

**NEREUS**

Núcleo de Economia Regional e Urbana  
da Universidade de São Paulo

The University of São Paulo  
Regional and Urban Economics Lab

# Boiling Hot! Economy-wide Impacts of Climate Change on Colombian Coffee Yields

*"International Workshop on Interregional Economic  
Modeling: Applications for the Colombian Economy"*

*Banco de la República, Cartagena, Colombia  
March 19-21, 2020*

Pedro Sayon

# Research team – NEREUS

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# Weather vs. Climate

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“If you don’t like the weather in New England, just wait a few minutes.”

Mark Twain

# Weather vs. Climate

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**Weather** refers to atmospheric conditions that occur locally over short periods of time – from minutes to hours or days

- ✓ Familiar examples include rain, snow, clouds, winds, floods or thunderstorms.

**Climate**, on the other hand, refers to the long-term regional or even global average of temperature, humidity and rainfall patterns over seasons, years or decades

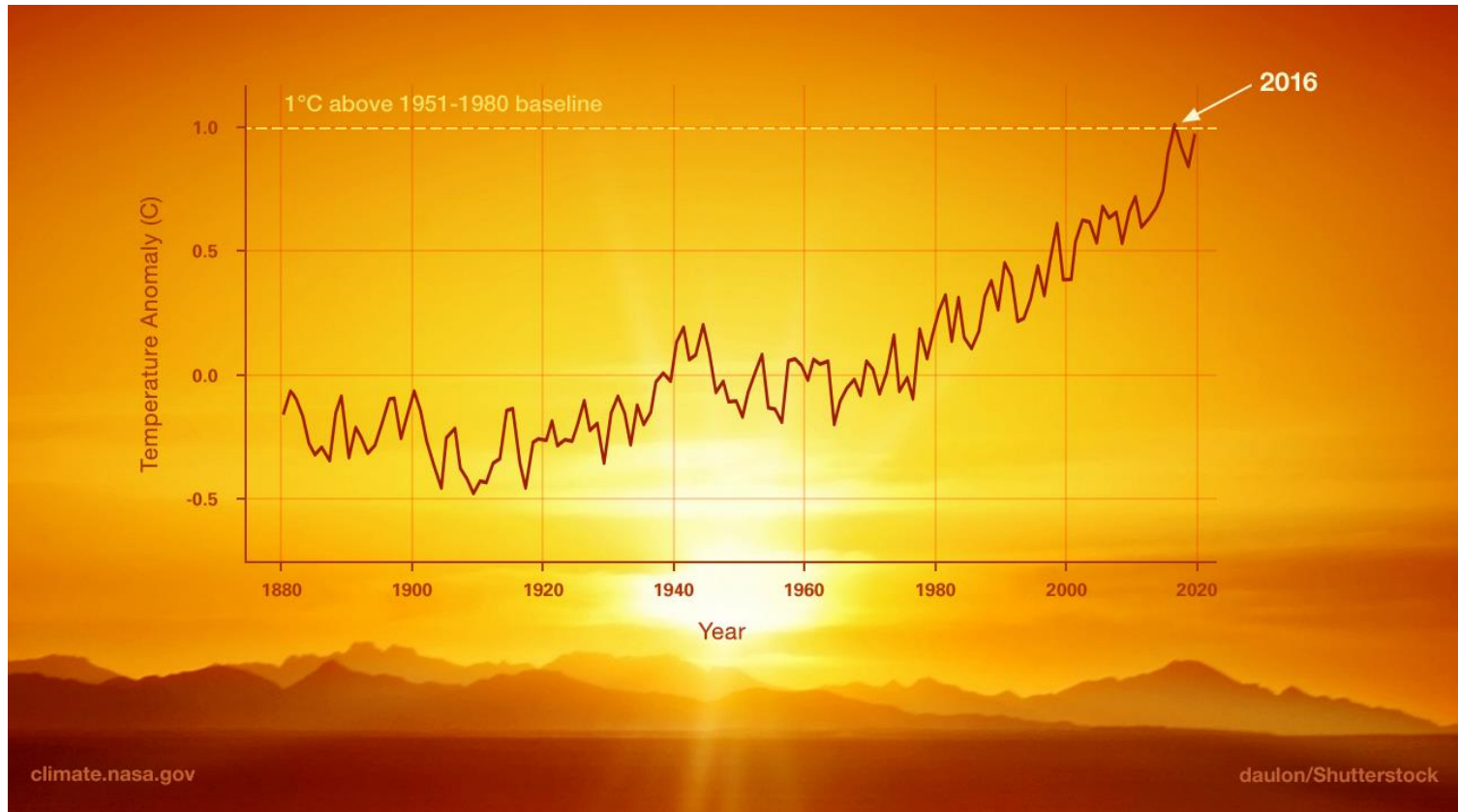
# Climate change

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The term “climate change” refers to a physical phenomenon in which there are globally **long lasting shifts** in temperature, precipitation, cloudiness, among other atmospheric conditions in regard to their historical averages

Such variations may be caused by many different reasons, such as internal Earth processes, external forces (e.g. solar activity), or, more recently, because of human activity

# Global warming



Source: NASA's Goddard Institute for Space Studies

# History

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Coffee first appeared in Colombia by mid 18th century, when the Society of Jesus introduced it in its farms at the Eastern Plains (Orinoquía region)

It remained a marginal crop for over a century, not only in Colombia, but also all around the world

Only by late 19th century with the advent of Industrial Revolution began the real history of the coffee industry

In Colombia, its first commercial experience came out as a sub-product of the pinnacle of coffee growing in the Venezuelan Andes after its independence

# History

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The first decade of the 20th century did not seem likely to yield a large coffee expansion. International grain prices remained at extremely low levels and coffee farms were unproductive and still affected by the greatest civil conflict in Colombian history.

Nevertheless, the coffee industry took an unexpected turn, having quintupled its yields by the end of the 1920s. Not only did it become Colombia's top export, but also the country became the world's second largest producer.

The great bonanza that the coffee economy experienced until the crisis of 1929 was not abruptly interrupted. On the contrary, it kept growing in later decades. In the early 1960s, its yields reached three times what it was in the mid 1920s.



