an online survey in order to identify the future actions to prioritize to adapt vegetable production to climate change from farmers' perspective in terms of practice exchanges between farmers, training, experimentation, public policy (work in progress). As interactions with farmers showed a strong concern about water use, a dedicated collective workshop will be organized in autumn 2022, combining (i) projections of water availability in the region, (ii) modelling of increased water needs by farmers, (iii) involvement of local authorities to discuss water regulations and governance. To our knowledge, this study is the first attempt to involve vegetable farmers in a collective participatory process about adaptation to climate change based on climate projections with indicators and temporal scales relevant to their specific needs.

Keywords: Horticulture, Climate resilience, Climate vulnerability, Climate indicators, Participatory approach, Climate data

INTRODUCTION

Climate change is challenging agricultural production worldwide (IPCC 2019). Vegetable production does not escape this reality (Scheelbeek et al. 2018; Abewoy, 2018) and in the Parisian Region, vegetable growers, whether organic or conventional, feel more and more concerned about this issue. Although historically important till the first half of the 20th century, vegetable production is nowadays limited, covering around 4500 ha and only 0.8% of the regional UAA (DRIAAF Ile-de-France, 2019). However, vegetable production is increasingly supported by municipalities willing to develop local supply chains or "regaining food autonomy" (Aubry, 2013). Supporting the adaptive capacity to climate change of vegetable farmers is key in contributing to enhance the climate resilience of the city region food system. The adaptive capacity of farmers is defined as their ability to cope with climate change, including climate variability and extremes, in order to moderate potential damages, take advantage of emerging opportunities, and/or cope with its consequences (IPCC 2001). For short and long-term issues, almost farmer's decisions are influenced by weather and/or climate patterns (Haight and al., 2018). As climate change impacts vary by regions and crops, climate information must be locally relevant to be useful in guiding decisions at the local level (Singh and al., 2017).

This study is part of the CLIMALEG project (adaptation of vegetable productions to climate changes) in the Parisian region. It follows previous studies on the adaptation of crops and field crops based on climate data (Caubel and *al., 2015;* de Noblet and *al.*, 2016; Sauquet and Pellerin, 2021).

The objective of our exploratory study was to develop a participatory process to investigate collectively with vegetable farmers their priorities and needs to adapt to climate change based on climate data relevant to them.

MATERIALS AND METHODS

We carried out a step-wise participatory process based on workshops with farmers and agricultural experts in three towns locating in contrasting territories of the Ile-de-France Region: Saclay (south from Paris), Cergy area (north-west from Paris), Le Mée-sur-Seine (south-east) as showed in Figure1.

Step 1: A first workshop with local experts to identify the relevant factors affecting vegetables in the Parisian region

In October 2021, this workshop brought together seven experts from the involved agricultural institutions, namely the Chamber of Agriculture, the Regional Association of organic farmers (GAB) and "*Terre et Cités"* a territorial association supporting farmers in the peri-urban area of the "Plateau de Saclay" area. Building on their expertise and past experiences, we identified the climate factors related to the vulnerability of different vegetable crops. For each relevant climate factor, its effect on vegetables and/or thresholds were also outlined. This material allowed to build indicators for climate projections to prepare step 2 (i. e., workshops with local vegetable farmers). For that purpose, we used DRIAS (Data on French Regionalized climate scenarios and Impacts on the environment and Adaptation of Societies, www.drias-climat.fr).

In Europe, regional climate model (RCM)-based projections for providing regional climate information is an emergent field in full expansion. Within the Coordinated Regional Climate Downscaling Experiment (CORDEX), high-resolution regional climate models (RCMs) provide regional and local climate information in relatively fine resolution, unavailable from large-scale global climate models (GCMs)[1]. For our purpose, we used the downscaled and bias-corrected CLMcom-CCLM4-8-17 / MOHC-HadGEM2-ES (RCM / GCM)[2] simulations model and the RCP[3]4.5 emissions scenario, which is neither optimistic (i.e., RCP2.5) nor pessimistic (i.e., RCP8.5). From 1950 to 2099, a large set of climate information is then available in the form of minimum, maximum and daily mean temperatures at 2m above ground level, rainfall, specific humidity, wind speed at 10m above ground level and potential evapo-transpiration

[1] https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels

[2] http://www.drias-climat.fr/document/listeScenarios_DRIAS-2020_publi.pdf

[3] *Representative Concentration Pathway*

(Etp). Such data can be obtained at fine resolutions for each of the three areas covered by this study.

