ANALYSIS OF THE UNCERTAINTY IN THE MONETARY VALUATION OF ECOSYSTEM SERVICES - A CASE STUDY AT THE RIVER BASIN SCALE

Dr. Guy Ziv

School of Geography

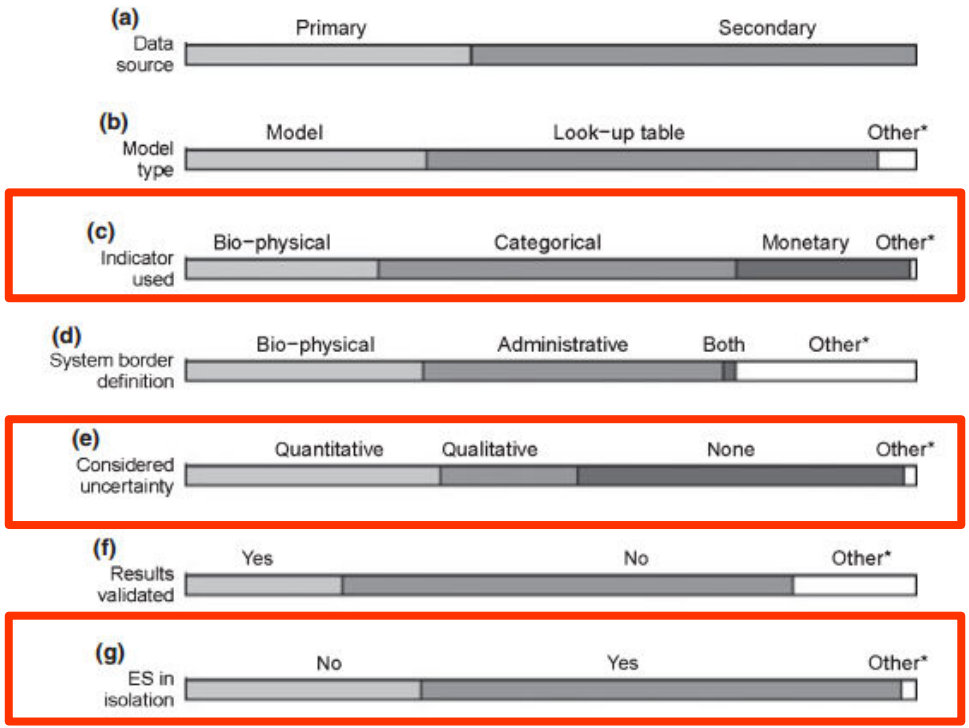
J. Applied Ecology, *under review*

Boithias, Laurie; Catalan Institute for Water Research (ICRA),
Terrado, Marta; Catalan Institute for Water Research (ICRA),
Corominas, Lluís; Catalan Institute for Water Research (ICRA),
Kumar, Vikas; University Rovira and Virgili, Departament d'Enginyera Química
Marqués, Montse; University Rovira and Virgili, Departament d'Enginyera Química
Schuhmacher, Marta; University Rovira and Virgili, Departament d'Enginyera Química
Acuña, Vicenç; Catalan Institute for Water Research (ICRA),

Uncertainty is important …
…but often forgotten

the lack of monetary valuations has been identified as one of the underlying causes for the observed degradation of ecosystems and the loss of biodiversity (TEEB 2010)

small differences in the value of quantified benefits might influence CBA decision on whether or not to perform a conservation management action (Ben Dor et al. 2011)



A quantitative review of ecosystem service studies: approaches, shortcomings and the road ahead
Seppelt R. et al. J. Applied Ecology 2011, 48, p:630-636