# The Colombian coffee industry

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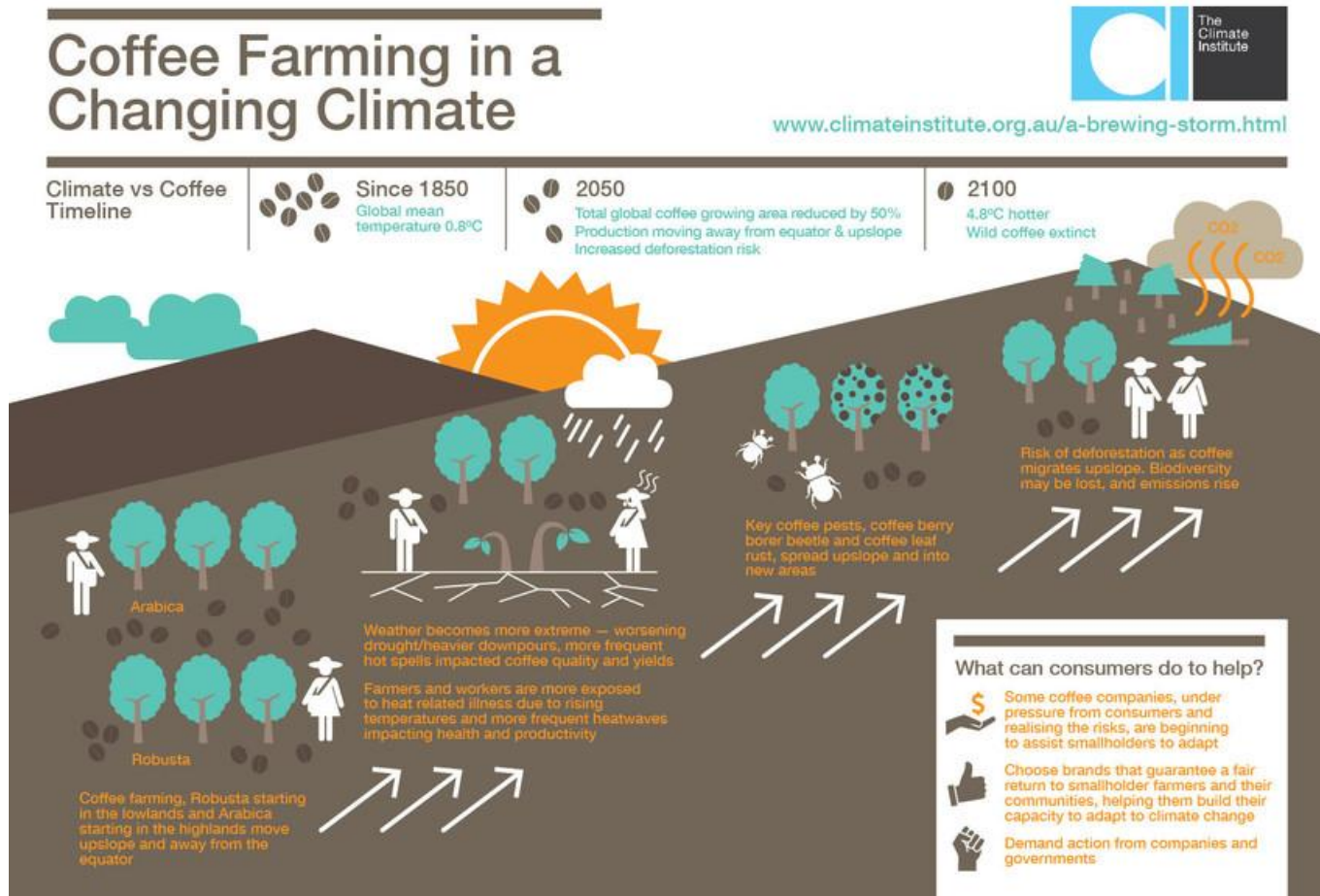
Colombian coffee is renowned worldwide for its quality and delicious taste

It is one of the major crops of the country, being the world's third largest producer

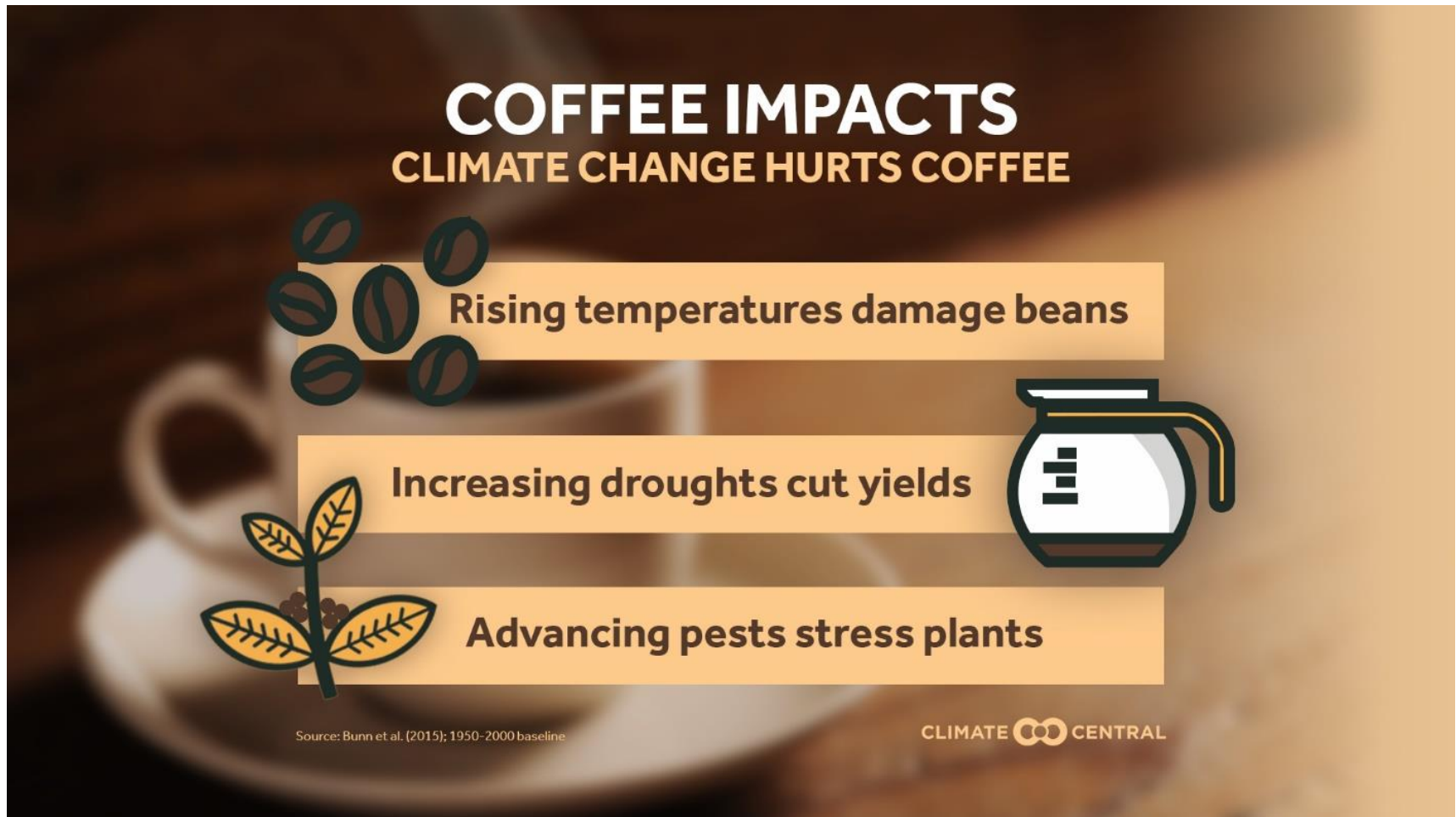
Although coffee growing is not relevant in terms of GDP (less than 1%), it plays an important role when it comes to employment, with over half a million families benefiting directly from it, potentially more indirectly

Given the importance of this commodity to the economy, climate change has sparked the discussion about how to overcome the coming hindrances imposed by new weather conditions

