Economic Benefits of Meteorological Information: Some Case Studies

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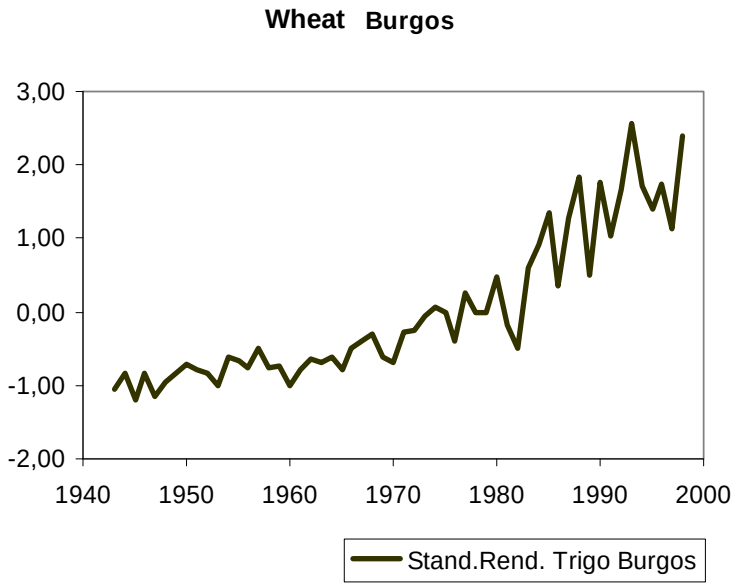
Case Study 1: An analysis of cereal production risk to climate variability in Spain

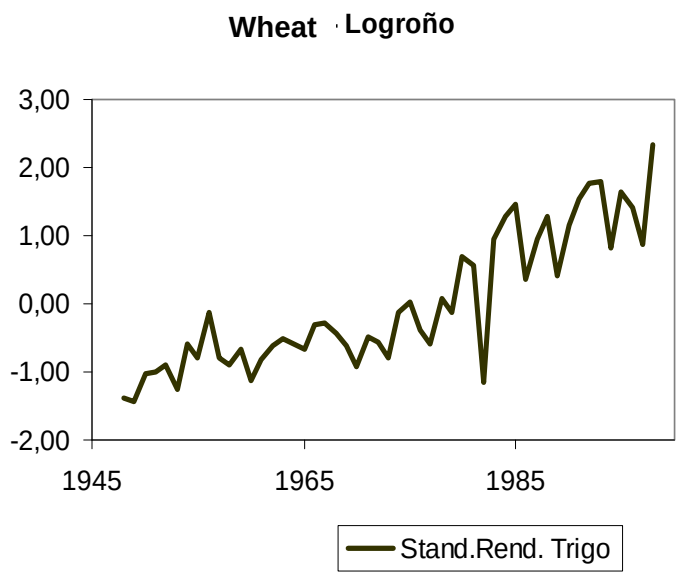
Impacts – District level

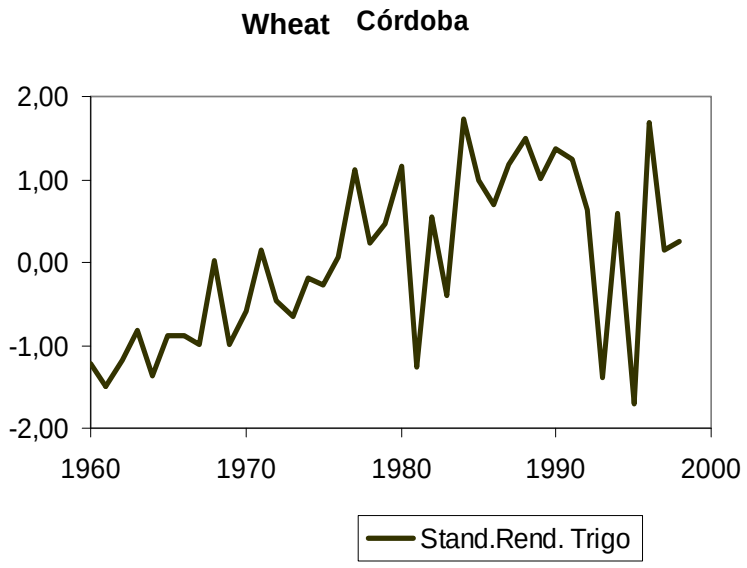
LOCAL CASE STUDY
Climate, technological and management variables

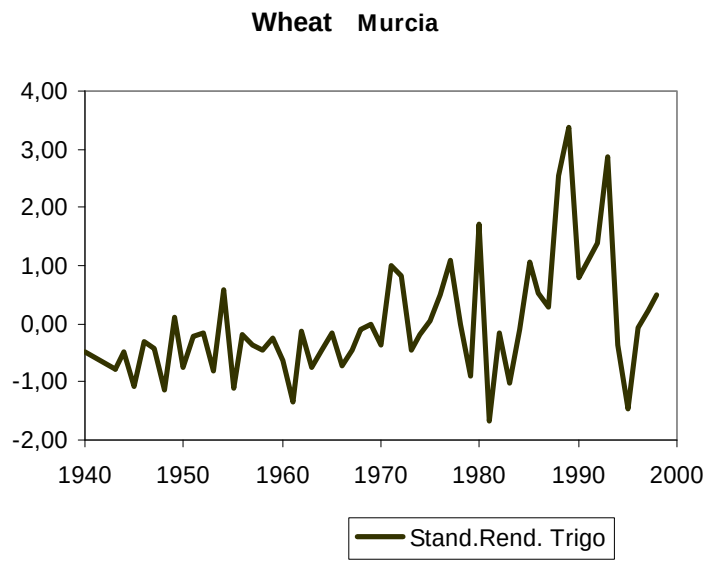
Crops	Sites for the analysis
Wheat	Burgos, Córdoba, Murcia & La Rioja
Grapes	Burgos, Córdoba, Murcia & La Rioja
Olive	Córdoba, Murcia & La Rioja
Orange	Valencia, Murcia & Córdoba
Barley	Valladolid

WHEAT YIELD


Wheat Burgos
3,00
2,00
1,00
0,00
-1,00
-2,00
1940
1950
1960
1970
1980
1990
2000
Stand.Rend. Trigo Burgos


Wheat Logroño
3,00
2,00
1,00
0,00
-1,00
-2,00
1945
1965
1985
Stand.Rend. Trigo


Wheat Córdoba
2,00
1,00
0,00
-1,00
-2,00
1960
1970
1980
1990
2000
Stand.Rend. Trigo