Sources of uncertainty in ecosystem services valuation

water @leeds

UNIVERSITY OF LEEDS

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Biophysical Modeling

Economic Modeling

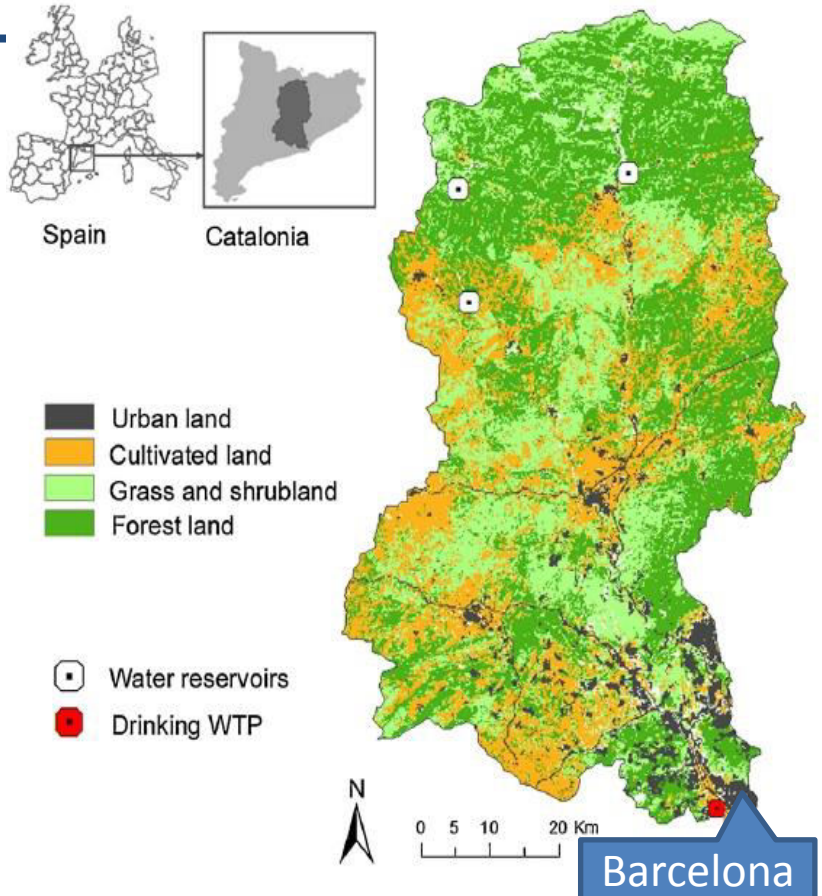
Ecosystem Service	Change in Constituent	Endpoint	Change in Valued Attribute	Beneficiaries	Valuation Approach
Lake recreation	P and/or N	Lakes	Water clarity	Lake recreationists Lakeshore property owners	Recreational demand model Willingness to pay for recreation Hedonic pricing
Clean drinking water	N	Sourcewater treatment facilities	[Nitrate] above 10ppm	Treatment facility & taxpayers	Avoided treatment costs for nitrate
Clean drinking water	N	Groundwater	[Nitrate] above 10ppm	Well owners	Avoidance costs (bottled water) Remediation costs (treatment) Replacement costs (new well)
Clean drinking water	N	Drinking water (surface or groundwater)	[Nitrate]	Consumers, particularly at-risk subpopulations	Increased risk of disease * value of statistical life/health Avoidance costs
Commercial fisheries	N	Bays, estuaries, coasts	Fish and shellfish productivity	Fish and shellfish industry and consumers	Fishery rents Value per unit fish/shellfish