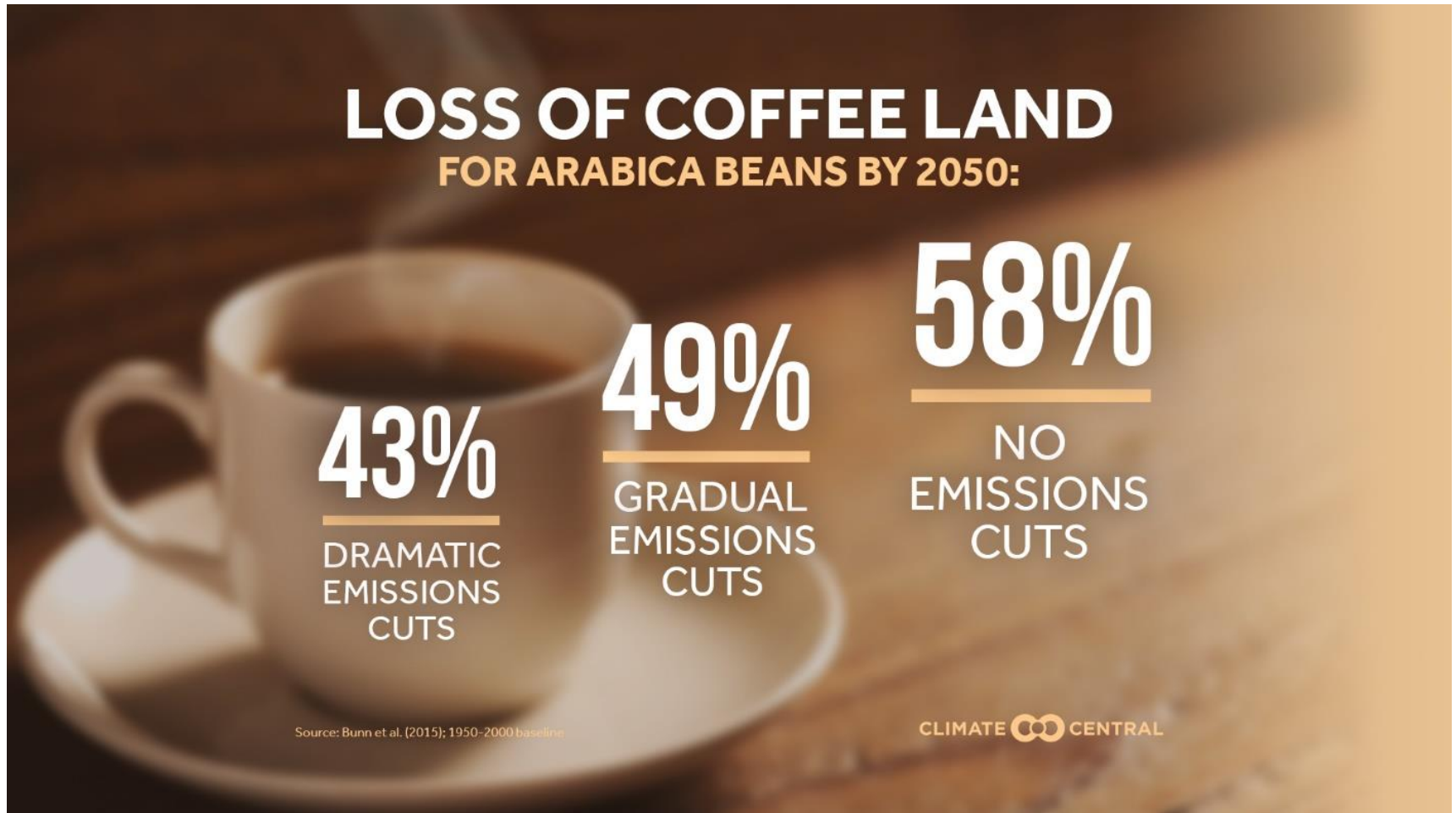
# Climate change and coffee



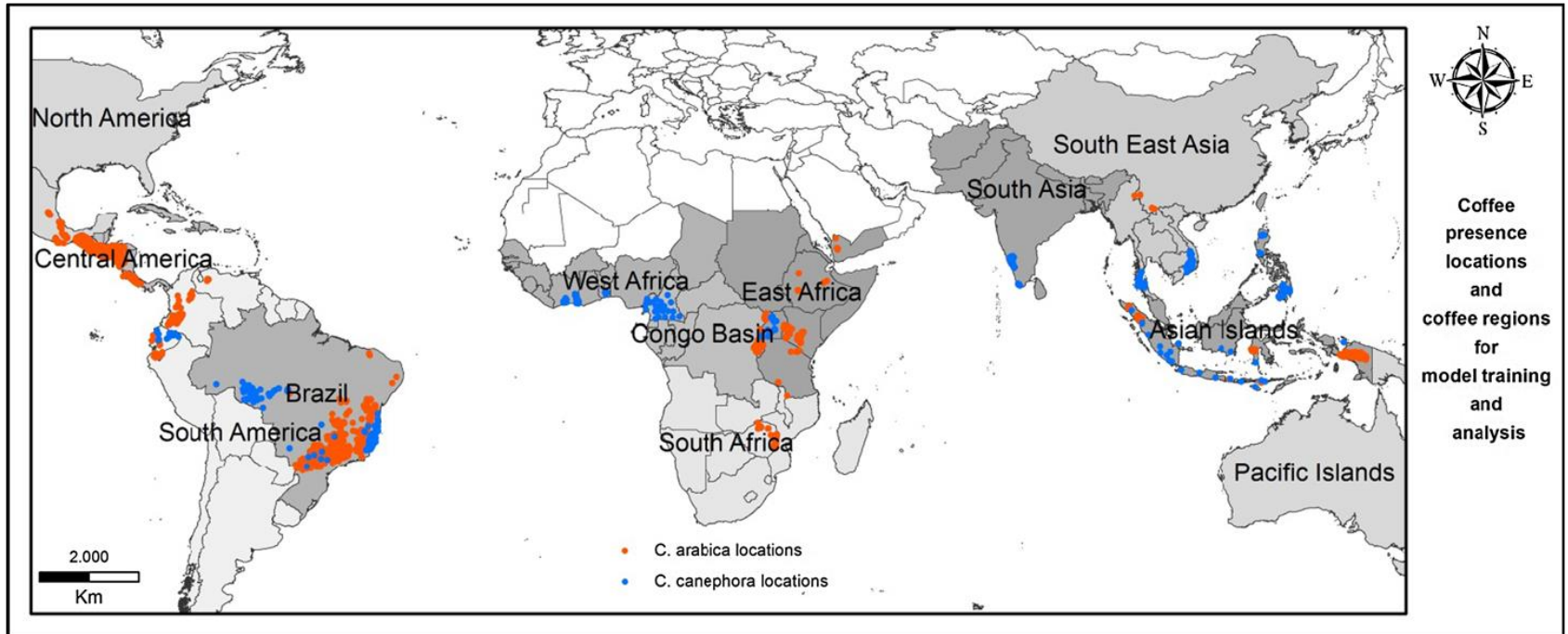
# Climate change and coffee



# Climate change and coffee



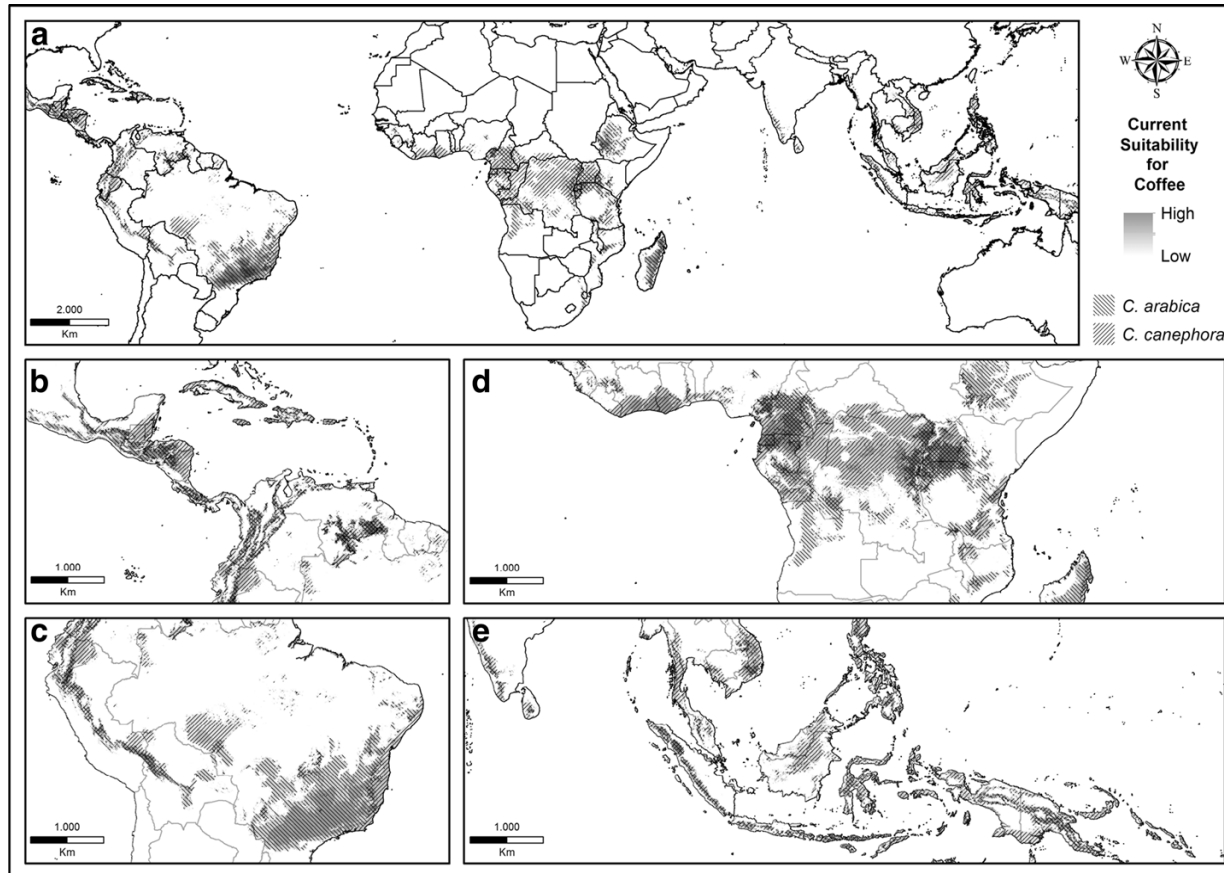