Wheat Murcia
4,00
3,00
2,00
1,00
0,00
-1,00
-2,00
1940
1950
1960
1970
1980
1990
2000
Stand.Rend. Trigo

The Model

$$\ln R_t = \eta \ln R_{t-1} + \alpha_0 + \alpha_{1Mac} Mac_t + \alpha_{1Fertiliz} Fertiliz_t + \alpha_{1Pestic} Pestic_t + \alpha_{1Irri} Irri_t +$$
$$+ \alpha_{2i} Tme_{it} + \alpha_{3i} Froz_{it} + \alpha_{4i} Plut_{it} + \alpha_{5i} Tmax_{it} + \alpha_6 Dro_t + \beta_t^{t^*} Imp_t^{t^*} + \gamma_t^{t^*} Esc_t^{t^*} + \varepsilon_t$$

TYPE OF VARIABLE	VARIABLE	NAME	DESCRIPTION	DATA SOURCE
OUTPUT	YIELD	R_t	Crop productivity into an agroclimatic area	MAPA
MANAGEMENT VARIABLES	MECANIZATION	Mac_t	Power of agrarian machines	MAPA
	FERTILIZERS	$Fertiliz_t$	Total of nitrogenous fertilizers consumption	FAO
	PESTICIDES	$Pestic_t$	Total of pesticides importation for agriculture	FAO
	IRRIGATION	$Irri_t$	Irrigated soil proportion over total	MAPA
CLIMATIC VARIABLES	TEMPERATURE	Tme_{it}	Temperature average (i month)	AEMET
	TEMPERATURE	$Tmax_{it}$	Maximum Temperature (i month)	AEMET
	PRECIPITATION	$Plut_{it}$	Total precipitation (i month)	AEMET
	FROST	$Froz_{it}$	Frozen days (i month)	AEMET
	DROUGHT	Dro_t	Dummy variable of drought years	Elaborated from AEMET data

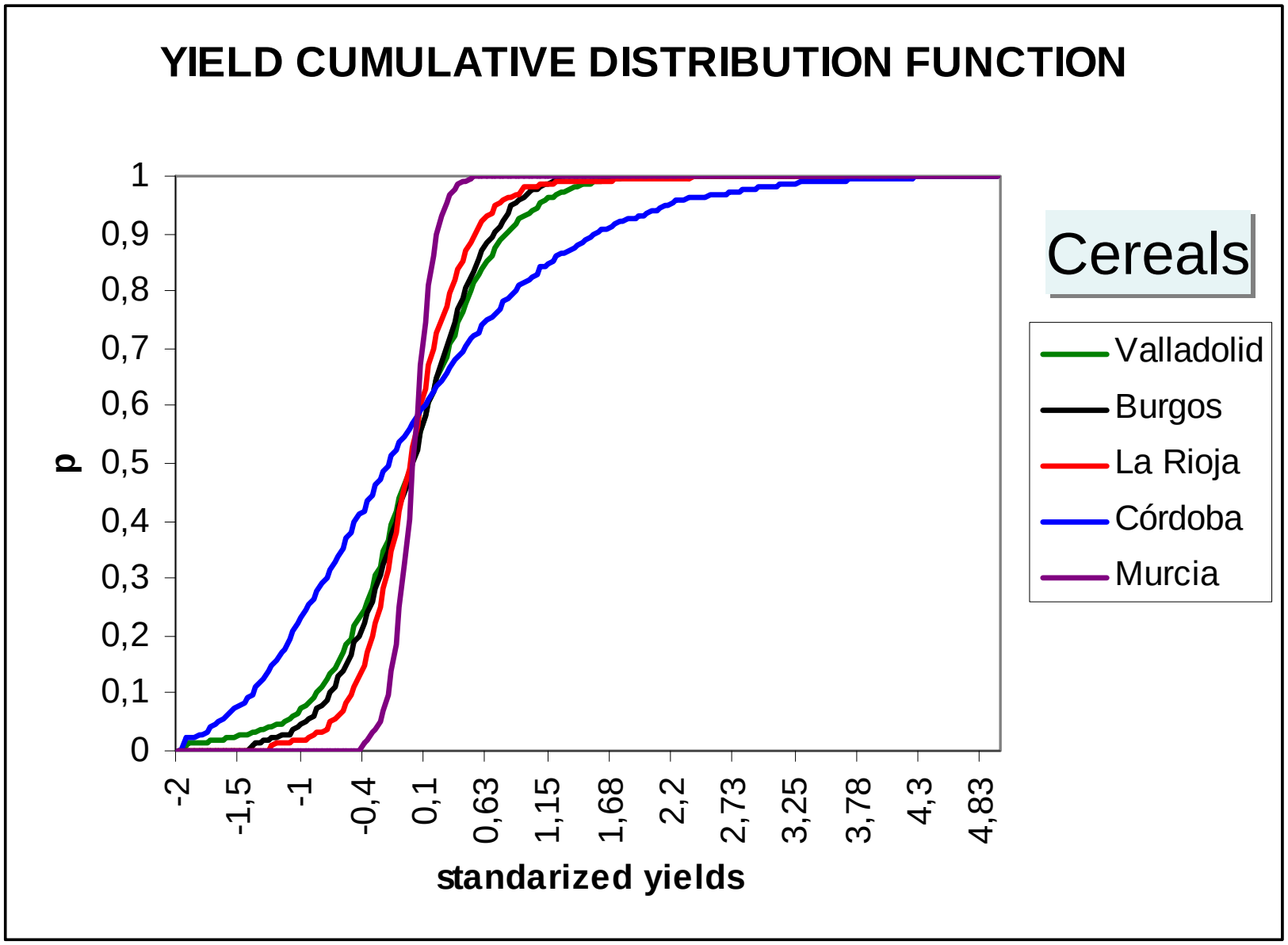
Estimation of elasticity

Regression Model Estimation

Crop/Site		Grapes / Córdoba			Grapes / La Rioja	
		Estimation	P-value		Estimation	P-value
Variables	lnR_{t-1}	0.2553	(0.0316)	Mac	0.0025	(0.0000)
	Tmeoct	-0.1162	(0.0000)	Tmedec	-0.0488	(0.0442)
	Tmedjf	0.0781	(0.0155)	Plutfeb	0.0055	(0.0263)
	Plutfeb	-0.0043	(0.0000)	Plutsep	-0.0022	(0.0496)
	Plutaug	0.0130	(0.0148)	Tmaxmay	0.0748	(0.0000)
	Dro	-0.2101	(0.0046)			
	Imp^{76}	-0.7094	(0.0005)			
Ljung-Box	Q_1	0.6293	(0.428)		0.2939	(0.588)
	Q_2	2.3256	(0.313)		0.3180	(0.853)
	Q_3	2.3476	(0.503)		0.7825	(0.854)
	Q_4	3.1141	(0.539)		0.8015	(0.938)
White test		0.6028	(0.8089)		1.3900	(0.2230)
R^2		0.84			0.73	

21.01% of yield reduction due to drought

Climate Risk assessment



Results

- The estimated models at the district scale detect the effect of climate, technological and management variables over different crop yields and districts.