4 Parametric uncertainty

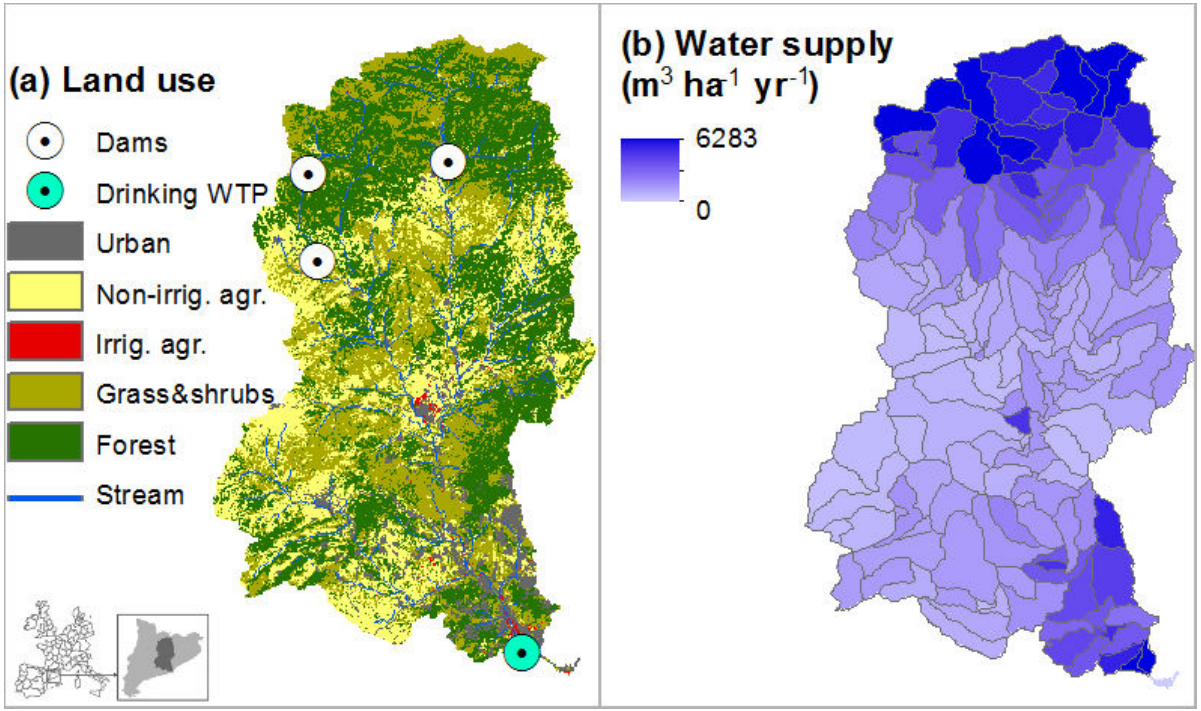
Linking water quality and well-being for improved assessment and valuation of ecosystem services
Keller B. et al. PNAS 2012, 109, p:18619–18624

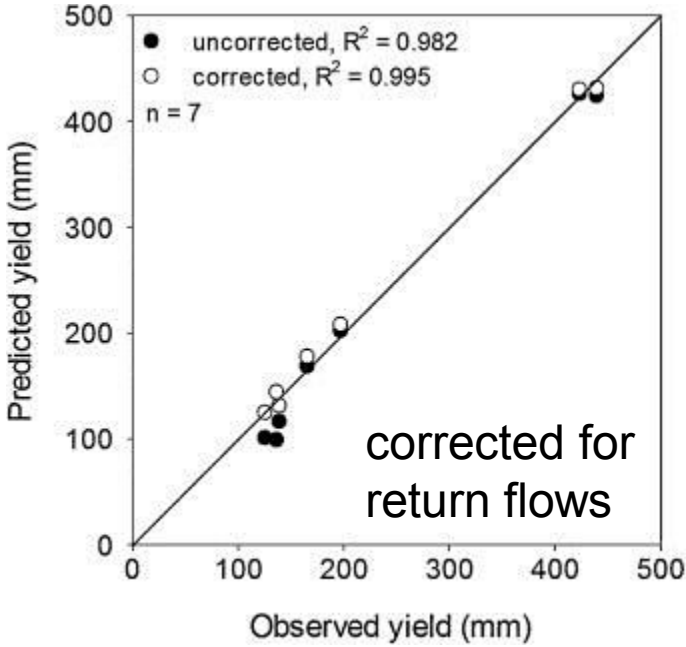
Study site

Llobregat basin: 4950 km^2
Barcelona: 3 million people
Annual rainfall: from >1000mm in mountains to <600mm near coast.
3 Reservoirs, 1 Drinking WTP