# Coffee locations



Source: Bunn et al. (2015)

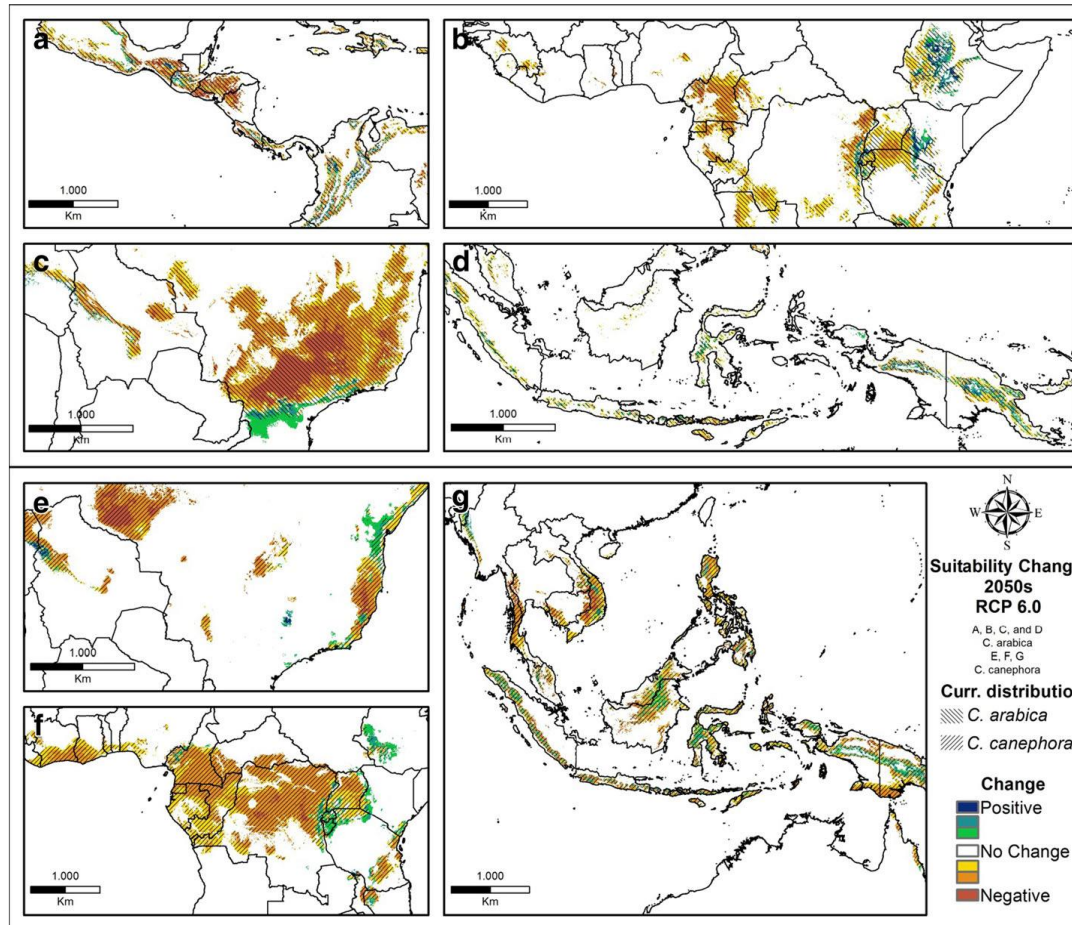


# Coffee suitability



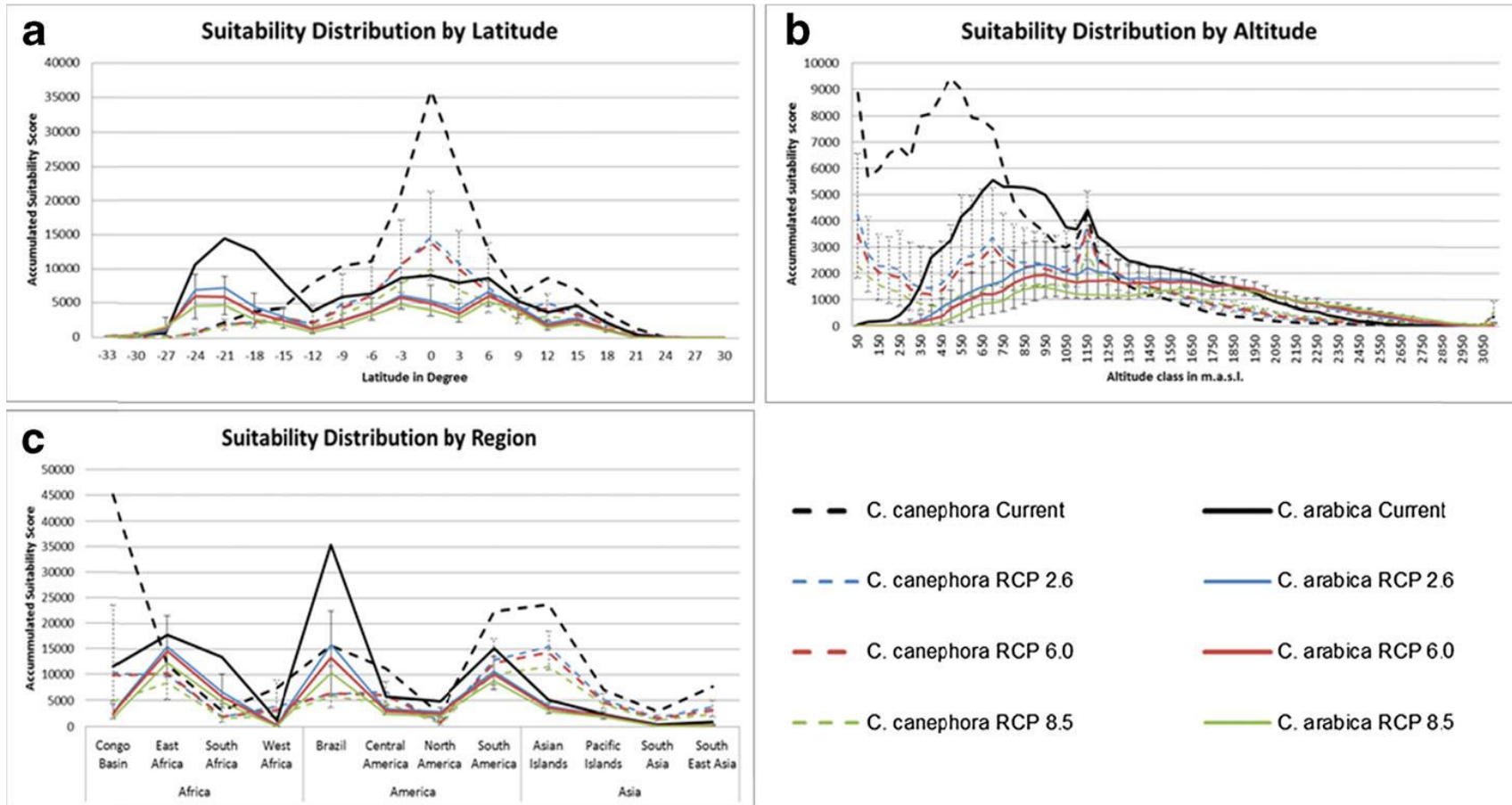
Source: Bunn et al. (2015)

