Hydrological drought index insurance in irrigated agriculture in a highly regulated system: an economic instrument for risk mitigation for the Jucar river basin

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Outstanding Student & PhD candidate Presentation contest

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Risk management - hazards

Vulnerable Agricultural Sector

- ✓ **Natural hazards**
- ✓ **Sanitary Risks**
- ✓ **Market risks**
- ✓ **Other risks**

Irrigated Agricultural

Affect productivity, yields, and the ability to generate revenue in the future







Hydro Economic – Financial instruments

The sustainable water resources systems management not only supposes environmental but also economical sustainability.

Economic instruments of water policy:

- Subsidies,
- water prices,
- water banks,
- water markets

Insurance

Traditional

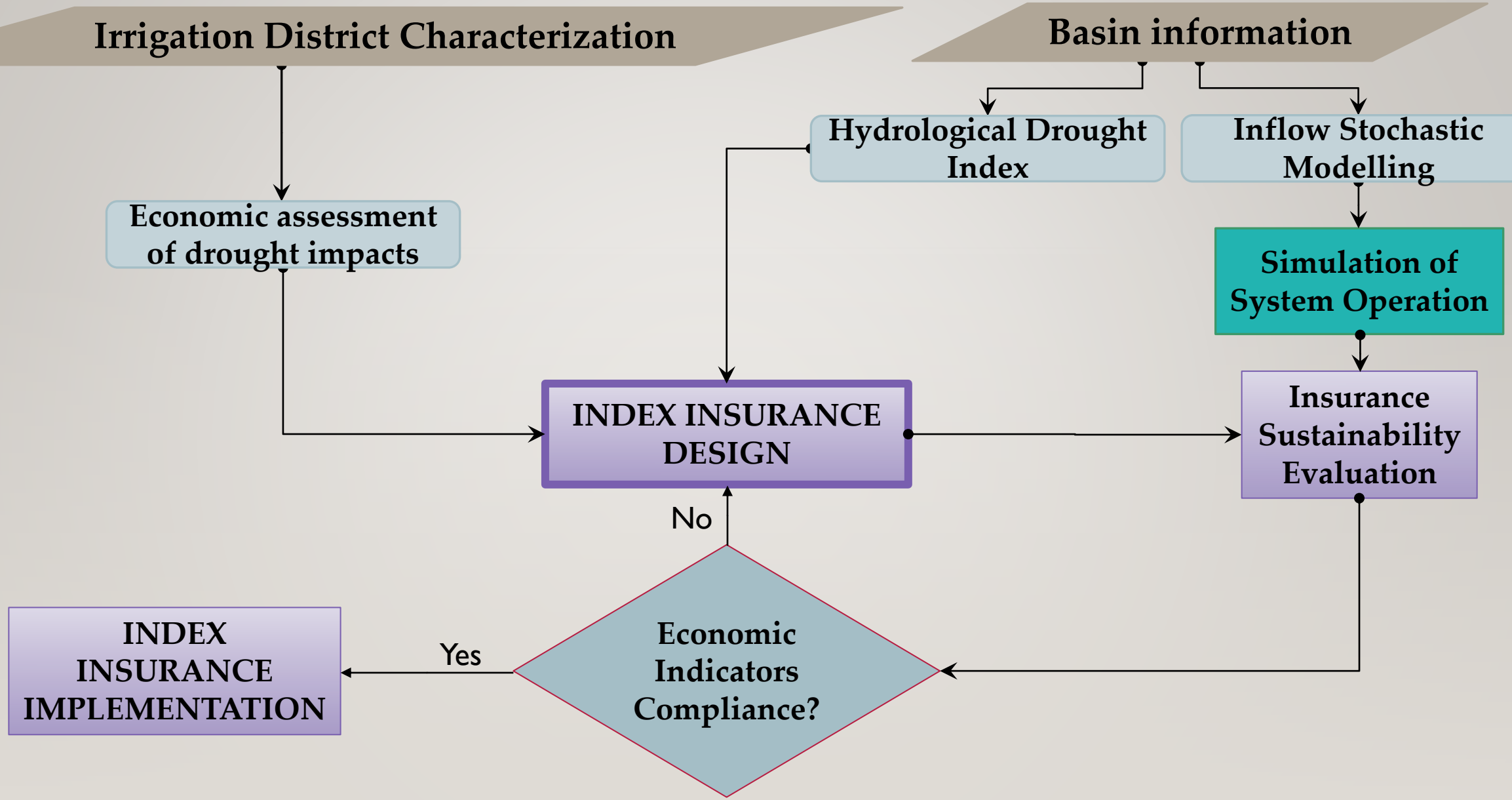
Damage assessment in field

Indexed

Trigger

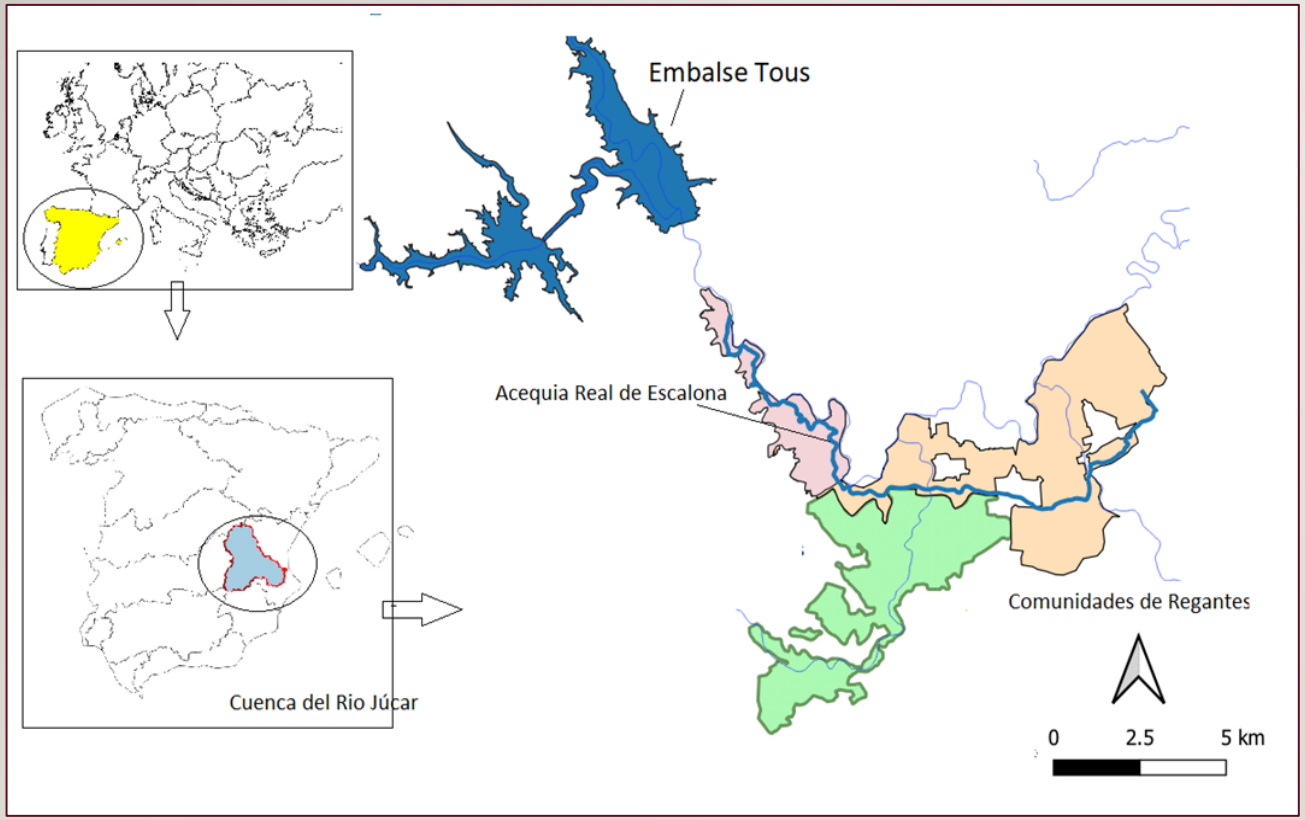
Hydrological drought

FRAMEWORK


Irrigation District Characterization
Basin information
Hydrological Drought Index
Inflow Stochastic Modelling
Economic assessment of drought impacts
Simulation of System Operation
INDEX INSURANCE DESIGN
Insurance Sustainability Evaluation
No
Economic Indicators Compliance?
Yes
INDEX INSURANCE IMPLEMENTATION

Economic assessment of drought impacts

Real Acequia De Escalona (RAE) Irrigation District.
Jucar River Basin (Spain)



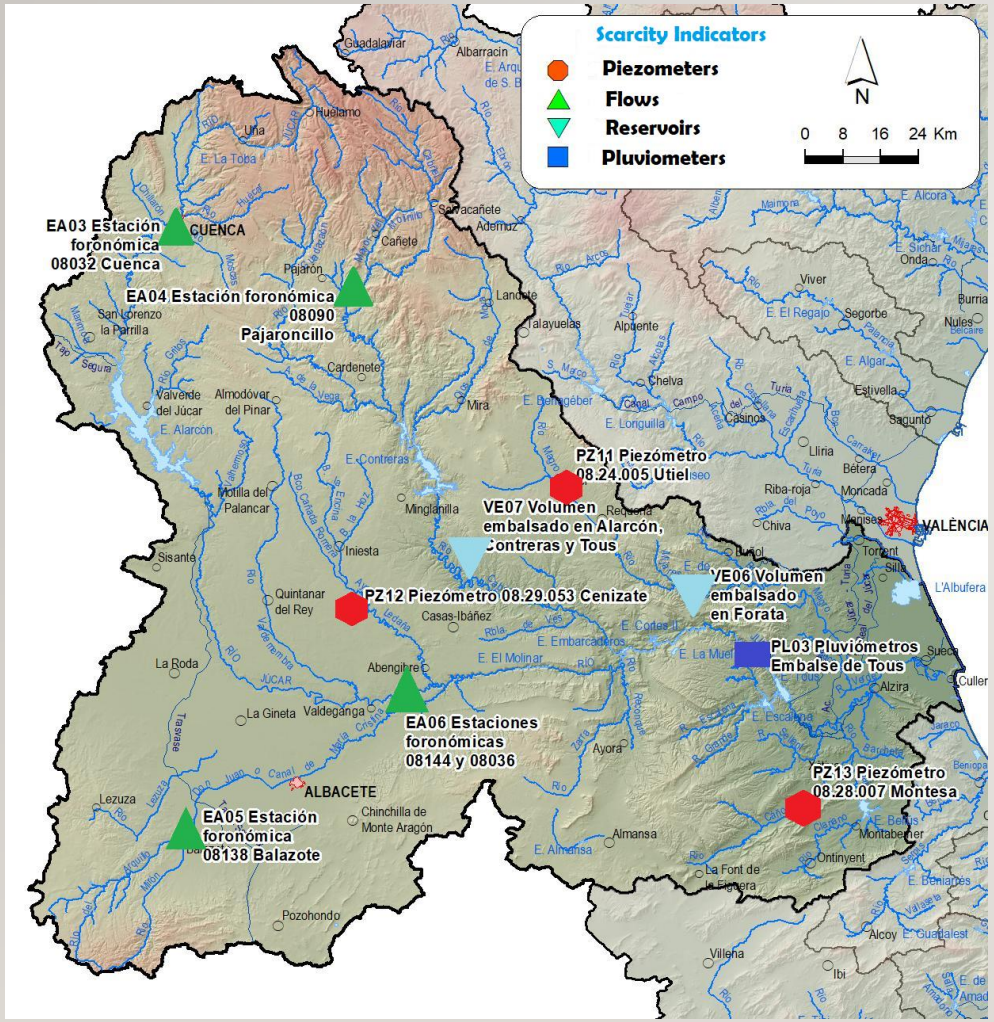
Irrigation District Characterization:

