FELLOWSHIP SUMMARY REPORTS

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BUILDING A CLIMATE CHANGE RESILIENCE INDEX: A TOOL INSTRUMENT TO PRIORITIZE POLICIES IN THE AGRIFOOD SECTOR.

THEME II. STRENGTHENING RESILIENCE IN THE FACE OF MULTIPLE RISKS IN A CONNECTED WORLD

Host institution: Charles H. Dyson School of Applied Economics and Management.
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I consent to my report being posted on the Co-operative Research Programme's website.

1. What were the objectives of the research project? Why is the research project important?

The first objective of the stay is to define the Resilience of the sector agrifood in a climate change scenario through data-based indicators physical and socioeconomic in different geographical areas. The Resilience Index will allow assess the extent to which regions are preparing to meet the challenges of Climate Change in light of the latest reports from international organizations such as FAO, WHO, and others, who warn of the need to double the amount of food produced, in the same surface, with less fertilizers, less water and without fossil fuels.

Thus, during the stay, the different indicators that best adapt to the impacts are considered with the objective of evaluating the sustainability of the systems agri-food in different territories. To develop these indicators it is necessary to include information generated from the bio-economic models that will be integrated into the indicators finally designed.

The second objective will consist, from the results of the indicators, to generate economic and environmental impact **risk matrices** at different scales (local, regional, global) on the territories, in order to transfer knowledge to decision makers. These matrices developed in a spatial-sectoral manner contribute to generating resilience at the regional scale used and designing adaptation and mitigation measures in the face of climate change.
Our final result will be the linking of the key aspects of the indicators developed at the territorial level and the perception of socio-economic risk in the agrifood system. This information is basic to anticipate decisions in different scenarios and minimize the impacts and the expected socioeconomic and environmental risk.

Importance of the research

The **scientific knowledge from multiple research areas is a key resource** for addressing the current climate challenge, and must be focused on two fundamental issues. On one hand, knowledge is needed to face the essential **reduction of the concentration of Greenhouse Gases (GHG, calculated -and therefore referred to as- CO_2)** in the atmosphere, for which all countries and regions must be involved. On the other hand, knowledge is also essential to **generate Resilience**, that is, to provoke the necessary changes in production systems to make them viable in the years to come that according to the IPCC reports will be increasingly difficult until the necessary stabilization of the climate.

Both approaches must be developed together to be effective and truly useful building resilience. Without a holistic view of knowledge that coordinates and has the climate issue as the guiding axis of the actions, the objectives will not be achieved within the timeframes required by the current climate crisis.

Natural resources and the agri-food sector, in a context such as the current one of climate change face future challenges that affect the structure of production such as water deficits, desertification, pollution, evolution of the world population and socio-economic situation.

It is therefore very useful to undertake an analysis to generate knowledge that allows quantifying this loss of productive capacity of agricultural systems. Ensuring well-being, food and essential services for years to come can be threatened by climatic conditions and their adverse effects on natural resources and the economy.

The impact on the territories makes the exchange of scientific results and knowledge when making decisions to different scales.

This study presents a method for the design of Vulnerability and Resilience Indicators to ascertain the impacts that Climate Change will have on natural resources, the environment, scociety and the economy of the region of NY STATE in northeast EE. UU.

This is a necessary and urgent step to evaluate:

a) the immediate risks posed by Climate Change,
b) how resilient are the communities of NY State to face the climate emergency at the regional and local levels.

Based on international modelling outputs downscaled at the regional level of NY State, this study examined mapped results for Climate Change impacts, and relevant data were extracted at the 'county' level.

2. Were the objectives of the fellowship achieved?
Or are they on the way to being achieved? YES

If not, for what reasons? (The data or research is still ongoing or being analysed; technical reasons (e.g. equipment not working, adverse weather conditions, unexpected results, etc.; other reasons?)