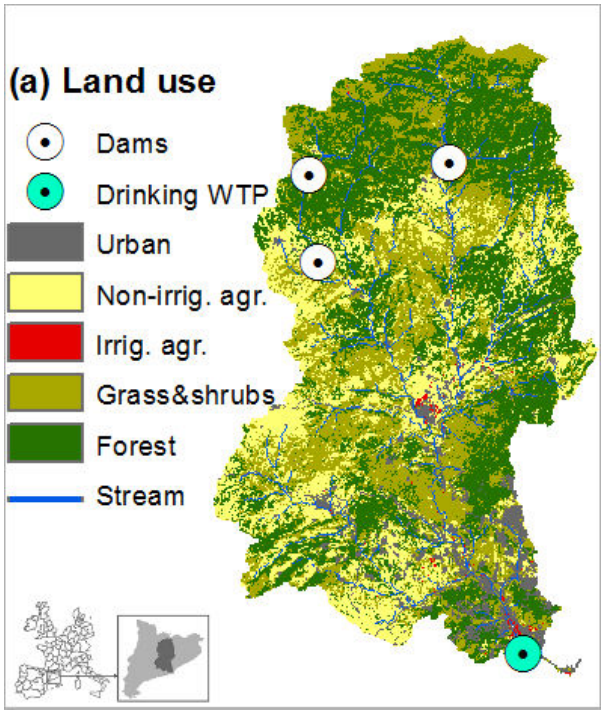
Ecosystem services – Biophysical Modelling





Impact of climate extremes on hydrological ecosystem services in a heavily humanized Mediterranean basin
Terrado M. et al. Ecological Indicators, 2014, 37, p:199-209

Ecosystem services – Biophysical Modelling



Model calibration
La Baells reservoir

Model validation
outlet

Parameter	Observed	Predicted
Water supply ($\times 10^6$ m^3 y^{-1})	606	606
TN export (Mg y^{-1})	6000[a]	5998
TP export (Mg y^{-1})	420	422
Sediment export – 1 (Gg y^{-1})	200[b]	150
Sediment export – 2 (Gg y^{-1})	602–1418[c]	1535