# Suitability change



Source: Bunn et al. (2015)

# Suitability distribution



Source: Bunn et al. (2015)



# What about Colombia?

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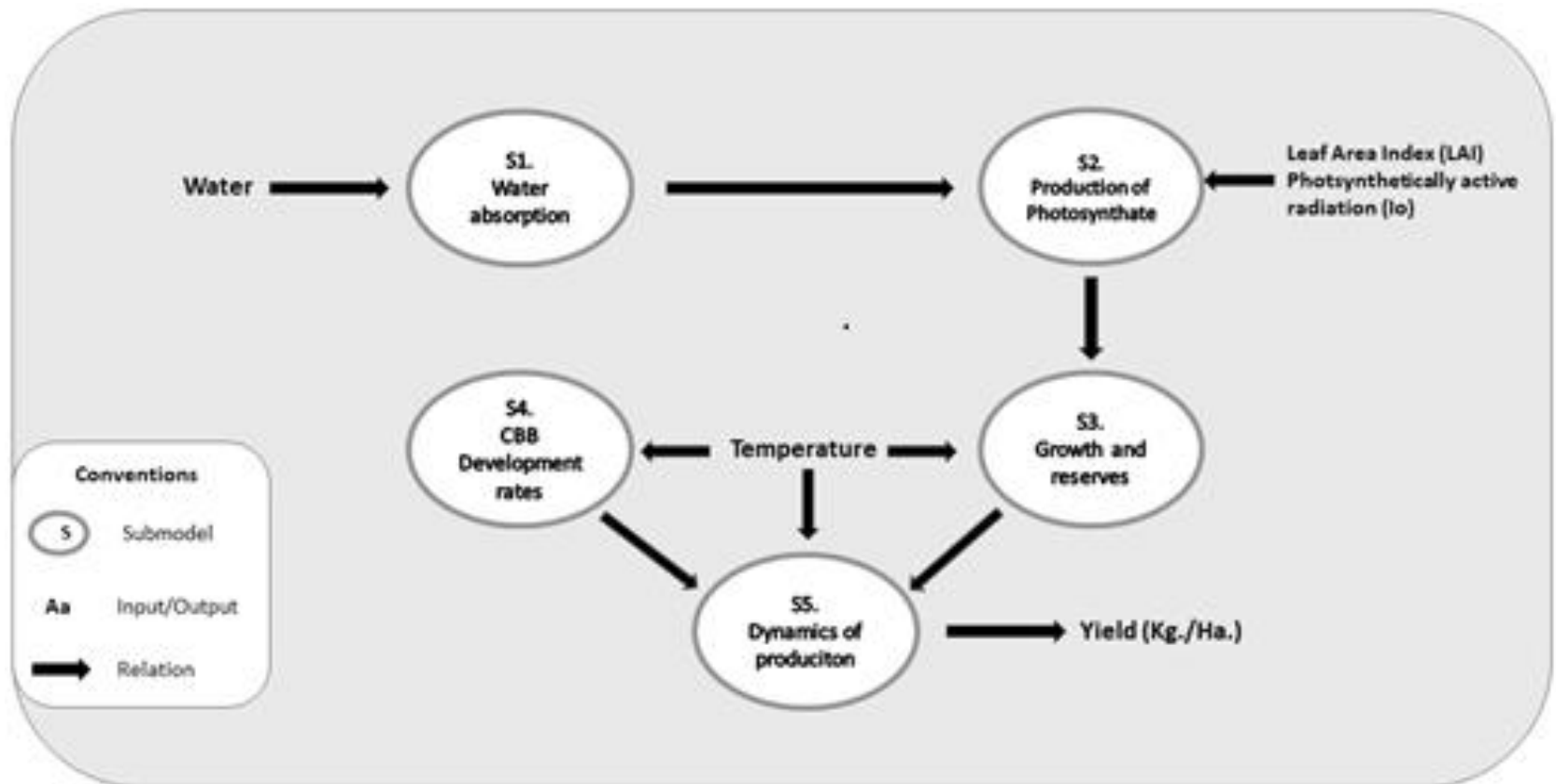
Sierra (2019) uses a multi-step model to predict the outputs for each municipality in Colombia producing coffee (>500)

- Project an increase between 4% and 24% in coffee yields on a national level
- High degree of spatial heterogeneity

Climate affects productivity (i) mainly through temperature and precipitation; (ii) in turn, they impact water absorption, production of photosynthate and consequently growth; (iii) coffee borer beetle reproduction rate

Sierra (2019) integrates all these elements into the dynamics of production, obtaining the resulting coffee yields

# Underlying mechanisms



Source: Sierra (2019)

