Climate change effects on agriculture in 2100. Trends in production for the Mexican region of Tabasco.

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Speaker: Melania Michetti

Co-authors:
Enrico Scoccimarro
Carlo Saocella
Emiliano Ramieri

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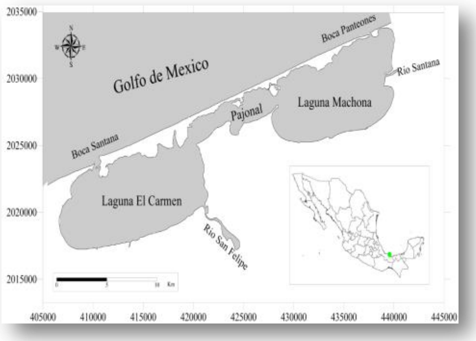
What

Analyse the impact of climate change on crop production in the short and long run

Where

Carmen-Pajonal-Machona lagoon system



Cárdenas (2), Comalcalco (5), Paraíso (14)

How

- **Climate scenarios:** RCP4.5 and RCP8.5
- **Climate parameters:** temperature, precipitation, sea level rise (salinization)
- **Crops:** corn, banana, and coffee

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Why

Facts

- ❖ The local **population** are still **engaged** in **primary activities.**
- ❖ A **subsistence economy** based on agriculture is the only source of living.
- ❖ **Backyard farming** is important for woman

Problems

The region surrounding CPM is experiencing an important level of ***environmental degradation (vicious cycle)****.*

- ❖ The rise in population **puts pressure on natural resources; economic conditions** lead to their **over-exploitation.**
- ❖ **Natural/climatic stress factors** amplify the effects (Slr, rainfall patterns, temperature increases)
    - **Land** available for agriculture **is shrinking**
    - **Water is scarce** and it is contaminated by **salt intrusion**
    - **Soil productivity** and agriculture production **decline**

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Approach- Crop behavior

❑ **Characterization of crop behavior** as a function of climate-related parameters.

This is done by combining phenological crop characteristics with climate-related information, based on agronomic relations:

- ❖ **Different thermometric levels**
  continuous curvilinear functions (cubic polynomial equations)
- ❖ **Different rainfall intervals**
  step functions are implied to assess the effects of jumping from one to another rainfall interval
- ❖ **Two salinization advancement cases**
  3.8 and 5.9 mS/cm

❑ Derived equations can be employed to **estimate the effects on harvest** reduction due to a variation in temperature and rainfall patterns.

This is done **by replacing the values** used for the crop characterization **with** climatological values resulting from **climate model projections**.

We summarize this information calculating harvest **coefficients**

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Approach- Coefficient determination

To allow a **direct comparison** amongst crop responses to climate change, we **calculated % coefficients expressing harvest**: % wrt maximum potential production in future times.

- ✓ crop responses to the climate parameters, considered **separately**
- ✓ **combined effect** of their joint variation (geometric aggregation)

Coefficients are used with respect to past trends in agricultural production to derive its variation in 2030/2100, for each climate scenarios and crop considered, for the **Tabasco** state and the **3 municipalities** considered surrounding the lagoon system (Paraíso, Cárdenas, and Comalcalco).



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Climate characterization

- ❑ **Nine state-of-the-art Climate Global Circulation Models** from the 5th Coupled Model Intercomparison Program (CMIP5)

Model name	Lat x Lon (degrees)	Institute (Institude ID)
CCSM4	0.9 x 1.5	National Center for Atmospheric Research (NCAR)
CMCC-CMS	1.9 x 1.9	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)
CMCC-CM	0.8 x 0.8	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)
CSIRO-Mk3-6-0	1.9 x 1.9	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence (CSIRO-QCCCE)
HadGEM2-CC	1.2 x 1.8	Met Office Hadley Centre (MOHC)
INM-CM4	1.5 x 2.0	Institute for Numerical Mathematics (INM)
MIROC5	1.4 x 1.4	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology (MIROC)
MPI-ESM-MR	1.9 x 1.9	Max Planck Institute for Meteorology (MPI-M)
MRI-CGCM3	1.1 x 1.1	Meteorological Research Institute (MRI)

- ❑ **Climate parameters averaged** over the box 92W:95W-16N:19N (region of interest, Cuenca del Río Tonalá, involving as a sub-basin, the lagoon of CPM)

- ❑ Two concentration scenarios: **RCP4.5**, **RCP8.5** (Riahi et al., 2011; IPCC, 2013a; Taylor et al., 2012), and two reference years: **2030** and **2100**

- ❑ Climate change is signaled by **climate anomalies**: climatic difference between the realization of the climate parameter during **1983-2012** and the future climate (**2005-2100**).

