Tradeoffs in water extremes: combining hydraulic and economic modeling to assess the economic and financial viability of the Lastras de Cuéllar Dam, Spain

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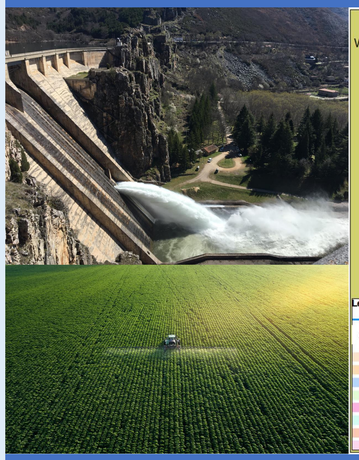
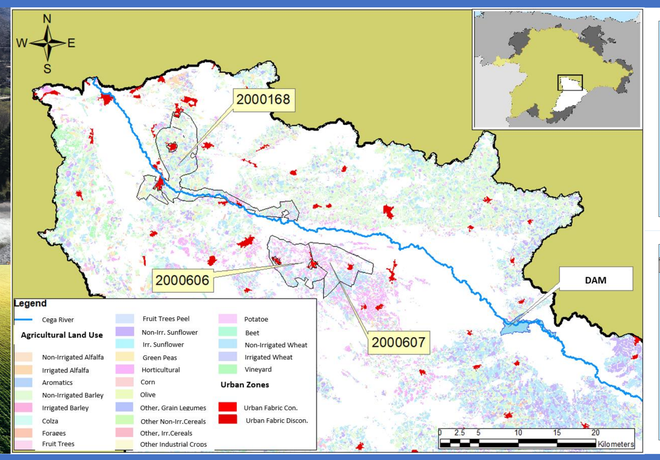
HIGHLIGHTS

- Growing population and water demand (e.g for irrigation, water supply) and the vagaries of climate, now aggravated due to climate change, intensify societal exposure to water extremes and the economic and environmental impact of floods and droughts in Mediterranean basins.
- The Douro River Basin Authority (DRBA) in central Spain is assessing whether to build a dam in the Cega Catchment to substitute irrigation withdrawals from overallocated aquifers with relatively more abundant surface water, and to mitigate flood damage in the middle and lower stretches of the Cega River.
- A Positive Multi-Attribute Utility Programing (PMAUP) that mimics farmer´s responses is used to assess the impacts on agricultural employment and gross value; while the hydrologic model River Analysis System (HEC-RAS) is used to simulate the economic impact of flood events considering standard return periods, based on global flood depth-damage functions.
- The dam construction strategy is assessed through two scenarios: no irrigation expansion (i.e. considering the current endowment that aquifer supplies (16,72 million m³)); and expansion scenario, increasing the endowment until 38,9 million m³ that can be supplied by the dam and is specified in the Basin Plan (DRBA, 2016a).

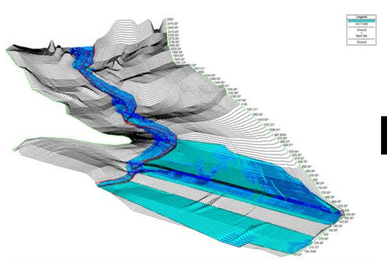
STUDY AREA



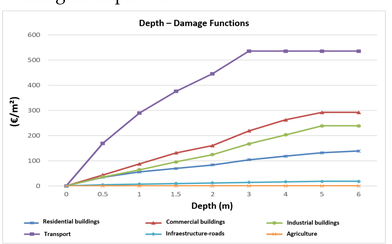


HEC-RAS FLOOD SIMULATIONS

METHODOLOGY

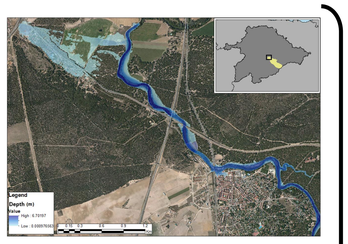


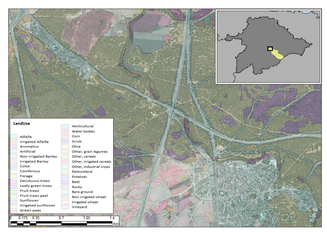
Delimitation of the flood áreas and its Depth. The Hydrologic model **HEC-RAS** uses Digital Model Terrain, maximum flood Flow (CAUMAX), and Manning coefficient established based on expert judgement, using orthophotos.

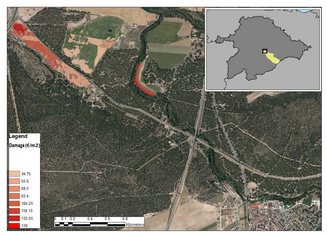


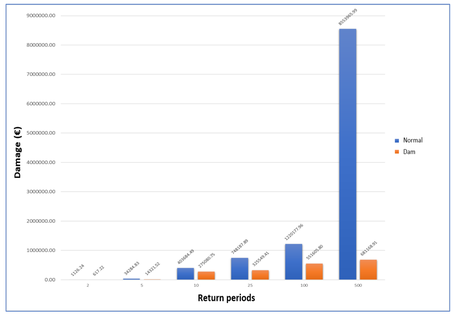
Depth-Damage Functions are used to establish the economic losses for each LandUse and return period. Then, through the Estimated Aggregated Damage (EAD) function, the results have been aggregated to assess the avoided cost per year.