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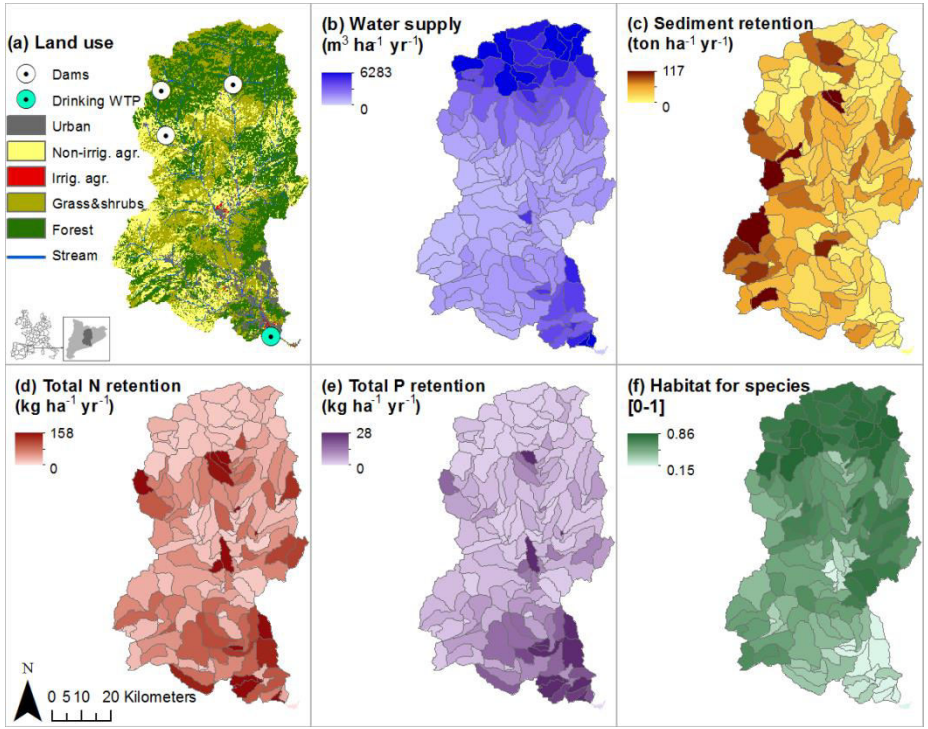
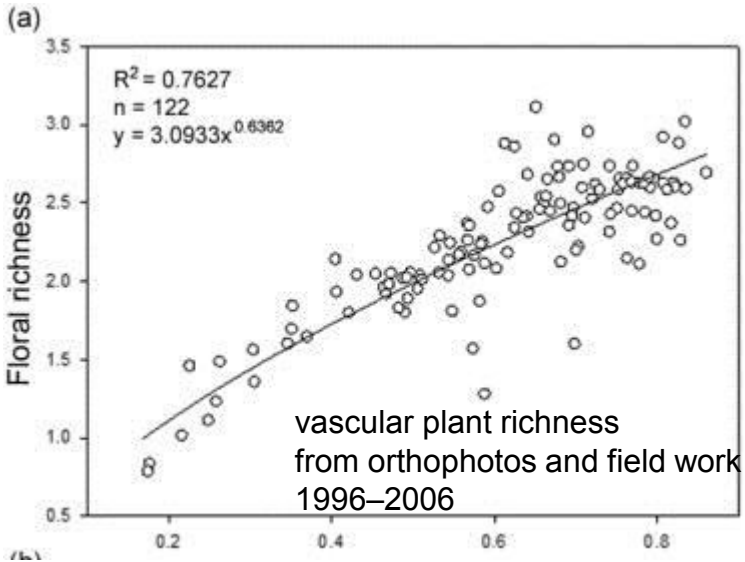
Ecosystem services – Biophysical Modelling