Crops (Citrus)
- Orange
- Tangerine

Crop area distribution (ha)
Annual yield (Kg/ha)
Sale prices(€/kg)
Production costs(€/ha)

Irrigation District Annual Water allotment (m3/ha)

Hydrological Drought Index SI.



Source: CHJ, 2018.

10 representative variables (precipitation (1), piezometric levels (3), flows (4), and reservoir volumes (2))

Description	Indicator Values/SI	State
Absence of scarcity	1,00-0,50	NORMALITY
Moderate scarcity	0,50-0,30	PREALERT
Severe scarcity	0,30-0,15	ALERT
Serious scarcity	0,15-0,00	EMERGENCY

Index Insurance Design

Deductible franchise (γ)

$$(1-\gamma) * GWA = f(IEE = Trigger)$$

The compensation received(€/ha)

$$f(x) = \begin{cases} 0, & if\ wa_t \geq (1-\gamma) * GWA \\ ws_t * wv_t & if\ wa_t < (1-\gamma) * GWA \end{cases}$$

Maximum guaranteed value €/ha

$$Liability = GWA * wv_t$$

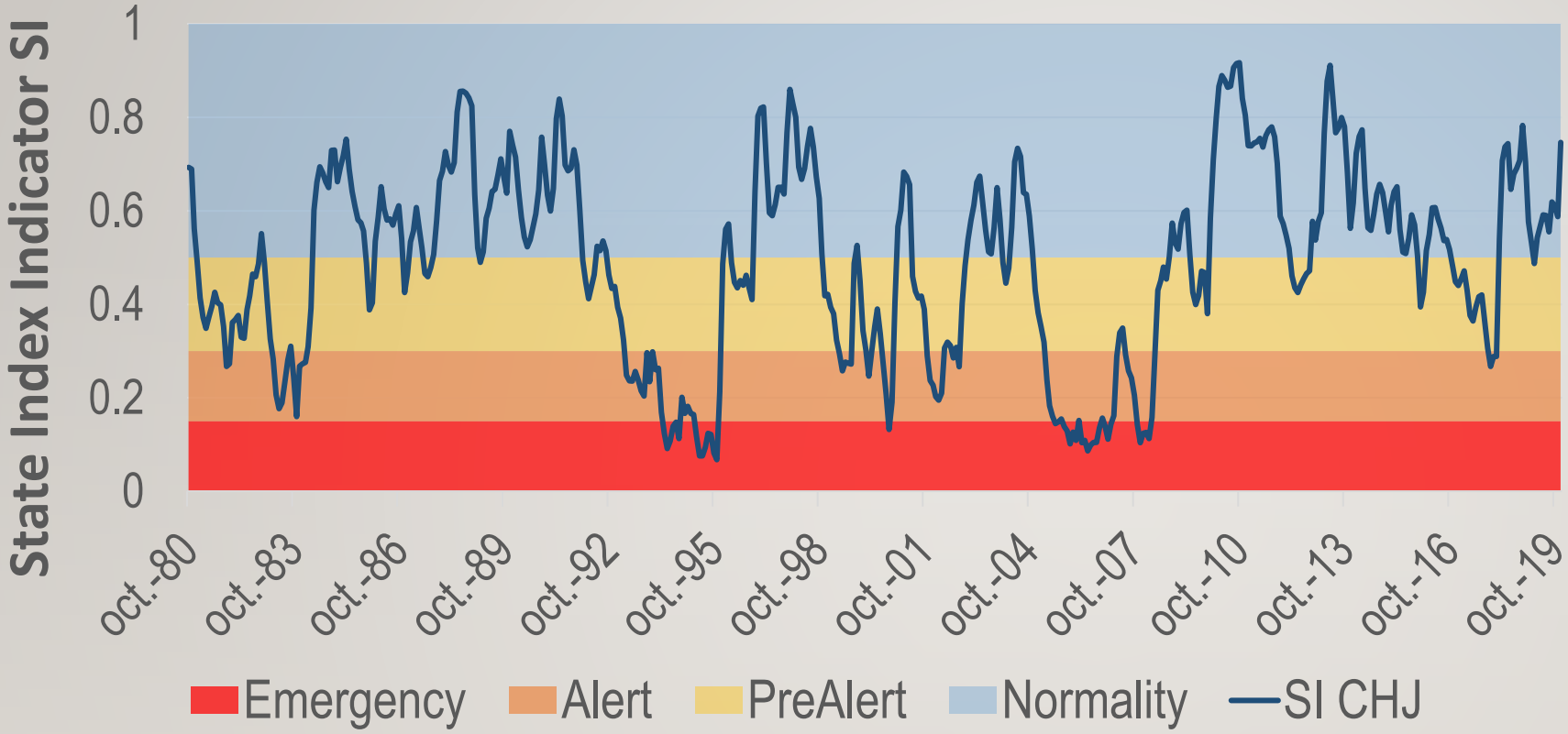
Fair premium rate

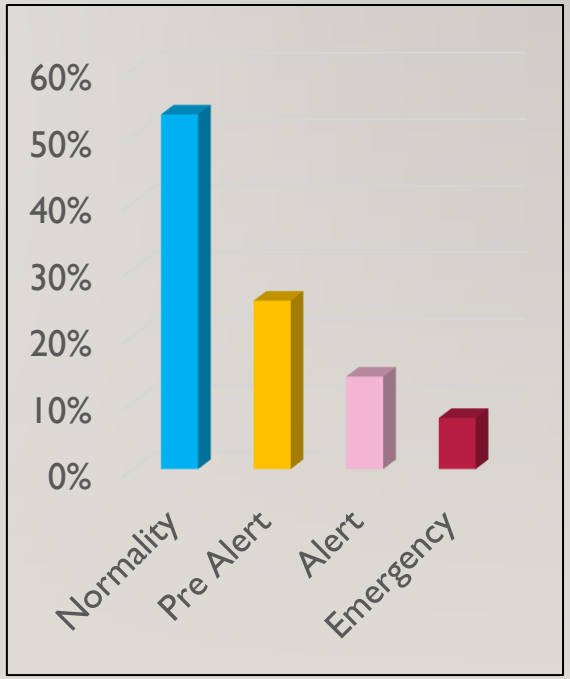
$$Premium = E(Ind_t) = \frac{1}{T} * \sum_{t=1}^{t=T} Ind_t$$

Index Insurance Design

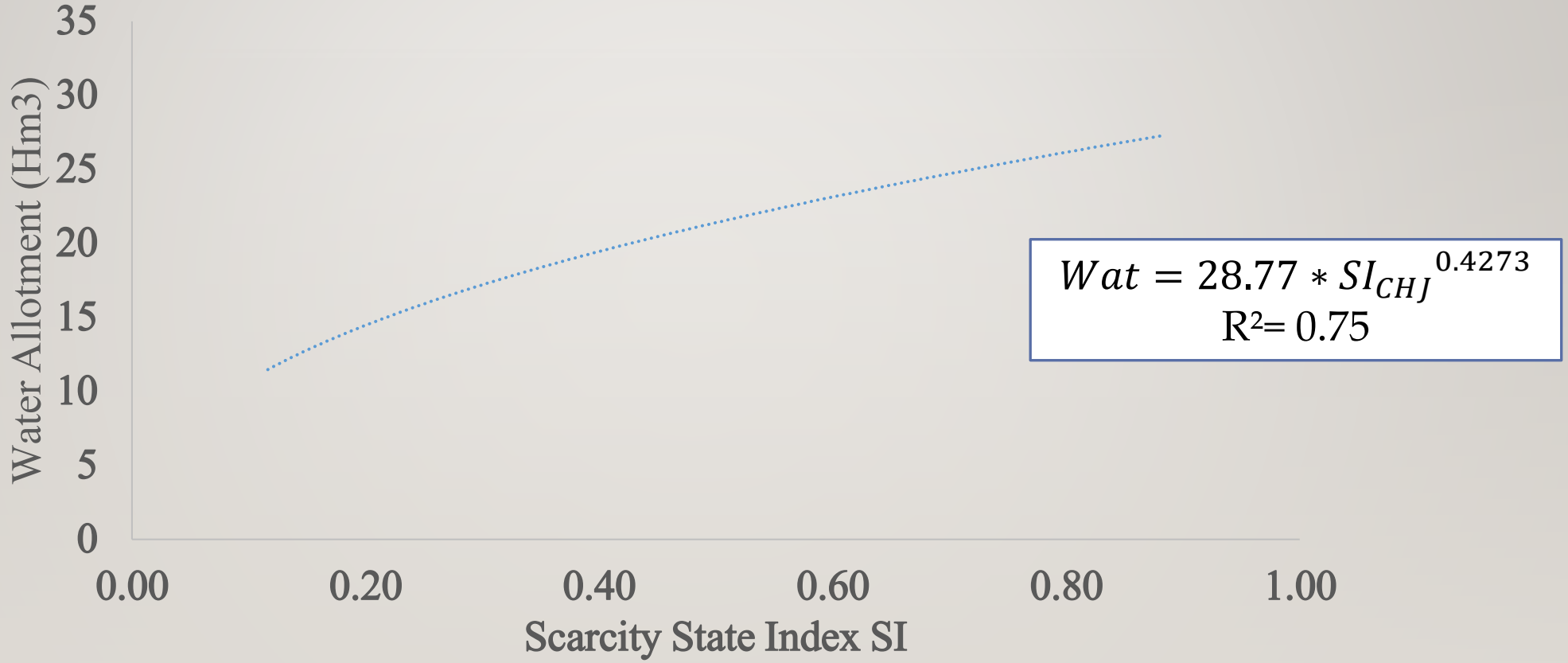
Insurance Scheme Option
Option 1: Variable premium and/or variable franchise based on the forecast of water availability for the secured irrigation season.
Option 2: Multi-year insurance contract. Premium rates depending on a pre-season index
Option 3: Early Contract with a Constant Premium.