Simultaneously, qualitative information was collected from literature in order to define what key Climate Change impacts and data to use to design suitable Vulnerability and Resilience Indicators, for which data on geographical, socio-economic and environmental characteristics, production systems and infrastructure were collected and analysed at the 'county' level.
A method of weighting both qualitative and quantitative information was created to model the current socio-economic development of each county against predicted Climate Change impacts grouped around six Vulnerability Indicators for the 3284 'counties' of all USA.
These were mapped by colour-grading them according to a matrix combining geographical area with main economic sector and degree of vulnerability.
A combination of the 6 Vulnerability Indicators was used to classify and map all counties into three categories of Vulnerability to Climate Change: Low, Medium, and High.
The maps illustrate differences in Climate Change Vulnerability and Resilience even for 'counties' that are near each other, responding to their specific geographical and socio-economic characteristics.
Counties heavily dependent on agricultural activities are the most vulnerable, while larger Resilience is observed with more diversification of economic activities, and linked to social characteristics such as younger age and higher level of formal education of the population.

Specific goals of this study are:

1. The development of a specific methodology for the creation of Vulnerability and Resilience Indicators.
2. The construction of a model and database of socio-economic-environmental data to enable updates and future impacts of Climate Change scenarios in USA.
3. An illustration of possible applications of the tools developed and the interpretation of results to inform planning recommendations and climate adaptation and resilience policies for key-examples in NY Stat.
4. Maps for all counties of USA based on downscaled and modelling outputs.

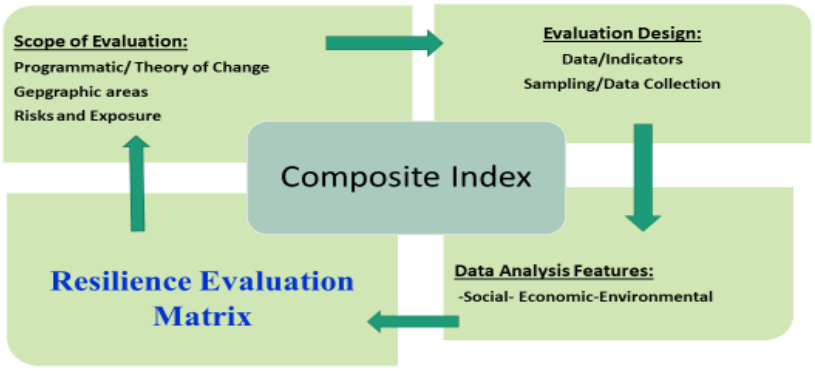
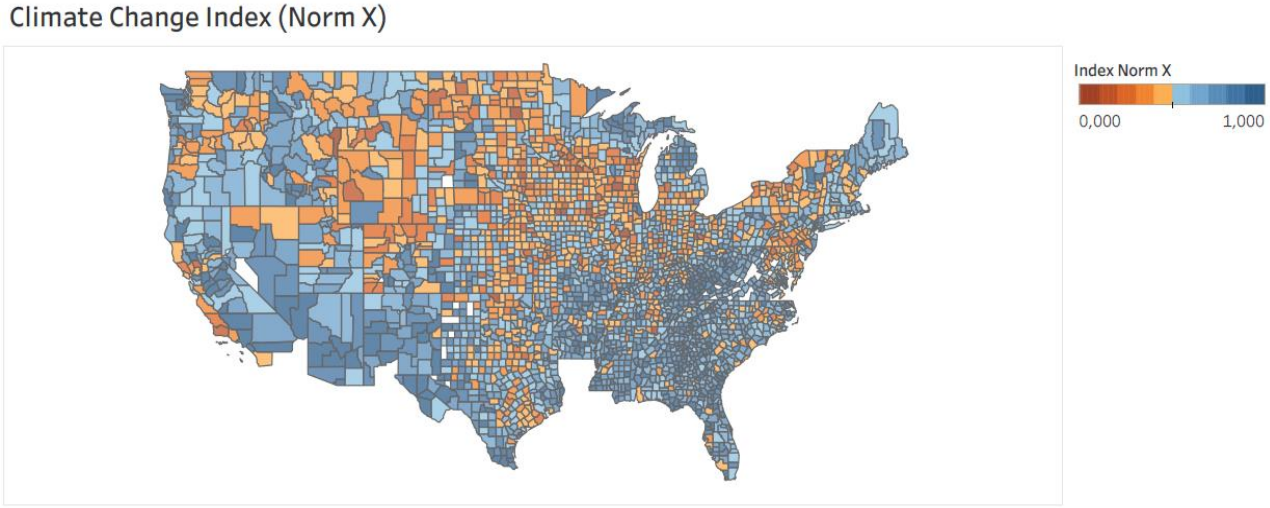