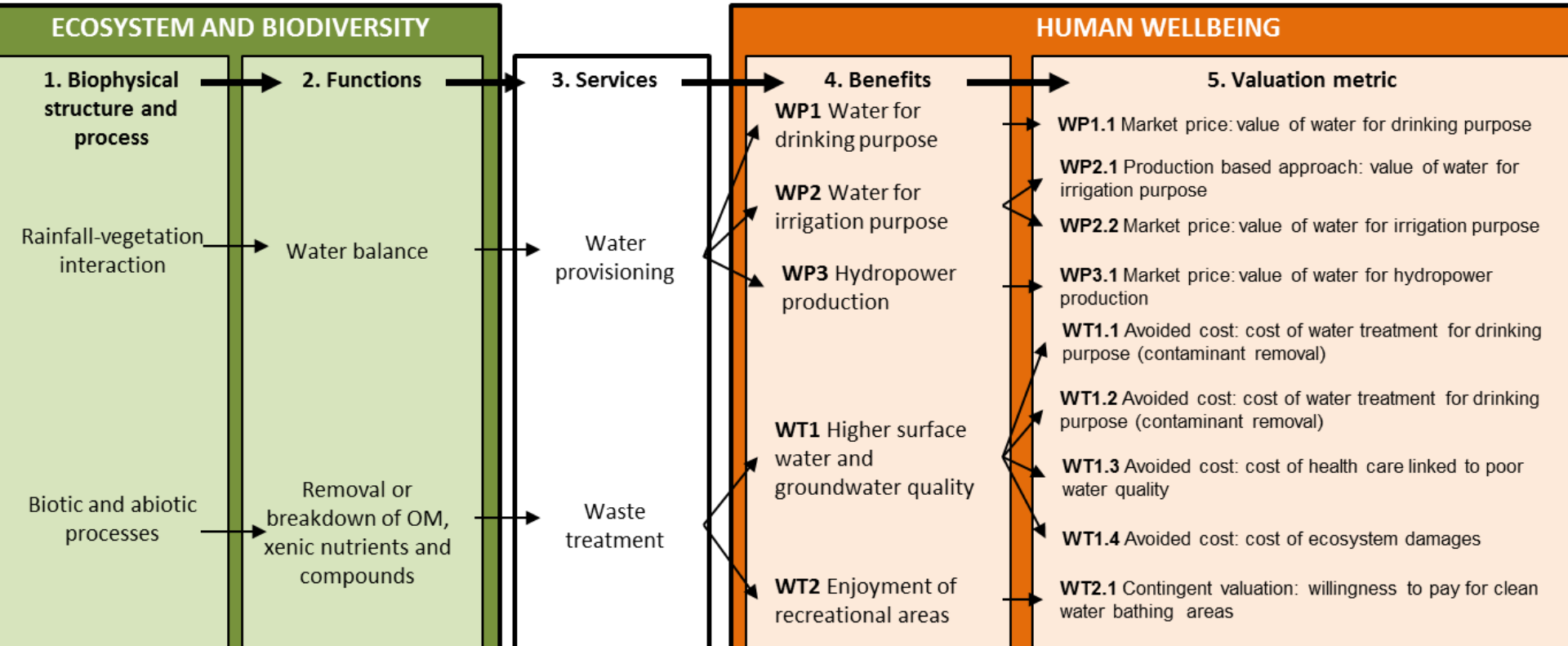


Threats included (a) urbanization; (b) agriculture; (c) roads; (d) mines

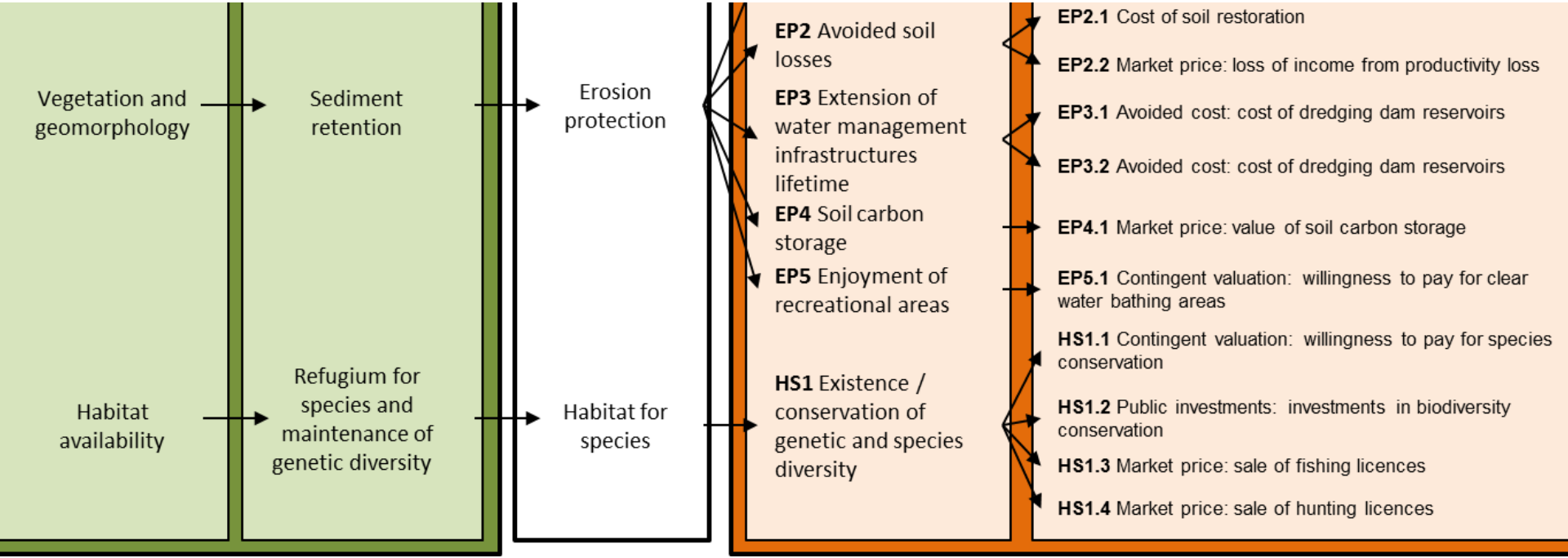


Model development for the assessment of terrestrial and aquatic habitat quality in conservation planning
Terrado M. et al. Science of the Total Environment, 2015, *in press* (available online)

Valuation Framework



Valuation Framework



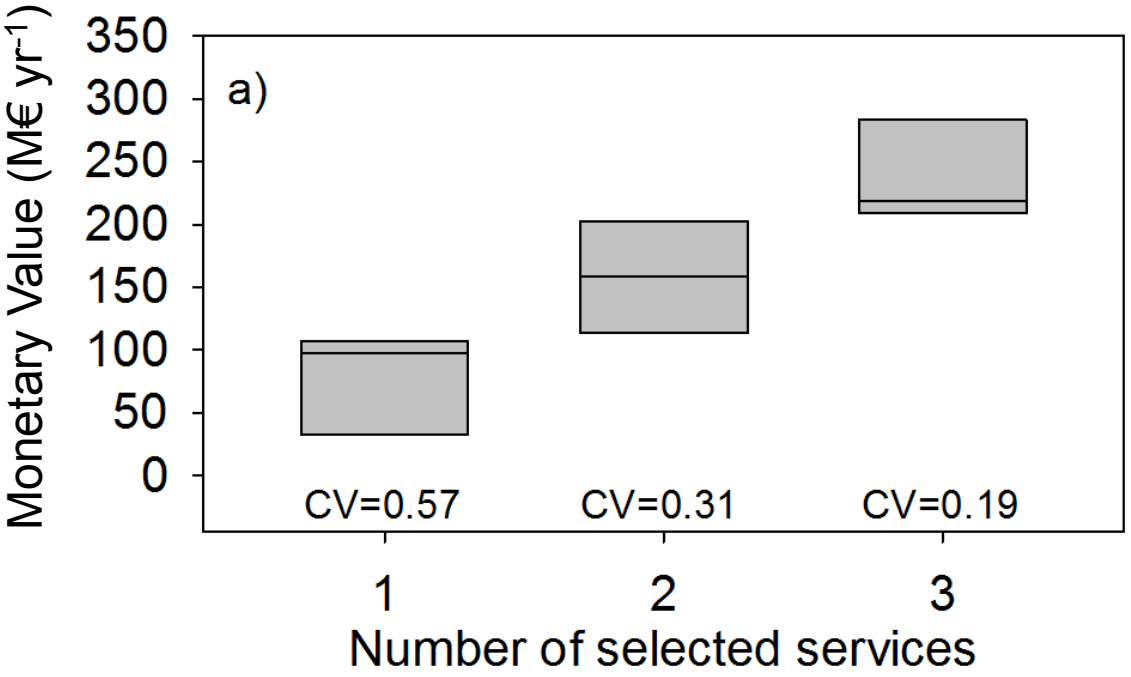
Valuation Results

	Benefits	Valuation metrics	Value (M€ yr^{-1})
Water Provisioning			
WP1.1	Water for drinking purpose	Market price	279
WP2.1	Water for irrigation purpose	Production based approach	87
WP2.2		Market price	0.63
WP3.1	Hydropower production	Market price	1.83
Waste Treatment			
WT1.1	Higher surface water and groundwater quality	Avoided cost	68
WT1.2		Avoided cost	4.1
WT1.3		Avoided cost	3.2
WT1.4		Avoided cost	24.5
WT2.1	Enjoyment of recreational areas	Contingent valuation	182