Hydrological drought index

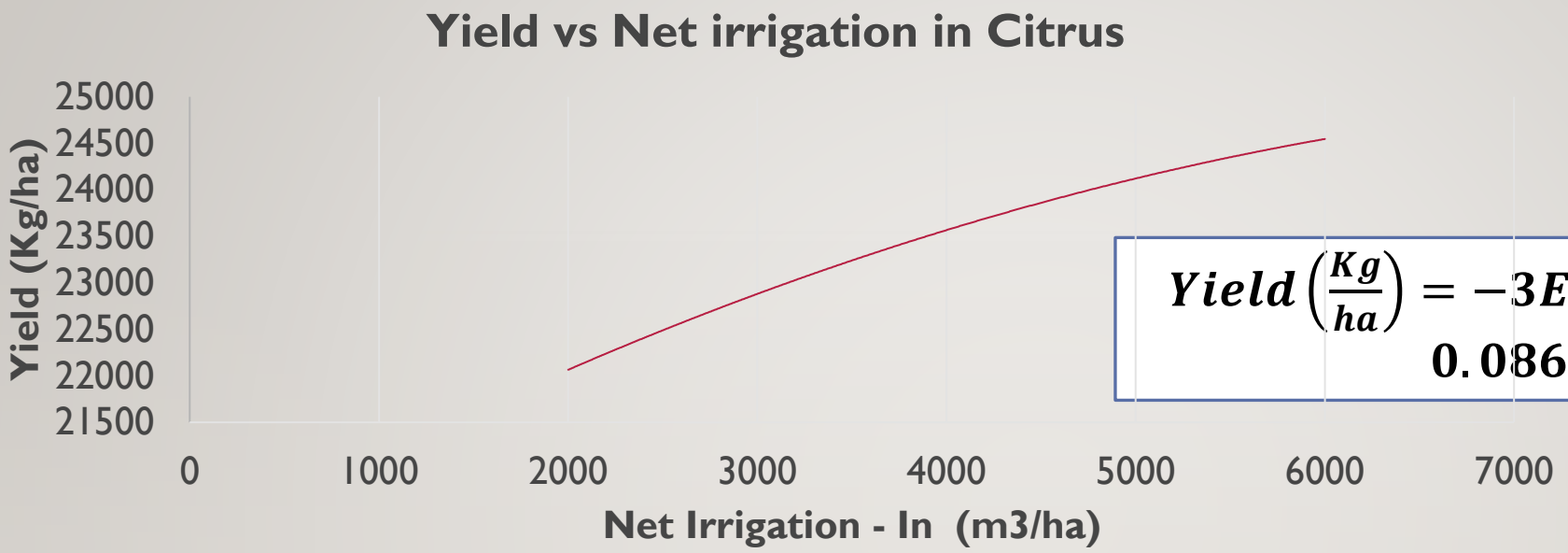




Water allotment according State Index in RAE



Economic assessment of drought impacts

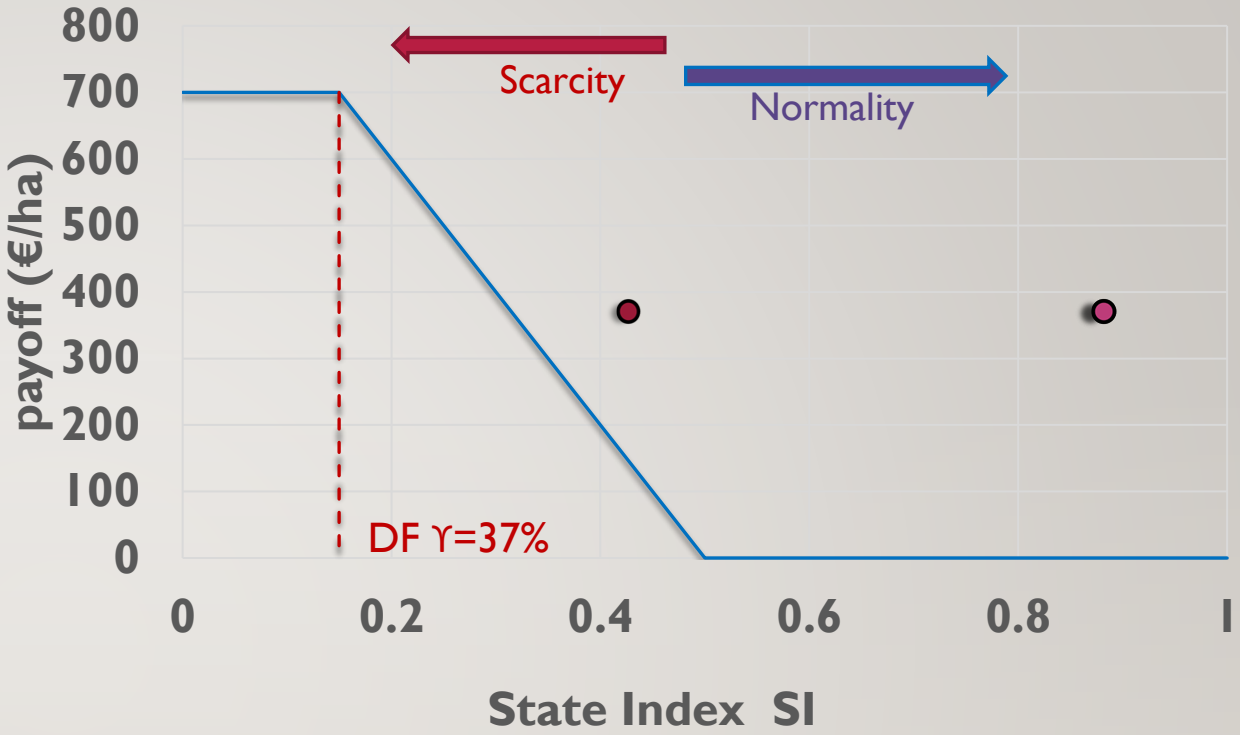


$$Yield\left(\frac{Kg}{ha}\right) = -3E-08In^3 + 0.0003In^2 - 0.0868In + 21495$$

	Normality	Prealert	Alert	Emergency