- The analysis over different sites can be used to compare the impact levels on different regions where hydrometeorological projects were implemented

- Inter-annual distribution of precipitations is a key issue in the levels of risk associated to the agricultural systems analyzed.

Case Study 2: Cost-Loss decision models with risk aversion

Risk behaviour

- **Cost-Loss Model:**
  - an essential condition is assumed: the stakeholder maximizes the expected value
- **But:**
  - Individuals are sensitive to risk, at least where important decisions are concerned
- **In our model:**
  - We introduce the attitude towards risk, so we can evaluate how the optimal decision is affected by the absolute risk aversion coefficient of Arrow-Pratt
  - Compute the economic value of the information in this context

The model

- We consider a situation in which a stakeholder, as part of management options, can protect some of the revenues from negative weather effects.
- Economic value of a forecast can be considered as the difference between the expected utility when the forecast is available and when just basic information exists.

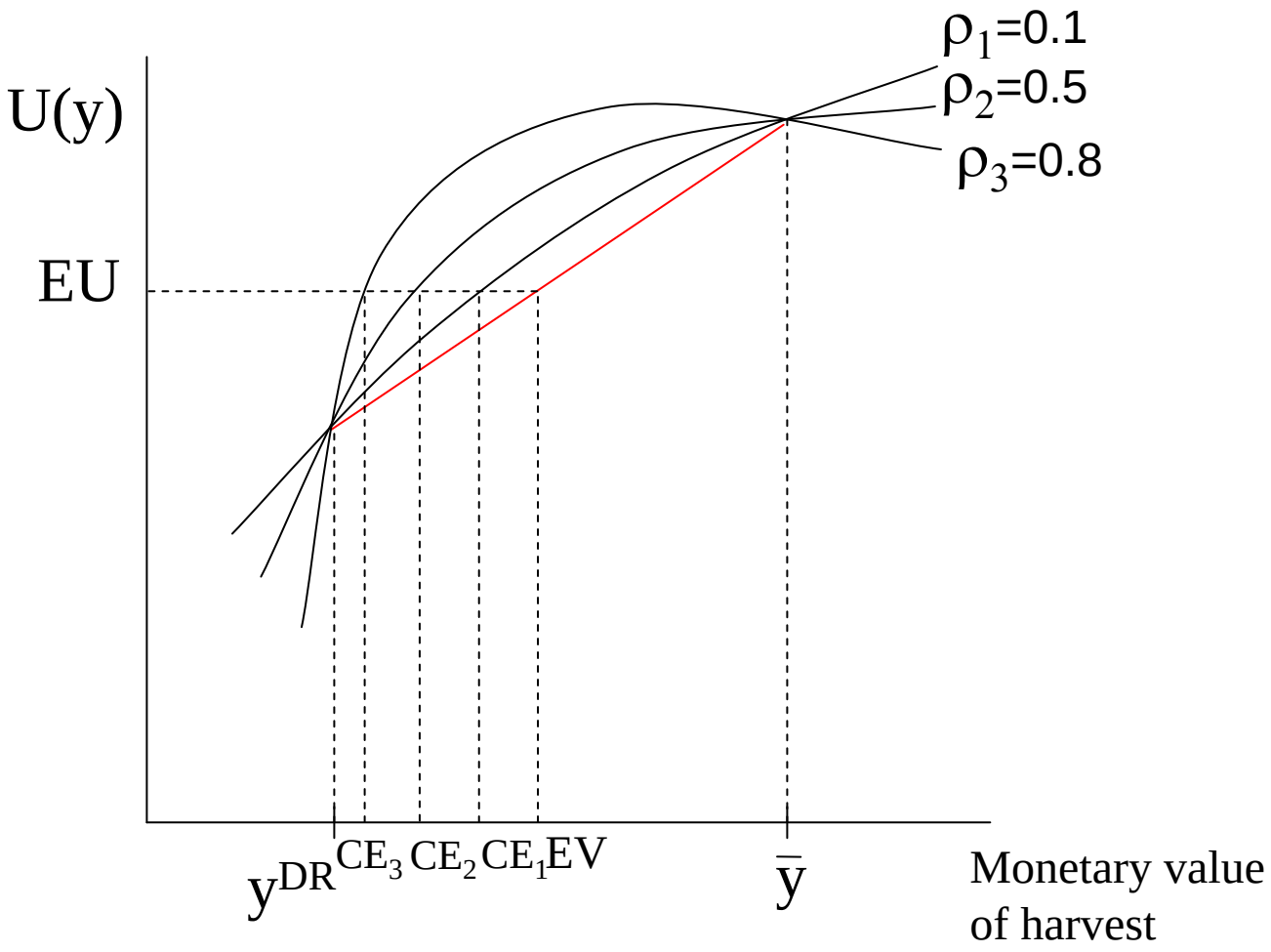
Cost-loss ratio model: information needs

	State of nature	
Action	Adverse weather	Non adverse weather
To protect		
Not to protect		

It is neccessary:

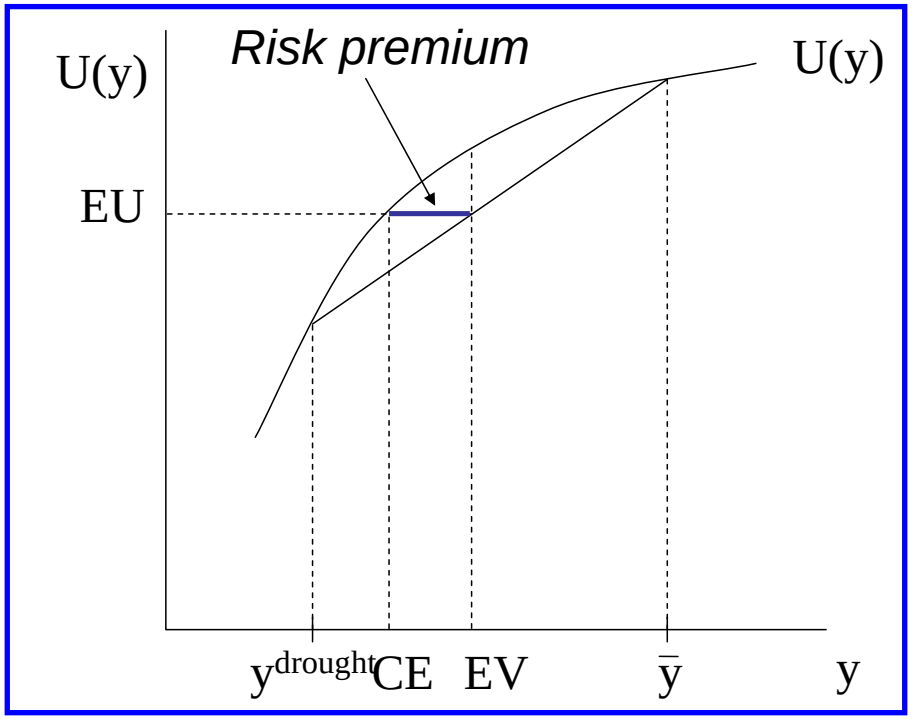
- Information on the expenses matrix
- Meteorological information (probability of adverse weather)
- If possible: Information about risk aversion level

Sensitivity analysis to risk aversion



DROUGHT IMPACT

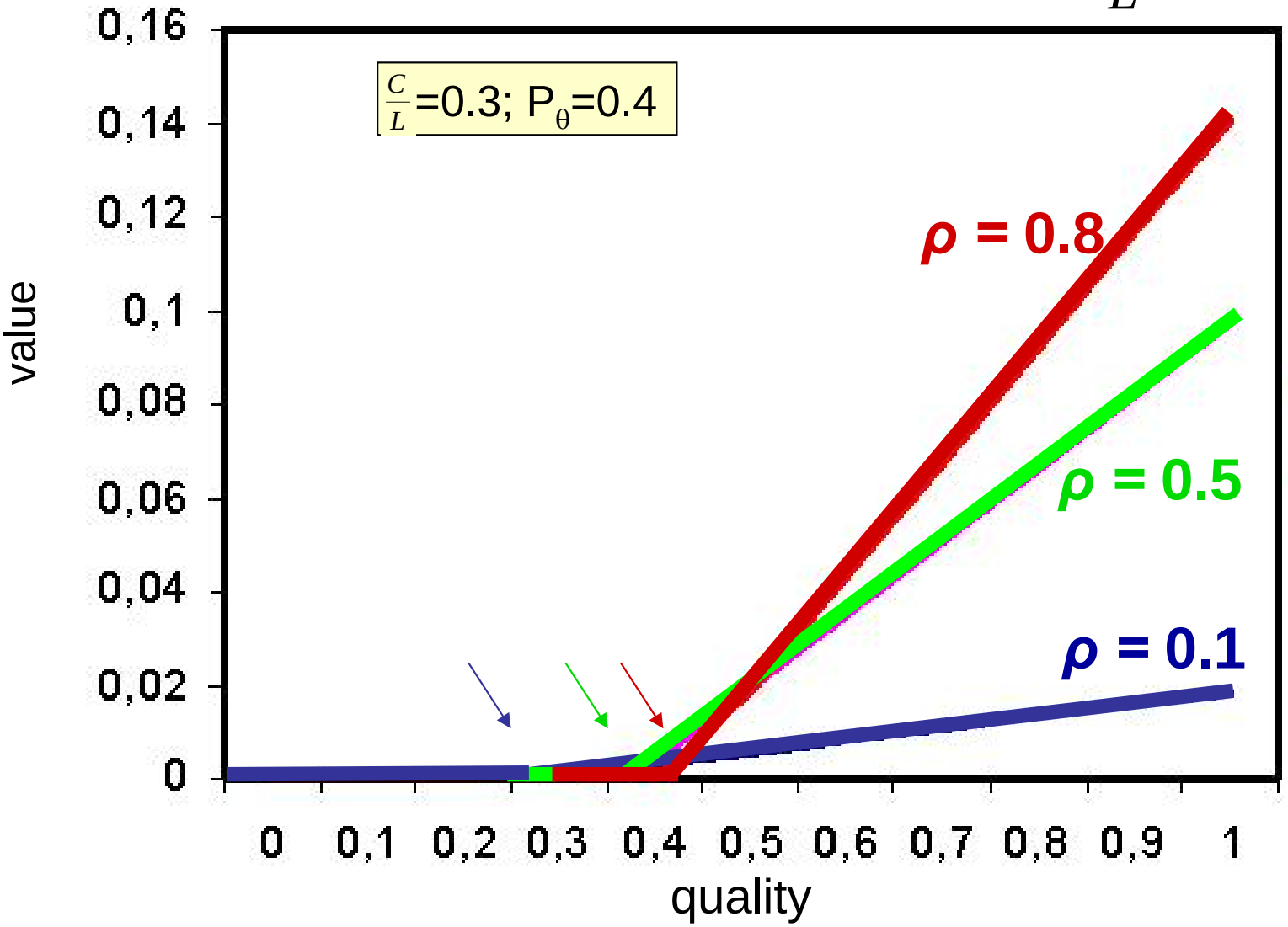
FROM YIELD REDUCTIONS CALCULATED ON THE PRODUCTION FUNCTIONS



	Wheat Cordoba	Grapes Cordoba
Elasticity to drought	0.33	0.21
Average yield	2.84	5.49
Risk premium	**1.42%**	**1.09%**