For our purpose, climate data were here merely deployed as a very practical dialogue tool to identify the needs of a specific stakeholder at the local scale. The irreducible uncertainties of climate projections were not addressed (see Jacob and *al*., 2020; Bartok and *al*., 2021; Coppola and *al*., 2021).

Step 2: Workshops with vegetable farmers to precise their needs in terms of climate data to support adaptation

The objective of these workshops was to discuss with farmers the climate indicators built with experts in step 1. Workshops were held in the three contrasting territories in winter 2021.

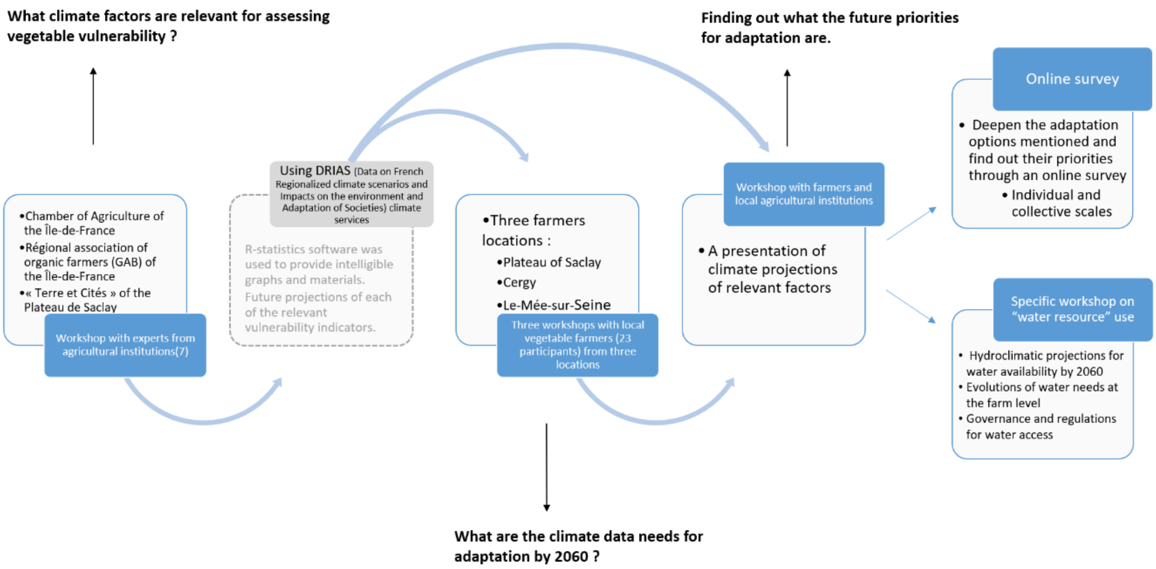

Figure 1. Outline of the participatory approach followed

DRIAS climate data were translated from a wide range of raw data to tailor-made data according to the specific needs arising from the first workshop. In order to present intelligible graphs and materials in the workshops, we used R-statistics software. DRIAS also can generate localized data (8km by 8km) around a geographic location, so for each workshop we presented a downscaled data for the three areas. These first projections were used to stimulate discussions with farmers about the information they need to think and reflect on for climate change adaptation. These workshops were recorded for further qualitative analysis. This analysis allowed us to precise relevant indicators, create new ones and clarify at which temporal scale farmers need information to support their strategic thinking on adaptation.

Step 3: Preparing the exploration of adaptation priorities from farmers perspective

Based on the results of step 2, we produced a synthetic table of climate projections based on indicators for vegetables farmers. A workshop with farmers and agricultural experts allowed us to validate this table and to improve its layout to make it easier to understand by farmers. A first exploratory discussion allowed us to highlight some adaptation perspectives from farmers' point of view. However, to collect material from more farmers, we decided to carry out an online survey.