Water Allotment (Hm3/año)	25.36	21.56	19.02	16.48
Net Irrigation (m^3/ha. año)	4107.33	3491.23	3080.50	2669.77
Yield (Kg/ha)	24120.80	23571.97	23197.49	22830.69

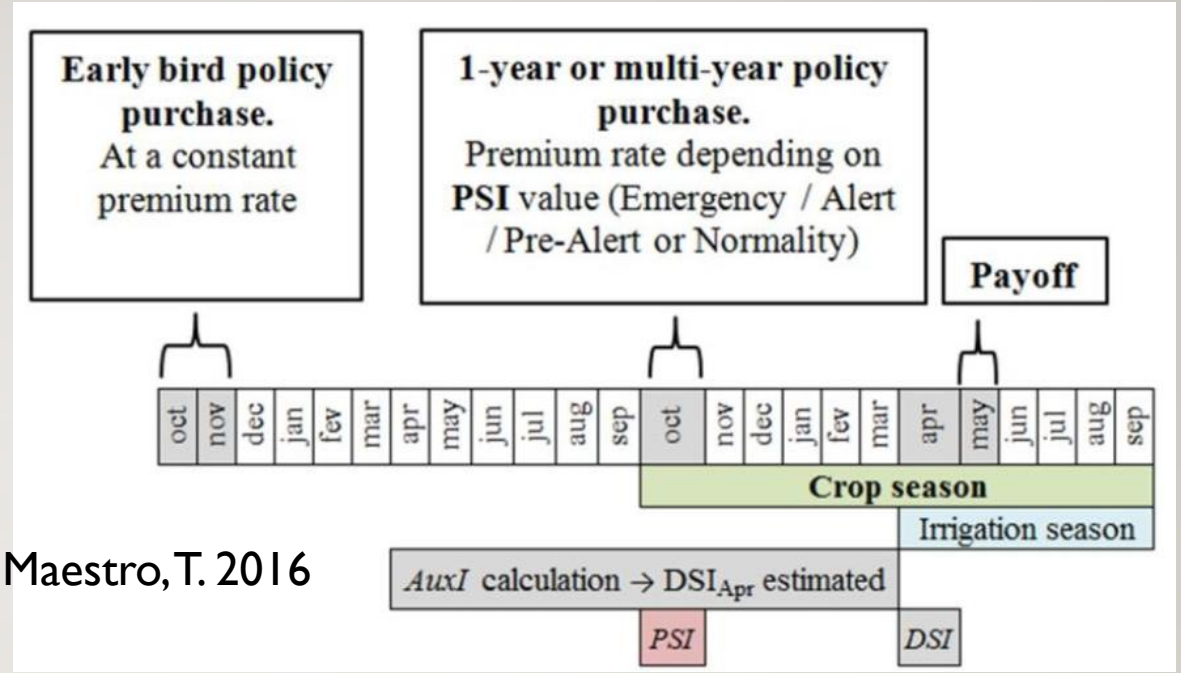
Option 1:Variable premium and/or variable franchise based on the forecast of water availability for the secured irrigation season.