Quality-Value relationship

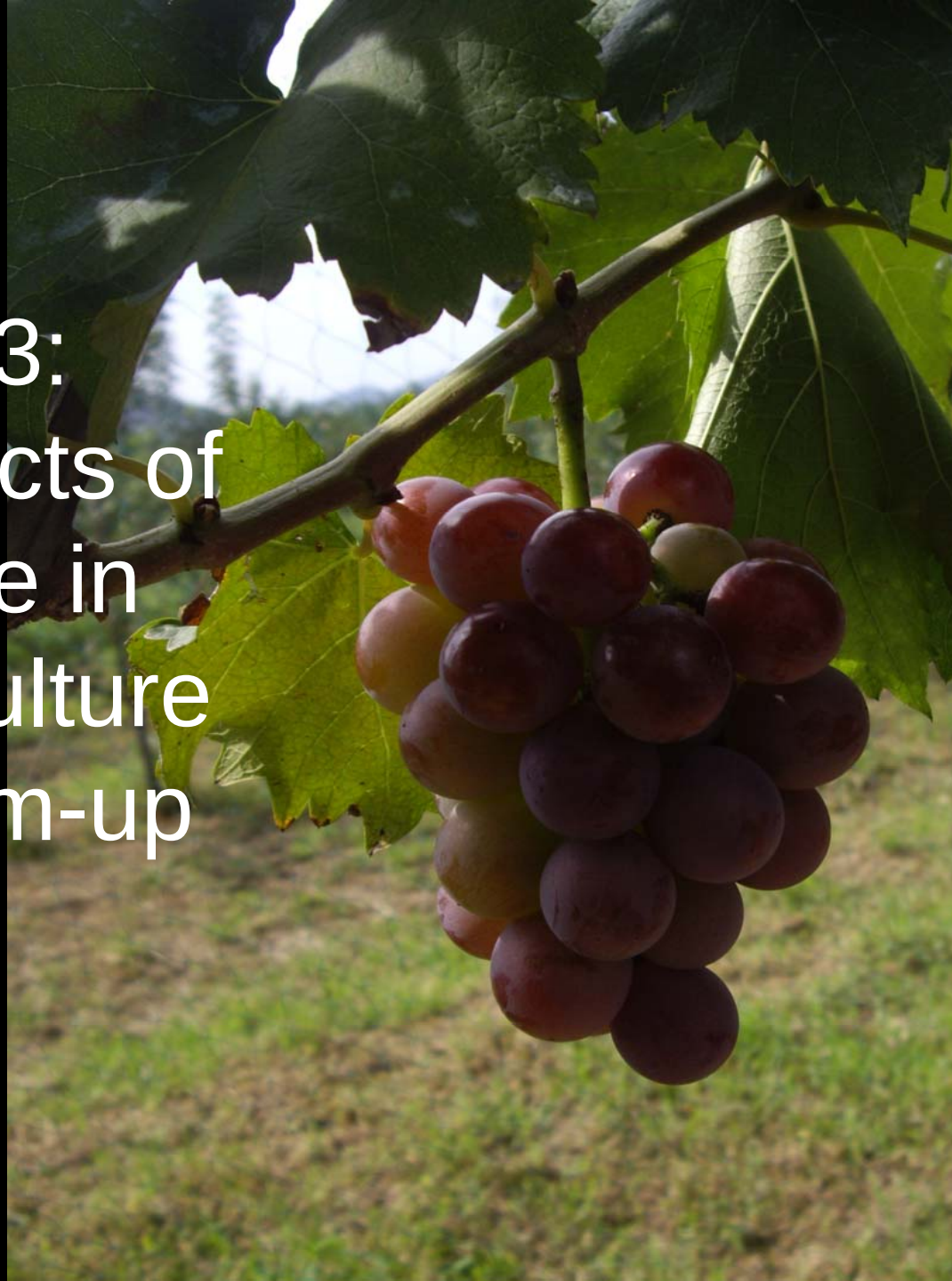
$$0 < \frac{C}{L} < P_\theta$$



Results

- Information has zero economic value below a quality threshold, which increase with risk aversion
- So, evaluating the relevance of a higher quality information system, we conclude that a forecast system whose quality is very low, does not offer an added value for the decision making with respect to the basic information

Case Study 3: Economic impacts of climate change in European agriculture based on bottom-up analysis



PESETA project
http://peseta.jrc.es/index.htm

- In this study:

- Quantify the impacts of climate change over crop productivity across different geographical areas in Europe, and

- Use this information to provide economic valuation of this impacts using different climate change scenarios.