Figure 1. Map Vulnerability Index. USA.



3. What were the major achievements of the fellowship? (up to three)

- Theoretical development of the resilience index
- Increase the resilience of the territory
- Risk matrix: as a guide for actions in the short term

4. Will there be any follow-up work?

- Is a publication envisaged? Will this be in a journal or a publication? When will it appear?

We are going to present our paper: "A novel multi-dimensional climate change vulnerability index: a tool to prioritize policies in the agrifood sector" at: Ninth International Conference on Agricultural Statistics (ICAS IX) to be held 17-19 May 2023 in Washington DC, USA.

Yes, we are working together in different publications we can send to different journals in 2023.

- Is your fellowship likely to be the start of collaboration between your home institution and your host?

Yes, we are planning a collaboration during 2023 and next years.

- Is your research likely to result in protected intellectual property, novel products or processes? No

5. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?

Environmental and economic indicators are defined as a set of data that help to objectively measure the evolution of a process or an activity, thus becoming a fundamental tool to identify trends and focus on possible solutions. The novelty of the proposed indicators goes further, introducing a multidimensional approach necessary to address climate change impacts. In this project we are going to develop a specific methodology for the creation of resilience indicators at the territorial level, under an IPCC moderate emissions scenario (IPCC RCP 6) until the year 2065. The main novelty is that these indicators will be built from physical data and socio-economic and a database will be generated to be able to model possible impacts of Climate Change.

From this information the novelty will be to generate practical applications such as risk matrices with information for planning, decision-making and adaptation and mitigation against climate change.
The indicators currently used to measure resilience lack the integration of socioeconomic variables. The novelty of this work is the inclusion of climate impact, measured through phenomena such as drought, floods, heat waves and also factors socio-economic at the local level, such as unemployment statistics, population, level of education, per capita income, value added by economic sector and other socio-economic statistics available

The potential impact of this work is based on being able to examine the measures or parameters of adaptation of infrastructure / techniques and adaptation policies / measures that generate Resilience in the territories in the present, and model for the future.
- Improving Resilience in the territory, reducing Vulnerability is how the greatest benefits are achieved, and that includes physical adaptation measures (eg infrastructure), technical (eg prediction), political-strategic (eg training) and socio- economic.
- To increase Resilience, it is possible to improve the measurement and prediction of climatic aspects, adaptation to these through infrastructure, for example flood management (outside the framework of this phase of the study), and also improve through training socio-economic aspects such as educational level (which allows greater adaptation, eg knowing how to apply for aid), employment rate, per capita income, etc.
Building resilience implies:
- Management of the disposable income of the territory, the income can be used for investments that make the region less vulnerable or that even expose it to a lesser extent to risks related to the climate.
- Access to information and decision-making implies changes in the defined vulnerability.
- Diversification of economic activity: Faced with climate uncertainty scenarios, adaptation and changes in diversification of productive activity is a key element for vulnerability.
- Experts: Qualitative information is a necessary element to measure the level of knowledge and exposure of the territory to the impacts of climate change.