Water Value (Wv): 0.09 €/m3
Liability : 700 €/ha



SI_{CHJ} Trigger Deductible franchise	0.5 ɣ=0%	0.3 ɣ=19%	0.2 ɣ=31%	0.15 ɣ=37%	0.3 ɣ=0%	0.2 ɣ=0%	0.15 ɣ=0%
Premium rate (€/ha)	293	170	171	158	127	60	30
% liability	41.80	24.25	24.39	22.54	18.19	8.56	4.28

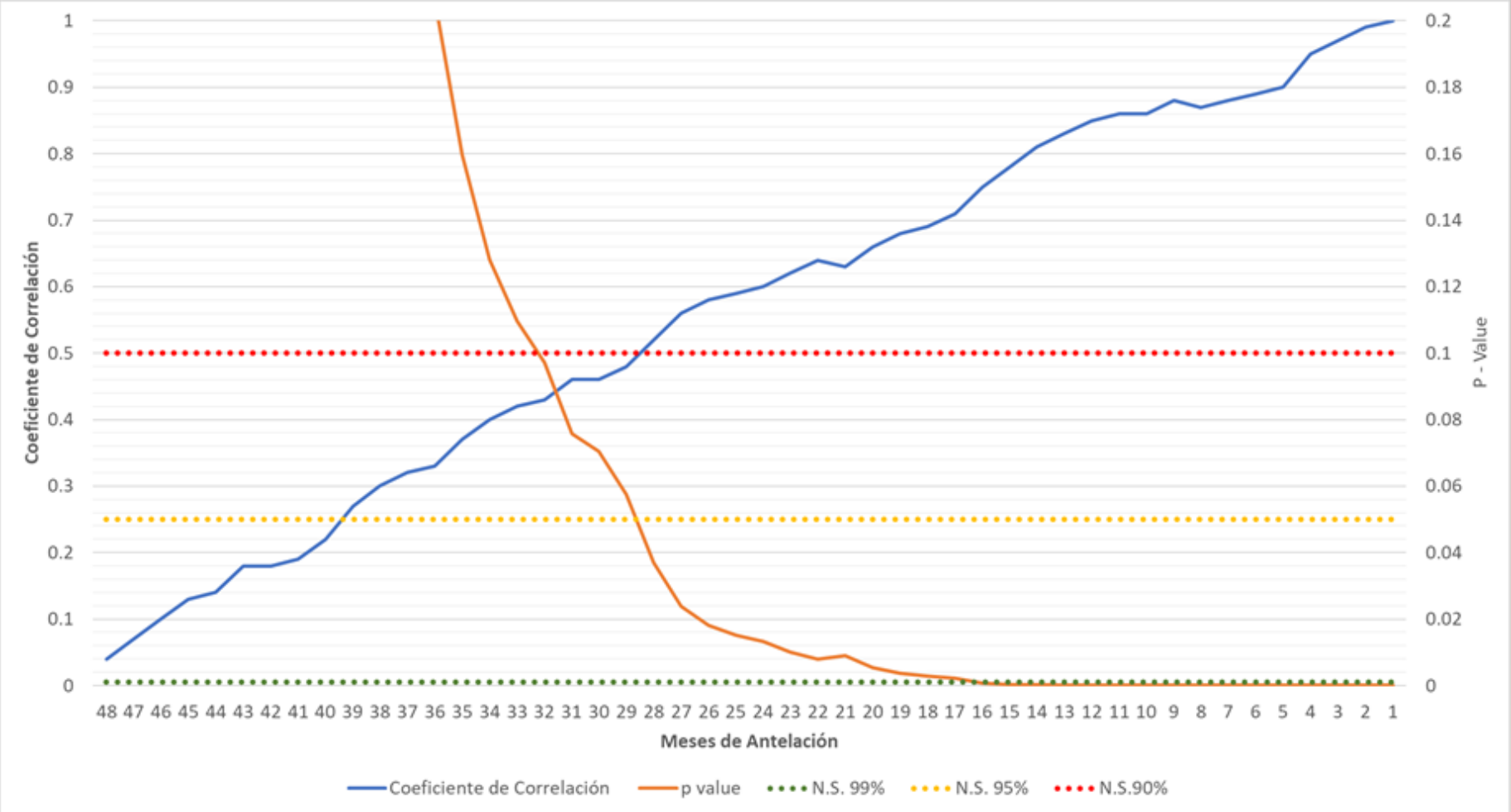
Option 2: Multi-year insurance contract. Premium rates depending on a pre-season index



Source: Maestro, T. 2016

		Premium 1 year-contract	Premium 2 year-contract	Premium 3 year-contract
		% Liability	% Liability	% Liability
Pre-season index contracts SI JUCAR	Normality	41.65	34.66	38.23
	Pre alert - Alert	77.32	77.32	71.04
	Emergency	135.09	112.41	124.25

Option 3: Early Contract with a Constant Premium



Insurance Assessment Indicators

Insurance Scheme	Additional Prime	Standard Deviation (€/ha)	Minimum Gross margin (€/ha)	RMSL (€/ha)	Basis Risk (gain) (%)	Basis risk (loss) (%)
No insurance		567.9	1193.1	84.1		
γ=37% SI=0.15	0%	**551.5**	1156.6	96.1	3.85	12.55
	10%	**551.5**	1140.8	103.2		
	37%	**551.5**	1098.1	122.7		
γ=19% SI = 0.3	0%	**550.8**	1144.6	101.5	3.85	12.84
	10%	**550.8**	1127.6	109.2		
	37%	**550.8**	1081.7	130.3		
γ=0% SI=0.5	0%	597.3	1021.6	158.3	2.71	25.96
	10%	597.3	992.3	172.4		
	37%	597.3	913.2	211.9		
γ=0% SI=0.3	0%	**550.8**	1187.1	**82.6**	3.85	12.84
	10%	**550.8**	1174.3	88.2		
	37%	**550.8**	1139.9	103.6		
γ=0% SI=0.15	0%	626.6	1163.1	99.2	9.13	3.85
	10%	626.6	1160.1	100.7		
	37%	626.6	1152.0	104.9		
γ=0% SI=0.2	**0%**	**550.8**	**1254.6**	**54.9**	3.85	12.84
	10%	**550.8**	**1248.6**	**57.2**		
	37%	**550.8**	**1232.4**	**63.5**		