# What if climate change affected coffee yields in regionally-differentiated ways?

## *How do we implement productivity change?*

**Which industry is affected?**

**And in which region?**

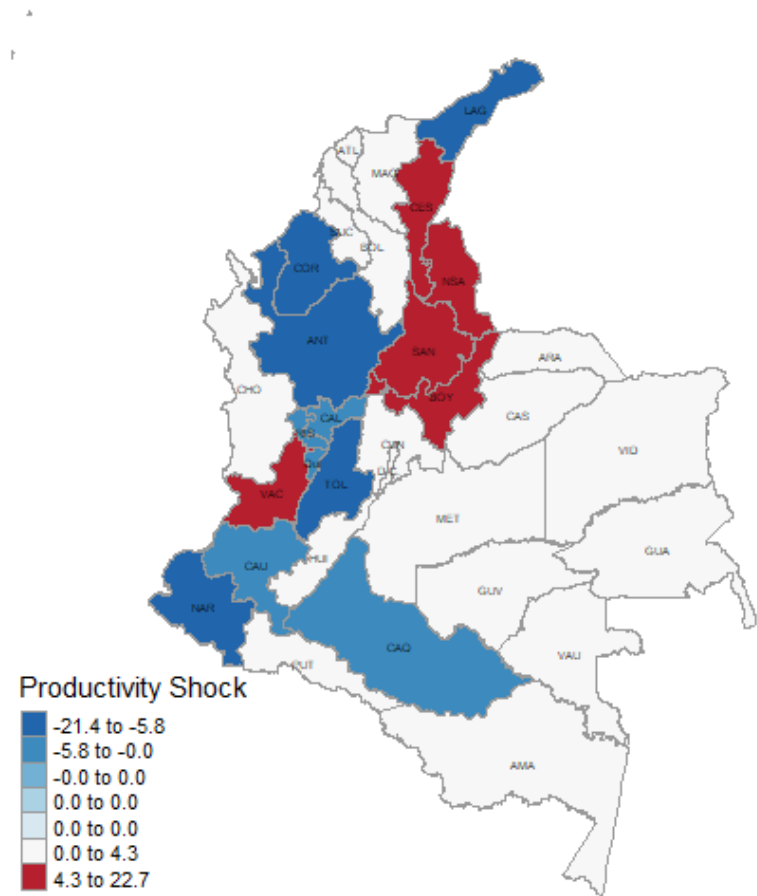
Shock  $a1("S2", "R5") = 15.275;$

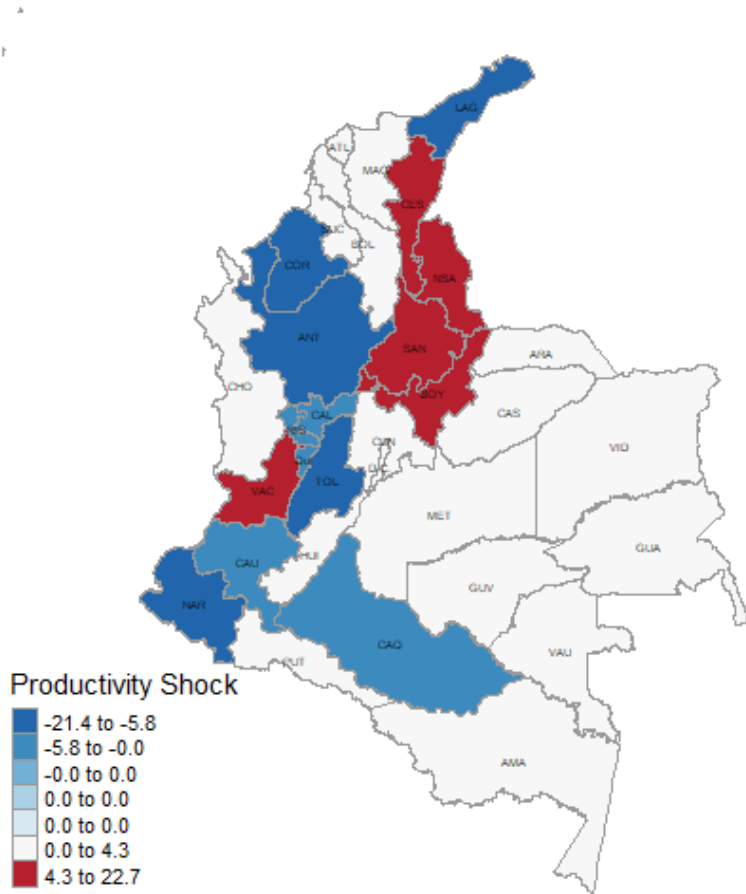
**15.275% more  
inputs needed to  
produce same level  
of output**

**All-input augmenting technical change**

# CGE shocks

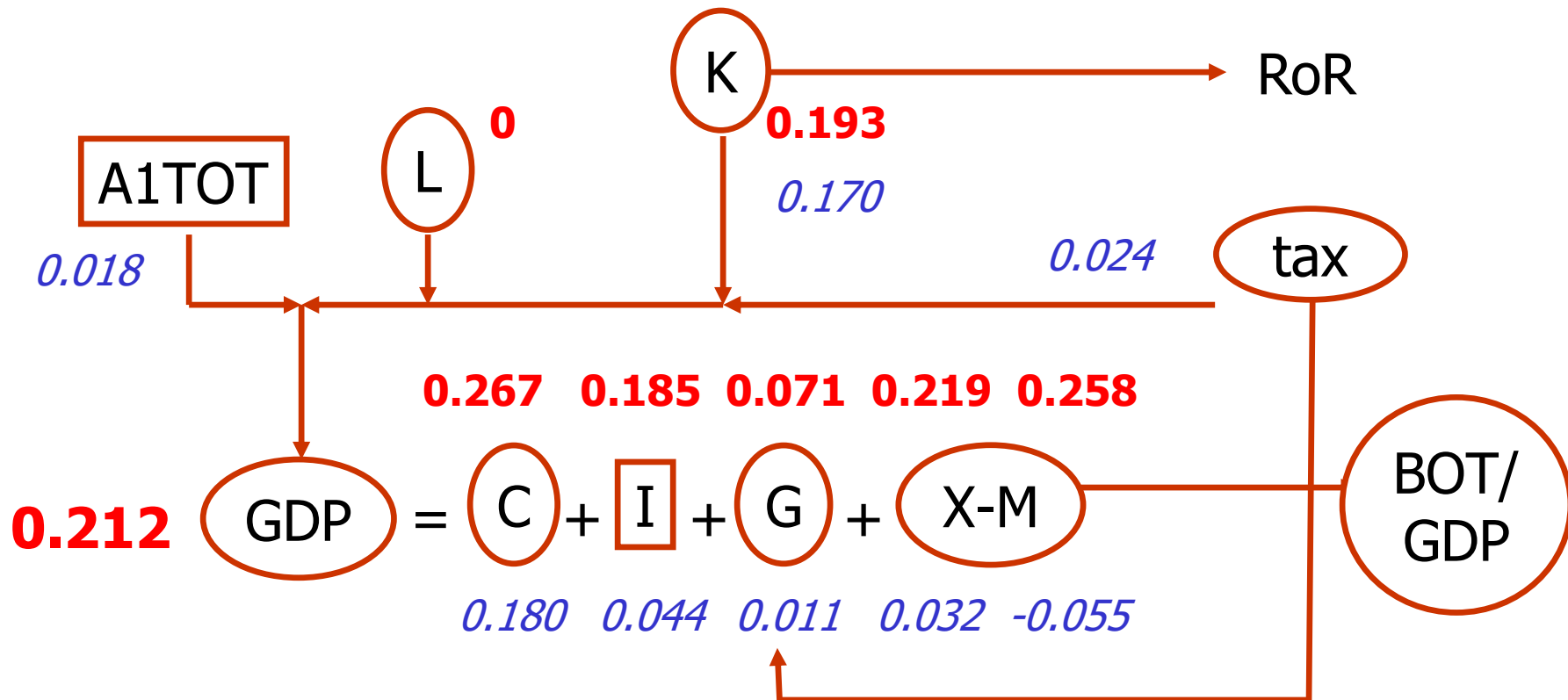
REGION CODE	REGION NAME	SHOCK
R1	Antioquia	-7.98
R5	Boyacá	15.28
R6	Caldas	-0.94
R7	Caquetá	-0.03
R8	Cauca	-5.70
R9	Cesar	4.36
R11	Cundinamarca	-10.37
R12	Chocó	0.29
R13	Huila	-21.38
R16	Meta	4.27
R17	Nariño	-5.92
R18	Norte de Santander	15.86
R19	Quindío	-1.91
R20	Risaralda	-0.54
R21	Santander	22.73
R23	Tolima	-16.28
R24	Valle del Cauca	6.16
R26	Casanare	0.83