In this project, the involvement and information that will be generated is extremely relevant for decision-making. We highlight the following aspects:
- More precise information for decision making: Different emission scenarios and horizons up to 2100 with regionalized data from IPCC predictions.
- Applications: Risk matrices.
- New maps and explanations, at a different scale possible but it is understood that the appropriate scale for decision and policy is the county level.
- Possible creation of 'Adaptation and Resilience Policy Packages'
- Analysis of factors that are the same number of physical factors and that socio-economic factors can be changed or included. It can be fine-tuned. Say why and how many.
- Weighting of factors and creation of Indicator with more or less aggregation.
- Modeling of how to achieve greater Resilience using various political and socioeconomic parameters, and of Adaptation measures and actions to build Resilience (eg. physical infrastructure such as urban and architectural - green recreational areas, shading and ventilation against high temperatures -; defense against floods; improvement of roads for extremes of rainstorms, snow etc; of general improvement against hail and wind of greater intensity etc.).

6. How was this research relevant to:

- The objectives of the CRP?

Reducing the vulnerability of the territory at its different levels, local provincial and regional autonomic is an objective that is implicit in our proposal. Vulnerability understood as the level to which a system is susceptible, in the face of the adverse effects of Climate Change, including climate variability and extreme events should be reduced through mechanisms that generate Resilience. The objective of this proposal seeks to select actions to reduce vulnerability by increasing the resilience capacity of a system (social, ecological, economic, etc.) to absorb shocks without losing its basic structure, way of functioning and ability to organize itself.

- The CRP research theme?

For the generation of resilience, the use of resources will be taken into consideration endogenous both material and human. This is the fundamental reason that prevent the resilience generated for a territory has a direct application to others. The incorporation of the results of bio-economic models that have to adapt to the characteristics of the human, physical and biological environment of the territory. It will be key for the work to consider the Bottom Up-Top Down strategy that will take into account the conditioning factors specific to each territory to achieve the best possible result with the available resources.
For this, it is essential to integrate economic, social and environmental information, in a territorialized way. This integration will also make it possible to identify new information needs, as well as generating indicators on which to build future evolution scenarios.

7. Satisfaction

- Did your fellowship conform to your expectations?

  Yes, this research project has all practical arrangements that will ensure its successful implementation and management. This proposal is aimed at obtaining funding for my stay at Cornel University in USA for 18 weeks. I have had full access to all necessary facilities at the host institution and I worked in close collaboration with Dr. Gómez.
  On the other hand, I have experience in economics of climate change and agriculture. Thus, this new collaboration brings together the required expertise from Cornell University and from University of Zaragoza to ensure the success of the project and a long lasting research collaboration between the two institutions after the fellowship is completed.
  Moreover, I have been in close contact with Dr. Gómez to plan for my visit.
  Since then, Dr. Gómez has visited to Zaragoza of a period of one week every two years, and I have been exploring collaboration research opportunities with him.
  This is a unique opportunity to strengthen the collaboration between Cornell University and University of Zaragoza.
  Cornell University is an internationally recognized center in Economics Agrarian and Agrifood. The center is an international leader in applied economics and management tools. Among his most outstanding lines of research are environmental economics, economics of biofuels and water resources, agreements trade and international impacts, study of emerging economies, economy of the consumer behavior and food psychology. Dyson has developed a wide range of innovative research programs, which places the University of Cornell at the highest levels of world policy research in a global stage.
  Professor Miguel I. Gómez and his research team are experts in international organizations in the field of agrarian and agri-food economics, and development of bio-economic models and sustainability of the agri-food sector. Your work on this area involves multiple multidisciplinary collaborations, being specialized in the development of evaluation models of the operation of the sector in multiple dimensions (economic, social and environmental). An expanding research area is the development of bio-economic models with application to different types of crops and food. The research group in which I will join, led by professor Gómez develops an intense research activity in the study of these models to the evaluation of environmental impacts. The team has made important contributions to the literature combining microeconomic theory with quantitative methods, emphasizing key concepts such as price transmission, response to demand, and extending the analysis to economic development and environmental sustainability. The scope of the team's research program is national and international, with demonstration projects in Latin America and the Caribbean. One of the lines of research is the study of the increase in food security of the underserved populations through sustainable regional food systems. Likewise, Professor Gómez is part of the David R. Atkinson Center, Center for a Sustainable Future, from Cornell University, where the study of the risk associated with impact of climate change is a priority line and will contribute to advance in the methodology to be developed in this proposal. These points are of special interest to the proposed theme. The methodology that will be worked on during the stay, to through the incorporation of information from bio-economic models in Resilience indicators, is the natural complement to the investigations of the team along these lines and, in turn, the extensive experience of the working group in these topics, it is the ideal framework to propose a joint, novel, fruitful and with new lines of joint work.