Insurance Assessment Indicators : - Claim Ratio

To assess the insurance performance

↓

(DSS) AQUATOOL

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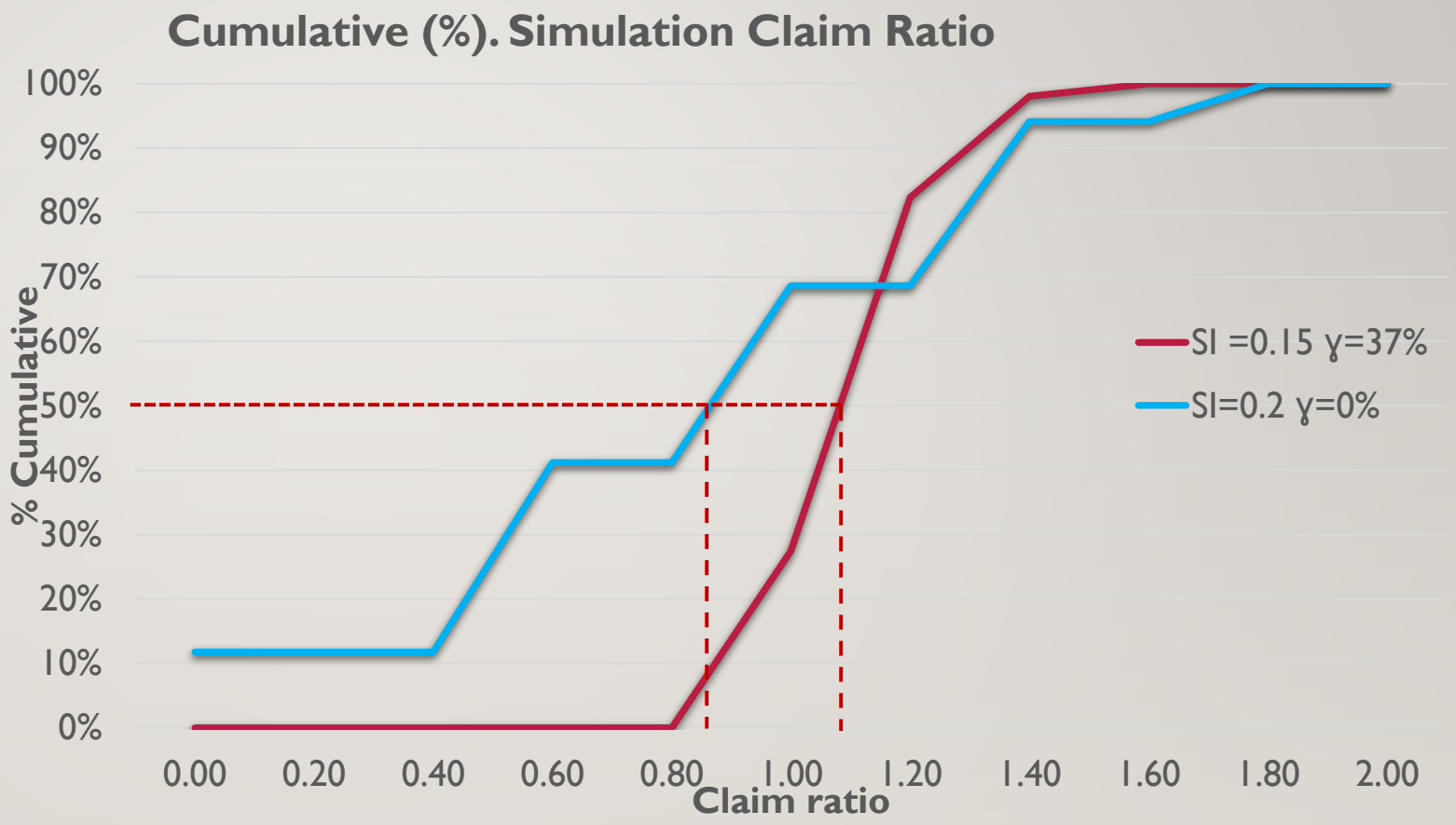
$$Claim\ ratio = \frac{\sum Claims\ incurred}{\sum Premiums\ paid}$$



- ✓ This first approach to an insurance scheme in the Jucar River Basin Agency allows us to identify initial starting values, methodologies, and research needs to optimize the design.

- ✓ The best insurance scheme is obtained with **SI=0.2** and **ɣ=0%**, and other options is **SI=0.3** and **ɣ=0%**.

- ✓ Due the above, this **Hydrological drought index insurance** is classified as a **Catastrophic Risk**.

- ✓ **Water scarcity** in the Jucar River basin is an event with a **low probability of occurrence**. However, it produces **high-intensity impacts** with significant environmental and economic consequences, especially in **irrigated agriculture.**

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Thanks

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Acknowledgments: Universidad Nacional de Colombia
MinCiencias Colombia. Doctoral Training Program.

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