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# Effects on GDP

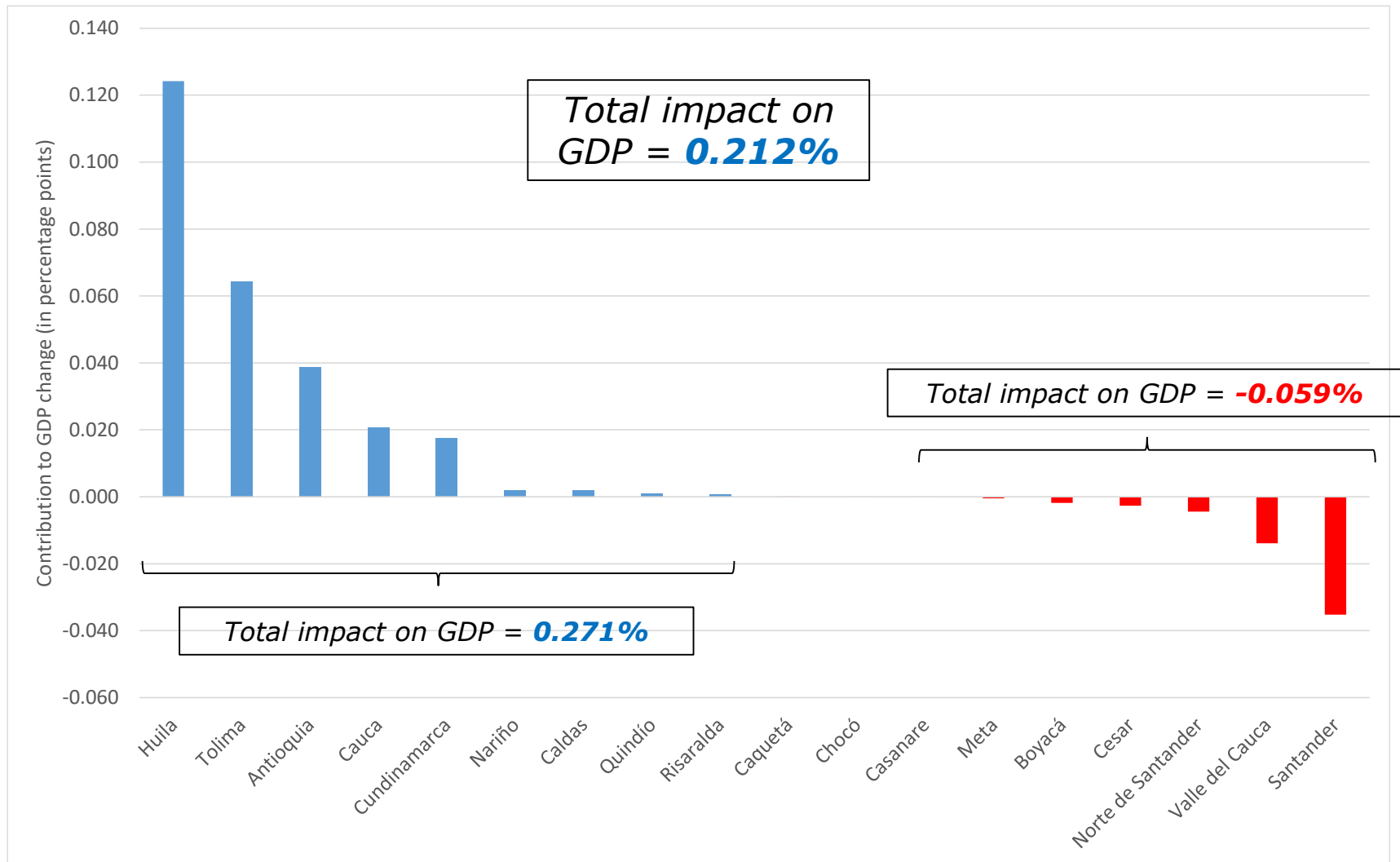


Endogenous

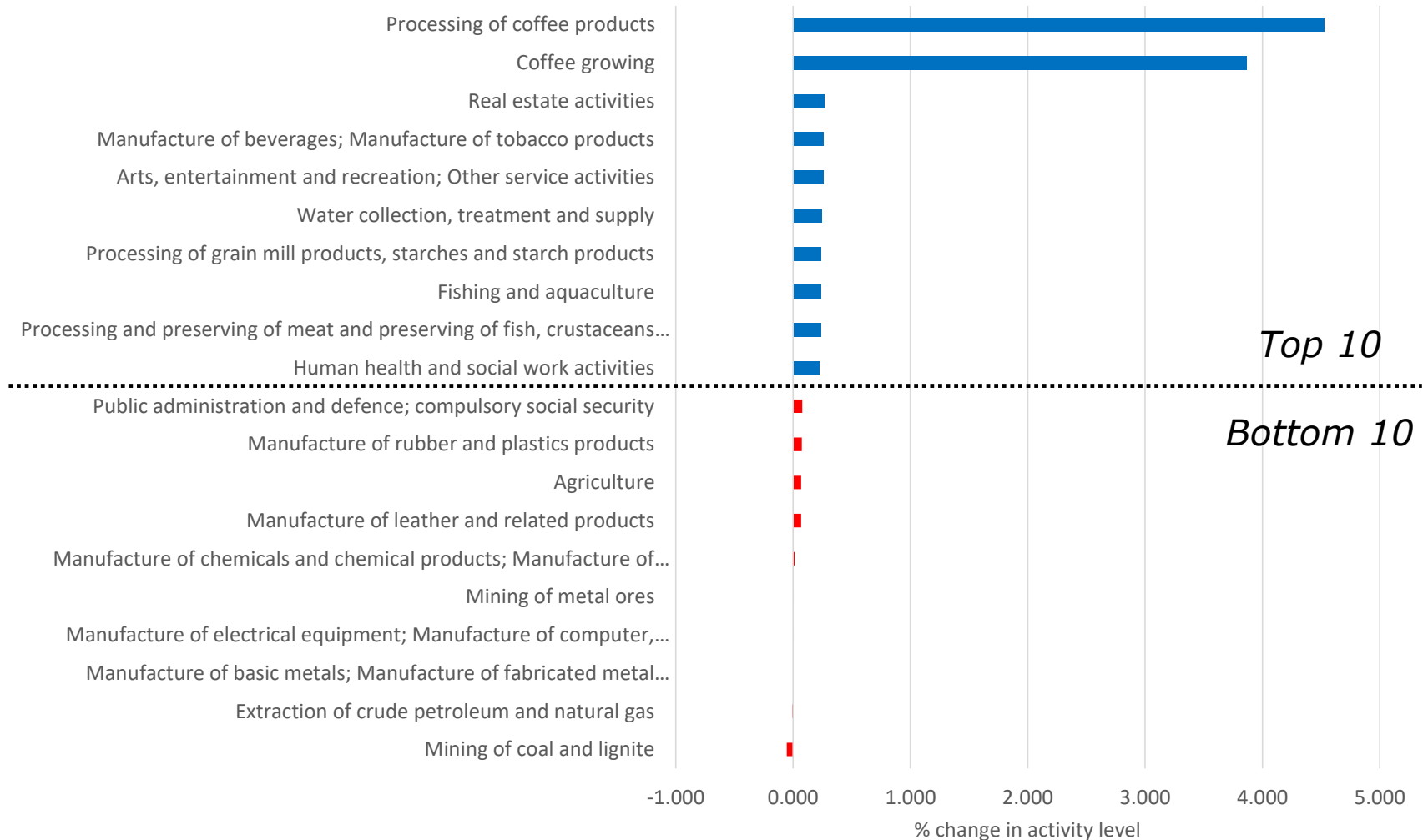
Exogenous

**Percent Change**  
*Contribution to %GDP*

# Contribution to GDP change, by source of shock



# Impact on activity level, by sector





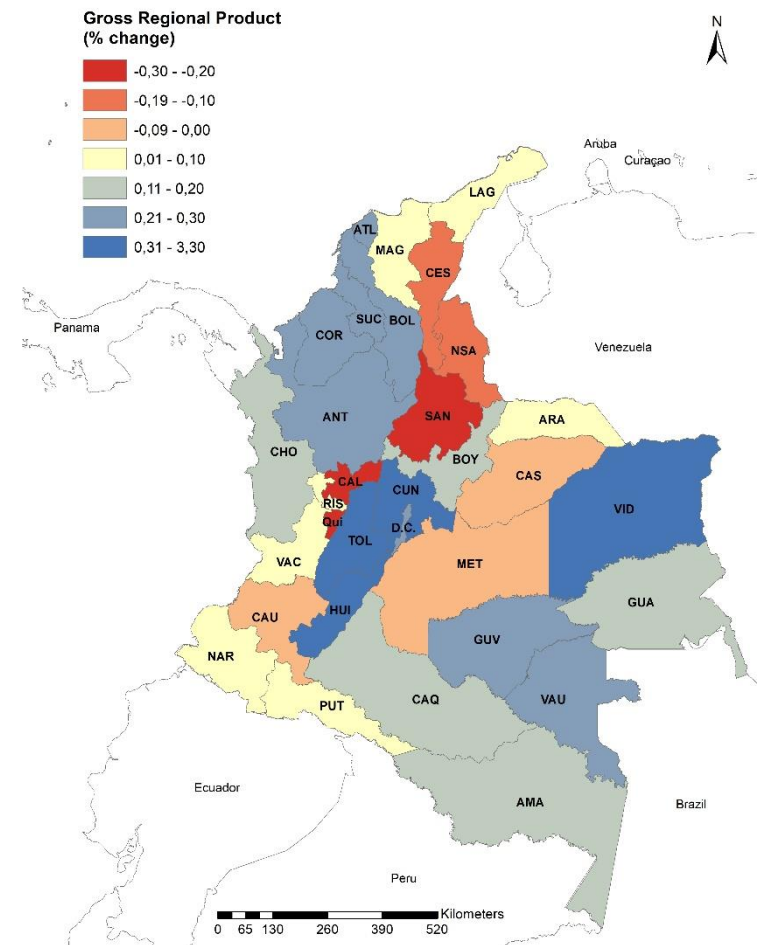
# Gross Regional Product

## Top 5

#	Department	GRP
R13	Huila	3.295
R23	Tolima	1.286
R11	Cundinamarca	0.320
R33	Vichada	0.311
R22	Sucre	0.291

## Bottom 5

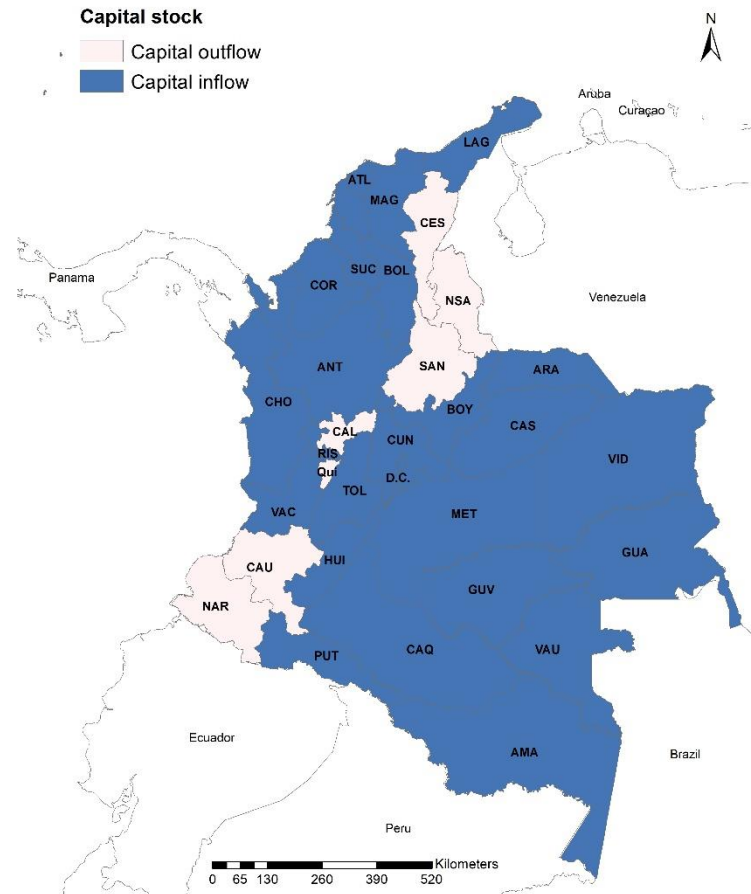
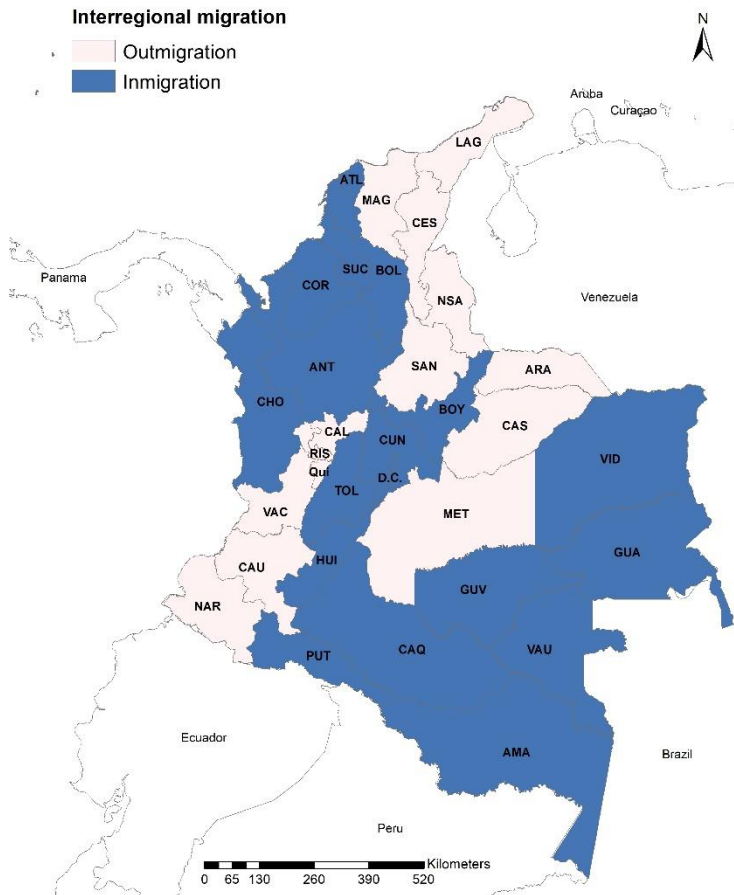
#	Department	GRP
R9	Cesar	-0.119
R18	Norte de Santander	-0.193
R19	Quindío	-0.232
R6	Caldas	-0.281
R21	Santander	-0.305



# Impacts on factor mobility

## Labor

## Capital



# Conclusions

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It is important to note that although macro results tend to be relatively small – consistent with Sierra (2019) – they are very heterogeneous among sectors and regions

Coffee related industries (growing and processing) were the ones most affected by the shock, which is to be expected given the production structure of this commodity

Height plays a major role in this simulation: lower regions may become unsuitable for coffee, whereas Andean regions will potentially experience a sharp increase in productivity for this crop

## Next steps (room for collaboration)

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Introduce a more detailed analysis regarding the difference between production quantity and quality

- What if the climate shocks also affected the quality of Colombian coffee?

Integrate a stochastic module into the model to deal with uncertainties

Input land as a specific primary factor

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