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Future harvest, percentage levels

Crop	Action/Agent		2030 RCP4.5	2030 RCP8.5	2100 RCP4.5	2100 RCP8.5
Corn	Individual response	Precipitation	95%	93%	95%	75%
		Temperature	97%	98%	99%	94%
		No salinity	100%	100%	100%	100%
		Low salinity	75%	75%	75%	75%
		Advanced salinity	50%	50%	50%	50%
	Joint response, low salinization		**69%**	**68%**	**71%**	**53%**
	Joint response, advanced salinization		**46%**	**45%**	**47%**	**35%**
Banana	Individual response	Precipitation	68%	68%	68%	64%
		Temperature	86%	86%	86%	75%
		No salinity	100%	100%	100%	100%
		Low salinity	60%	60%	60%	60%
		Advanced salinity	30%	30%	30%	30%
	Joint response, low salinization		**35%**	**35%**	**35%**	**29%**
	Joint response, advanced salinization		**17%**	**17%**	**17%**	**14%**
Coffee	Individual response	Precipitation	100%	100%	100%	100%
		Temperature	93%	93%	89%	68%
		No salinity	100%	100%	100%	100%
		Low salinity	30%	30%	30%	30%
		Advanced salinity	0%	0%	0%	0%
	Joint response, low salinization		**28,0%**	**27,9%**	**26,7%**	**20,5%**
	Joint response, advanced salinization		**0,0%**	**0,0%**	**0,0%**	**0,0%**

Future harvest, absolute values

Corn

Area	Annual mean corn harvest (t)	Joint response, low salinization				Joint response, advanced salinization			
		2030		2100		2030		2100	
		RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Tabasco	92.180	63.939	62.450	65.113	48.695	42.626	41.633	43.409	32.463
Paraiso	194	135	132	137	103	90	88	92	68
Comalcalco	4.435	3.076	3.005	3.133	2.343	2.051	2.003	2.089	1.562
Cardenas	11.917	8.266	8.073	8.418	6.295	5.511	5.382	5.612	4.197

Banana

Area	Annual mean corn harvest (t)	Joint response, low salinization				Joint response, advanced salinization			
		2030		2100		2030		2100	
		RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Tabasco	281.389	97.956	95.672	95.672	81.412	48.978	47.836	47.836	40.706
Cárdenas	6.726	2.341	2.287	2.287	1.946	1.171	1.143	1.143	973

Coffee

Area	Annual mean corn harvest (t)	Joint response, low salinization				Joint response, advanced salinization			
		2030		2100		2030		2100	
		RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Tabasco	281.389	97.956	95.672	95.672	81.412	48.978	47.836	47.836	40.706
Cárdenas	6.726	2.341	2.287	2.287	1.946	1.171	1.143	1.143	973

Conclusions

❖ **Tabasco** is progressively becoming a **non-suitable area** for the production of many crops

❖ **Food security** (corn) and livelihoods becomes a serious priority

Possible actions to reduce vulnerability and increase communities' resilience to climate change:

- **Selecting** more resistant **seeds** and **switching** to more resistant crops (already applies)
- **Identifying** innovative **solutions for irrigation and water management** to cope with water scarcity and water salinization
- Fostering a more **sustainable use of natural resources** by raising **awareness, providing training activities** and **technical tools or support**
- Improving **land management** and **planning**
- Enhancing **technological adoption** by fostering **credit access** and the use of **financial schemes,** which should be **complementary to governmental support**

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Comments are welcome

melania.michetti@cmcc.it

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- Project coordinator: Thetis SpA

- This framework forms part of a wider Project on adaptation in which local institution (INECC-IMTA-CONANP-CONAGUA-NAFIN-BM) have taken part

  "Proyecto de Adaptación de humedales costeros del Golfo de México ante los impactos del cambio climático – TF096681 "

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