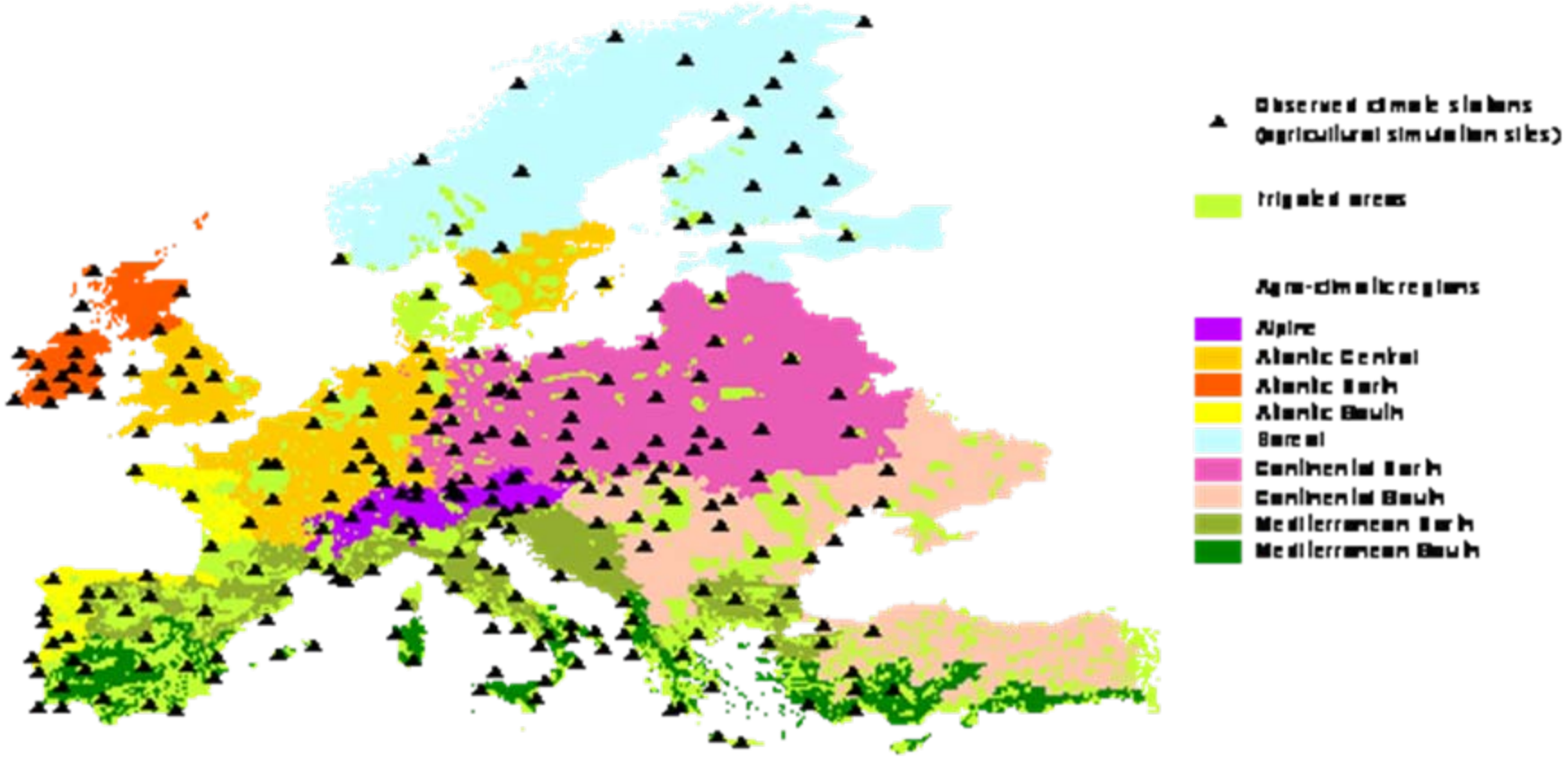
Methodology: bottom-up approach

1. Build a spatial database
2. Determine crop responses at the site level (yield and water demand)

   Process based crop models
3. Estimate crop production functions to be used at the regional level

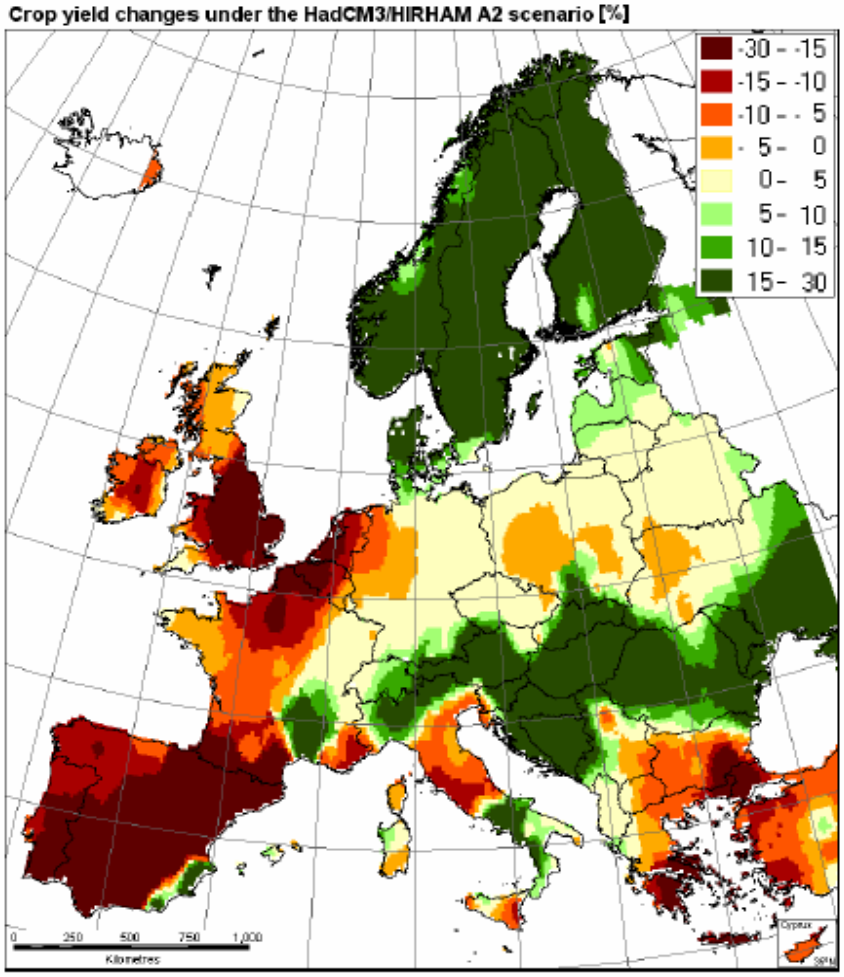
   [y = f (climate, management, adaptation, land use)]
4. Use global change scenarios to modify production values
5. Use scenario crop production estimates as inputs for the economic exercise

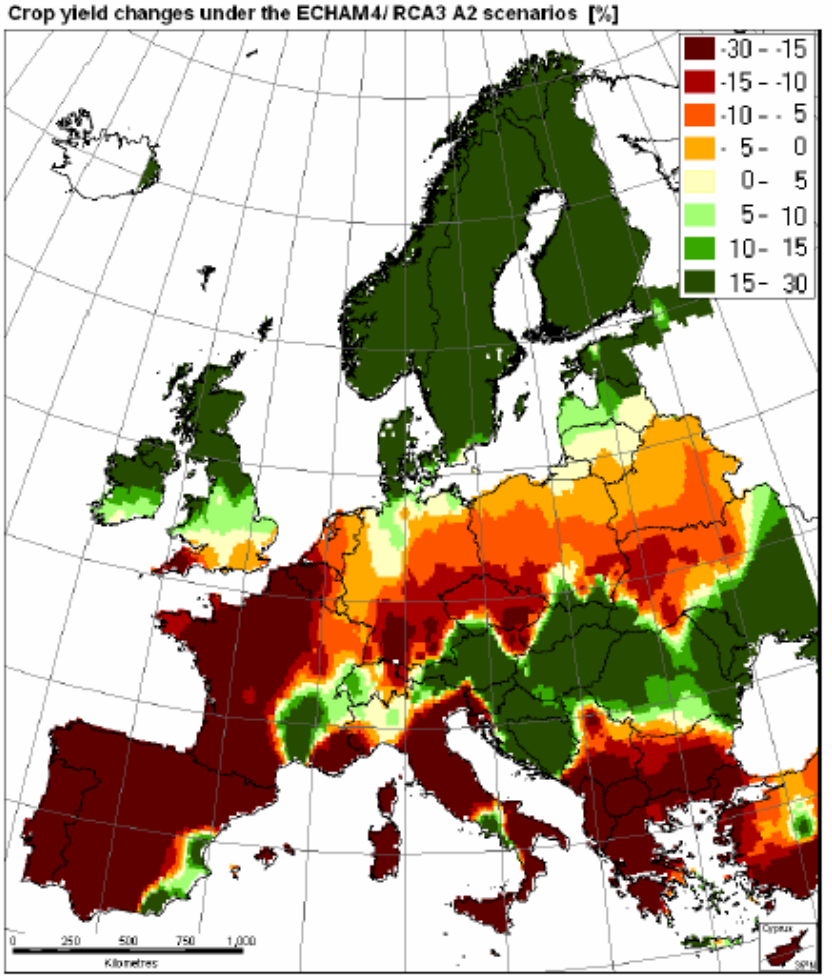
Definition of agro-climatic areas, irrigated areas and stations