Step 4 (in progress): running an online survey to further investigate farmers' needs and priorities for adapting to climate change

An online survey was developed were we integrated short videos explaining the synthetic table presenting the climate projections for every season (winter, spring, summer, autumn). After each video, questions were asked to collect farmers' reaction and adaptation priorities for the given season. Some questions were specifically oriented toward their needs for training, agricultural support and research, practice exchanges, political support.

Step 5 (to come in autumn 2022): facilitating a specific workshop on water use

As first workshops highlighted strong farmers concern about water use, we are planning to organise a future workshop based on elements raised by farmers: (i) projections of hydroclimate data to estimate water availability in the future, (ii) biophysical models to estimate increased needs of water for farmers (based on their crops and evolution of temperatures and evapotranspiration), (iii) involvement of local authorities to discuss water regulations and governance.

RESULTS, DISCUSSION

In addition to our participatory methodology, which is a result as such, we will present and discuss the 4 following aspects:

- The main climate indicators that were judged relevant by farmers to support their strategic thinking based on their impact on vegetables. For example:
    - Maximum daily temperatures and number of days with temperatures above 30°C as temperatures above this threshold affect negatively summer tunnel crops such as tomatoes, cucumbers, aubergines

    - Number of days with late frost, which means minimal temperatures < -2°C from March to May as this damages frosty vegetables at the seedling stage (5, 7 leaves), especially when trying to de-season them.

    - Length of heat waves, which is the number of days of with minimal temperature above 18°C and maximal temperature above 32°C successively over at least 4 days because this can prevent the emergence of plants which are sown in summer to be harvested in winter, especially with small seeds (e.g., carrots, beetroot, fennel)

- The temporal scale at which vegetable farmers judge relevant to present climate indicators to support their adaptation thinking:
    - Comparison of reference years of the past 1990-2020, near future 2020-2040, far future 2040-2060;
    - Seasonal scale (winter, spring, summer, autumn)
    - Median value (one year out of two), 4/5 quantile for high extreme values and 1/5 quantile for low extremer values (one year out of five)

  For example, maximal daily temperatures or number of days with temperature above 30°C should be presented for winter, spring, summer and autumn for the reference year, near future and far future as shown in Figure 2.

	Winter						Spring						Summer						Autumn					
	1 year out of 2			1 year out of 5			1 year out of 2			1 year out of 5			1 year out of 2			1 year out of 5			1 year out of 2			1 year out of 5		
	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060	1990 2020	2021 2040	2041 2060
Maximal temperature (°C)	15	16	16	16	17	17	26	27	28	28	31	30	34	37	39	37	39	41	28	32	32	29	34	34
Nb of days with temperature above 30°C	None						0	0	0	0	1	1,2	9	16	26	17	22	32	0	3,5	1,5	0	5	5,4

Figure 2. Example of 2 climate indicators at the temporal scale judged relevant for farmers to support strategic thinking about adaptation do climate change

- For vegetable farmers, strategic thinking on adaptation to climate change cannot rely on one single factors (e.g. temperature or rain) but requires to combine various climate indicators. For example, projection of maximal temperature as such is not enough for farmers to assess the impact on their vegetables. Indeed, the impact of high daily temperatures will also be related to the minimal night temperatures (need to present thermic amplitude) and the available water.

- The future actions to prioritize to adapt vegetable production to climate change from farmers' perspective in terms of practice exchanges between farmers, training, experimentation, public policy. For example, change in rain patterns showing more drought events in spring and summer can imply to develop policies guaranteeing the possibility of vegetable farmers to access to water in summer or to foster exchange groups between farmers to share and experiments cultivars which are more resistant to droughts in the local context.

CONCLUSION

To our knowledge, this study is the first attempt to involve vegetable farmers in a collective participatory process about adaptation to climate change based on climate projections with indicators and temporal scales relevant to their specific needs.

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