RESULTS







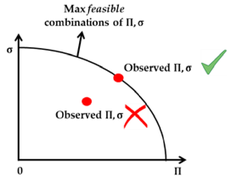


	Return period "T"	Probability of not exceed flow P=e^(-1/T) (per year)	Event probability	Damage (€) Statu quo	Annual damage Statu quo (€)	Damage (€) Dam	Annual damage Dam (€)
CURRENT SCENARIO	2	0,607	0,607	1126,24	683,10	617,22	374,36
	5	0,819	0,212	34784,83	7275,24	14321,52	3039,03
	10	0,905	0,086	416604,49	34759,91	275080,75	23686,29
	25	0,961	0,056	748187,89	41862,63	325549,41	18215,15
	100	0,990	0,029	1220177,96	35702,89	551605,80	16140,20
	500	0,998	0,008	8559865,99	68023,55	681168,91	5410,77
	DEA				188306,3311		66871,79470
	Avoided cost		=		121434,5363		
SCENARIO UNDER C.C.	Return period "T"	Probability of not exceed flow P=e^(-1/T) (per year)	Event probability	Damage (€) Statu quo	Annual damage Statu quo (€)	Damage (€) Dam	Annual damage Dam (€)
	2*	0,621	0,593	1126,24	666,64	617,22	365,34
	5*	0,822	0,201	34784,83	6884,48	14321,52	2875,80
	10*	0,906	0,084	416604,49	33823,10	275080,75	23047,91
	25*	0,961	0,055	748187,89	41306,57	325549,41	17973,20
	100*	0,990	0,029	1220177,96	35528,12	551605,80	16061,59
	500*	0,998	0,008	8559865,99	67941,36	681168,91	5410,30
	DEA				186150,2707		65733,74597
	Avoided cost		=		120416,5247		

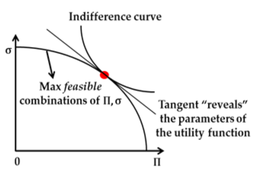
* Return periods modified according C.C predictions

PMAUP SIMULATIONS

METHODOLOGY



Chose the crop portfolios that leads the atributes to maximize the utility within de domain F(x) (quantifiable constraints)

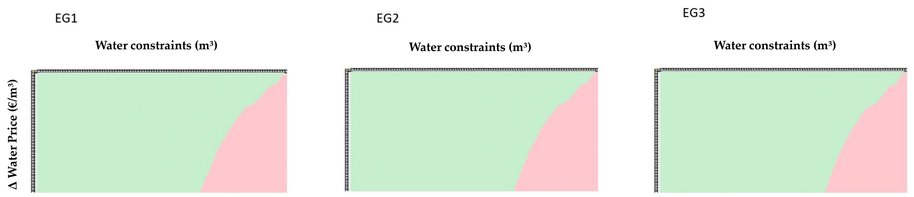


The calibration aims to obtain a utility function consistent with the Observed behavior and the domain F(x)

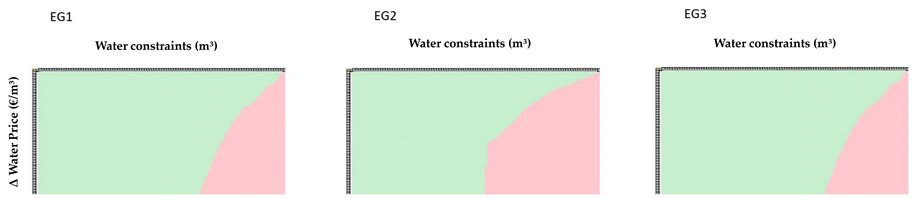
RESULTS: CROP PORTFOLIO CHANGES

RESULTS: SCENARIOS COMPARISON (STATU QUO V. DAM)

No irrigation expansion:



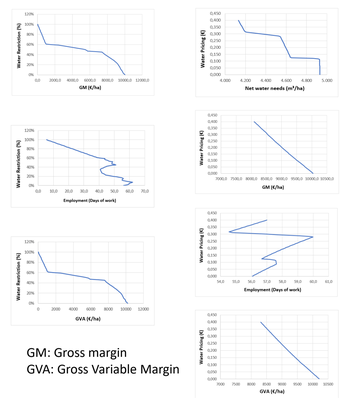
Irrigation expansion:



RESULTS: STRATEGIES IMPACT

Statu quo:

Dam:



GM: Gross margin
GVA: Gross Variable Margin

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SWAN

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