AGROCLIMATIC REGIONS DEFINED FROM 247 METEOROLOGYCAL STATIONS

Crop yield changes (source: PESETA project http://peseta.jrc.es/index.htm)





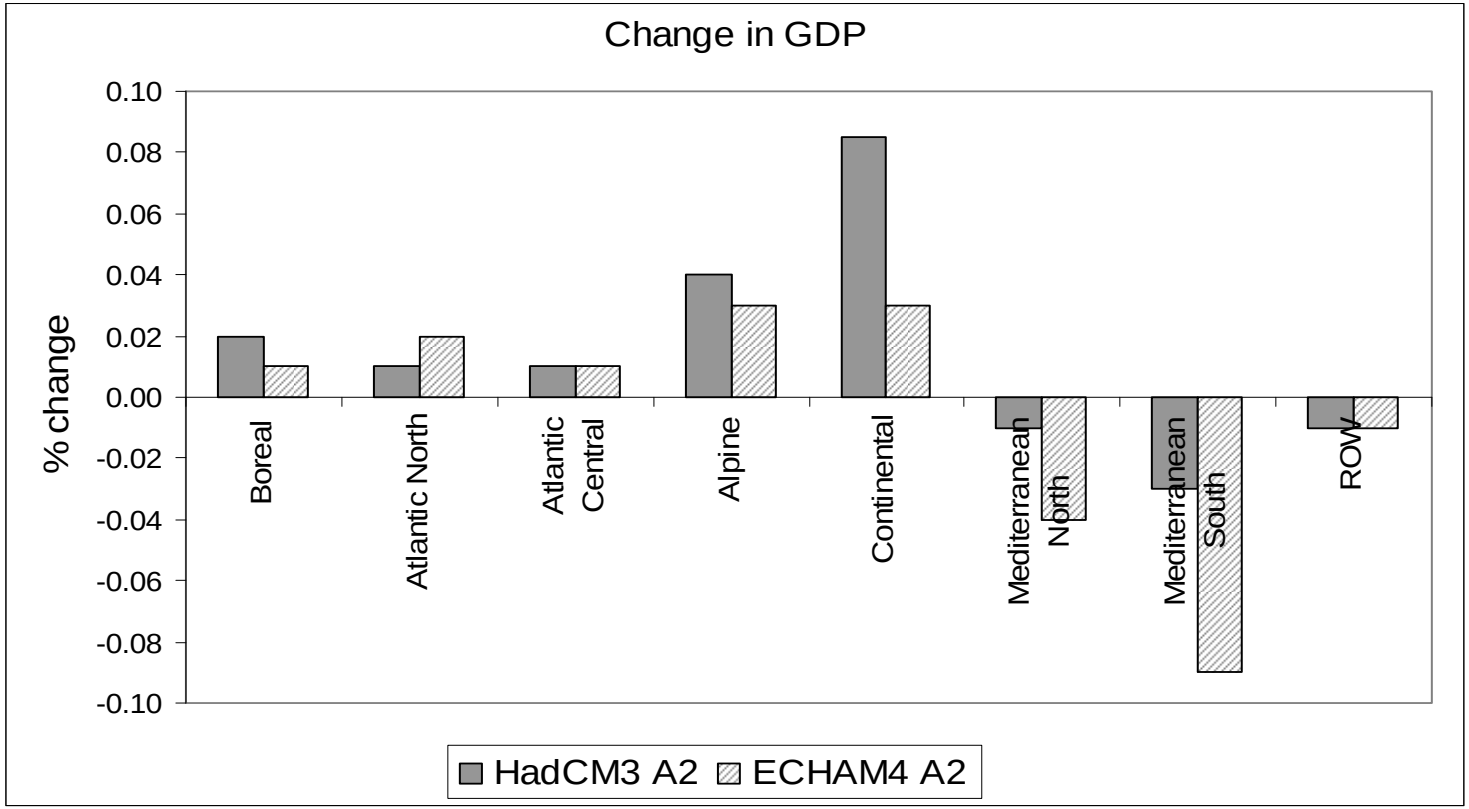
Crop yield changes under the HadCM3/HIRHAM A2 scenario and for the ECHAM4/ RCA3 A2 scenario for the 2080s

Computable General Equilibrium Models: GTAP

- GTAP is a global data base representing the world economy for 2001 year including a representation of all major economic sectors.
- Countries are linked through trade, world market prices and financial flows. Financial flows and commodity flows at the international level are consistent in the sense that they balance.
- Change in relative prices induce general equilibrium effects throughout the whole economy.