- Will the OECD Co-operative Research Programme fellowship increase directly or indirectly your career opportunities? Please specify.

The funding of this grant will be essential not only to achieve the goals described in the proposal but also to facilitate the establishment of a long-term relationship of the applicant with the research group in the host institution, University of Cornell. This opportunity has contributed to combine my expertise in the field of economic models and the economics of climate change with the experimental economics expertise of Dr. Gómez. In addition, Dr. Gómez and I will be work in collaboration with scientists in the US and in Spain who are focusing on production systems and sustainability.

This is enabling us to implement a multidisciplinary approach to reach the proposed project objectives. This new acquired knowledge will contribute to place our research not only in the front line of the applied economics field but will also place us in the position to make impacts beyond de academia, and will allow us to influence public policy decisions. Moreover, the proposed project allowed me to build future collaborations with researchers in United States and with researchers in other disciplines, giving me the opportunity to develop an international network.

My main methodological and empirical contributions have focused on the need to develop these indicators in the face of different impacts of climate change and in different economic, social and geographical contexts. I have worked on the definition of these indicators for decision-making at different decision scales (country, region and international context). One of the lines that I am currently working on is the development of these indicators at the regional level for the territories. This methodology requires specific knowledge of physical data processing in a socioeconomic context. Therefore, the relationship with Dr. Miguel Gómez and his experience in the bio-economic models will allow me to advance in the methodology of these indicators in a context of limitation of natural resources conditioned by the new aspects of the biodiversity of regions and systems. We will use this framework to build bio-economic models and indicators for the prediction and simulation of energy efforts resource conservation. The Cornell group's specialization in this line of work guarantees progress in the methodology and achievement of the objectives of this project.
During the 2015/2016 academic year, Professor Gómez carried out a research stay, corresponding to his sabbatical year, in the Department of Economic Analysis of the University of Zaragoza to which I belong. There he made different presentations of his current jobs, their interests, and taking into account the interests of my team of research (Growth, Demand and Natural Resources, CREDENAT) we began to design future collaboration possibilities. In 2018, Professor Gómez visited our center for a week and is scheduled to visit us again for a week in January 2022. Throughout this time we have seen real possibilities of integration of a promising part of our lines of work, in the context of study and application of bio-economic models and economic impacts and associated environmental. This stay and the joint research that arises is an ideal opportunity to launch these common research areas, with an important anticipation of future collaboration. The short-term goal is co-authorship of several jobs and, in the medium term, you want to request different research projects set between both teams. Additionally, the research teams that we coordinate have an important group of pre and postdoctoral researchers, so that the completion of the stay also aims to lay the foundations for subsequent collaborations, doctoral stays, teaching, etc. In this sense, the realization of the stay will result in the investigation not only of our teams but also of our centers. It is also expected that Professor Gómez will carry out his next sabbatical stay in our department in the academic year 2023-2024, which will enhance our collaboration.

- Did you encounter any practical problems?

  No, all management has been completely satisfactory.

- Please suggest any improvements in the Fellowship Programme.

  Look for the way to continue the collaboration and economic aid with the host institution in the months following the finalisation of the project.

8. Advertising the Co-operative Research Programme

- How did you learn about the Co-operative Research Programme?
  I know the programme since 2017. I have already had a fellowship in 2017.