Results

Average changes in regional GDP under the climate change scenarios



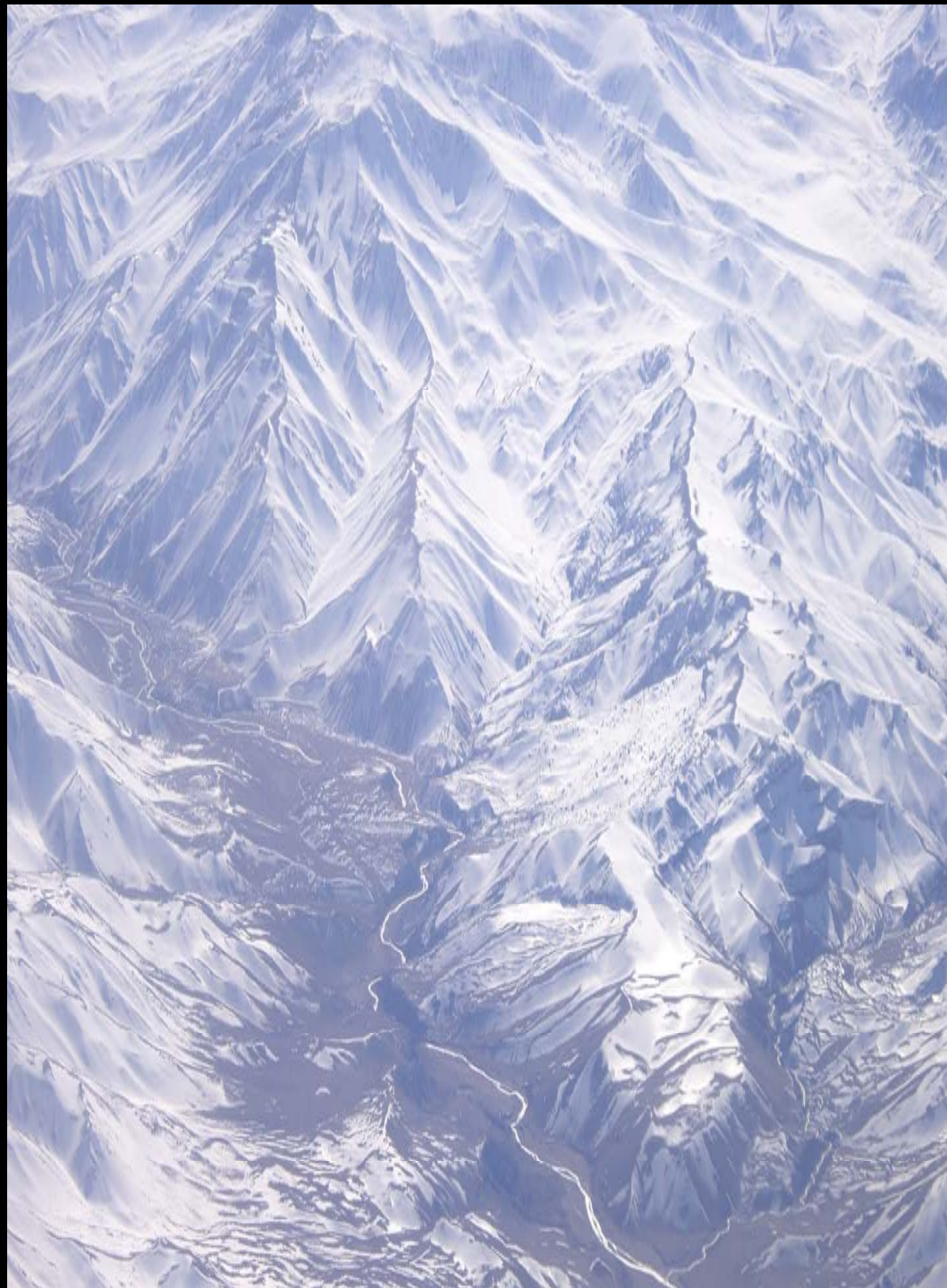
Case Study 4

Paso

Los Libertadores:

Avoided costs

Knowledge transfer



CONTEXT

- The Paso Libertadores, is a mountain pass in the Andes between Argentina and Chile. It is the main transport route out of Chilean capital city Santiago into Mendoza city in Argentina and so carries quite heavy traffic.
- Switchbacks on the Chilean side of the pass from the Argentinian side the route to the pass is a slow, gentle incline until entering a tunnel at around 3,500 m (11,483 ft) through the mountains.
- The path is often closed during winter because of heavy snows blocking both ends and the threat of rockfall.

Avoided costs

- It is necessary to define carefully the baseline and to evaluate the avoided costs with respect this reference.
- It is very important to determine “real avoided costs” of the program.
- With respect to the reductions on mortality risks qualitative or quantitative information can be provided.

Project: New localized prognostic

BETTER FORECAST COMMUNICATION

MORE ACCURACY

PREVENT FOR DISASTERS: IMPACT ON HUMAN LIFES

CHANGE ON DECISION MAKING: PROTECTION MEASURES

AVOID TO CLOSE THE BORDER UNNECESARILY

SOME COSTS OF INACTIVITY

- LOSSES ON:
  - TARIFS
  - COMMODITIES TRANSPORTED BY ROAD
  - TOURISM INCOMES
  - TRADE INCOMES

TARIFS

ESTIMATION ABOUT DAILY TARIF PAYMENTS IN EL PASO LOS LIBERTADORES (2008)	
Monthly value	US$ 30379.29
Daily value	US$ 1012.64

2008: 16 DAYS CLOSED 16202.24

US$16202.24

OPERATIONAL LOSSES

- Operational losses on commodity transportation depends on:
  - Type of vehicle (different velocity)
  - Total distance to final destination
- Knowledge transfer from a MOP (Public infraestructures Ministry) study in 1996:
  - Extrapolation to present values

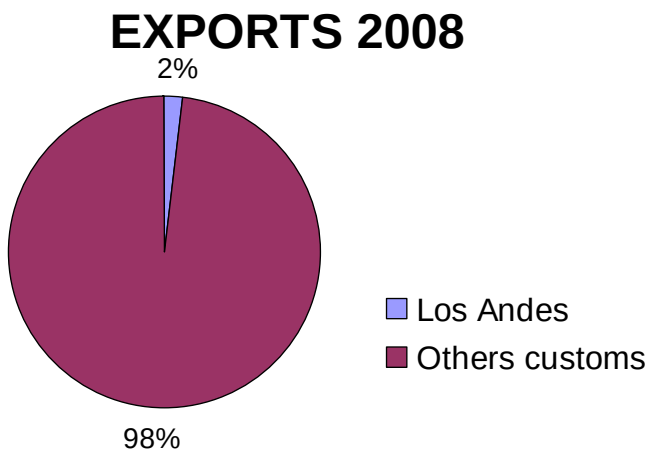
MOP-VIABILITY STUDY (1996)	
DAILY COST	US$ 2.06 MILLIONS

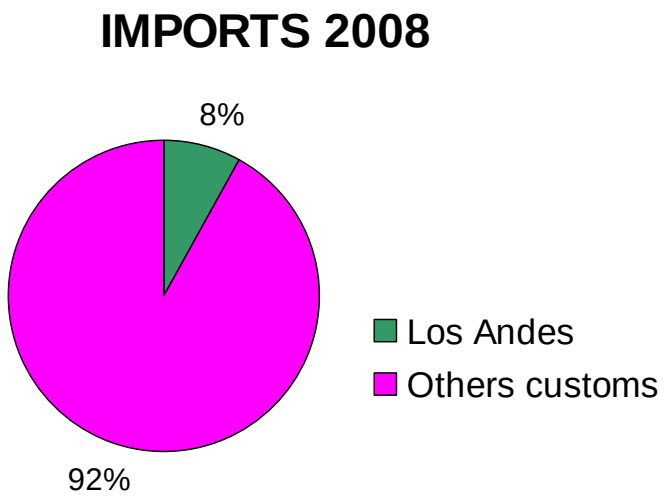
DAILY COST OF INACTIVITY

- This cost does not include:
  - Indirect impact on tourism
  - Indirect impact on trade

INFORMATION ON TRADE

- Total market value of daily trade commodities crossing this border are more than 363 million dollars





Some ideas…

- With very simple studies like avoidable costs you can say something about the economic benefits of a project.

- To be conservative:
  - Evaluate just real costs that you are sure that are being caused by the hydro-meteorological aspect analyzed.
  - Provide also qualitative information.

Thank you for your attention!

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