	Benefits	Valuation metrics	Value (M€ yr^{-1})
Erosion Protection			
EP1.1	Higher surface water quality	Avoided cost	49.5
EP2.1	Avoided soil losses	Replacement cost	0.84
EP2.2		Market price	0.79
EP3.1	Extension of water management infrastructures lifetime	Avoided cost	8.4
EP3.2		Avoided cost	7.9
EP4.1	Soil carbon storage	Market price	5.2
EP5.1	Enjoyment of recreational areas	Contingent valuation	0
Habitat for Species			
HS1.1	Existence/conservation of genetic and species diversity	Contingent valuation	350.7
HS1.2		Public investments	14.9
HS1.3		Market price	0.001
HS1.4		Market price	0.082

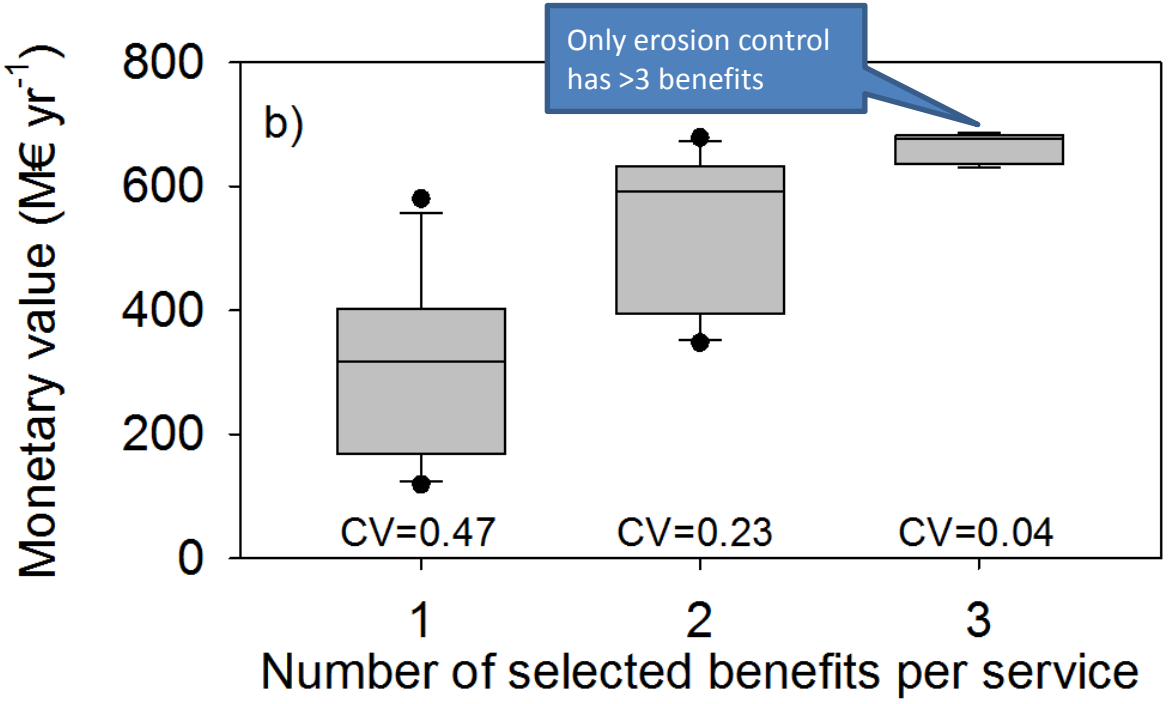
Structural Uncertainty

Including more than one services reduces significantly the uncertainty (C.V. drops 50% from 1 to 2 services)



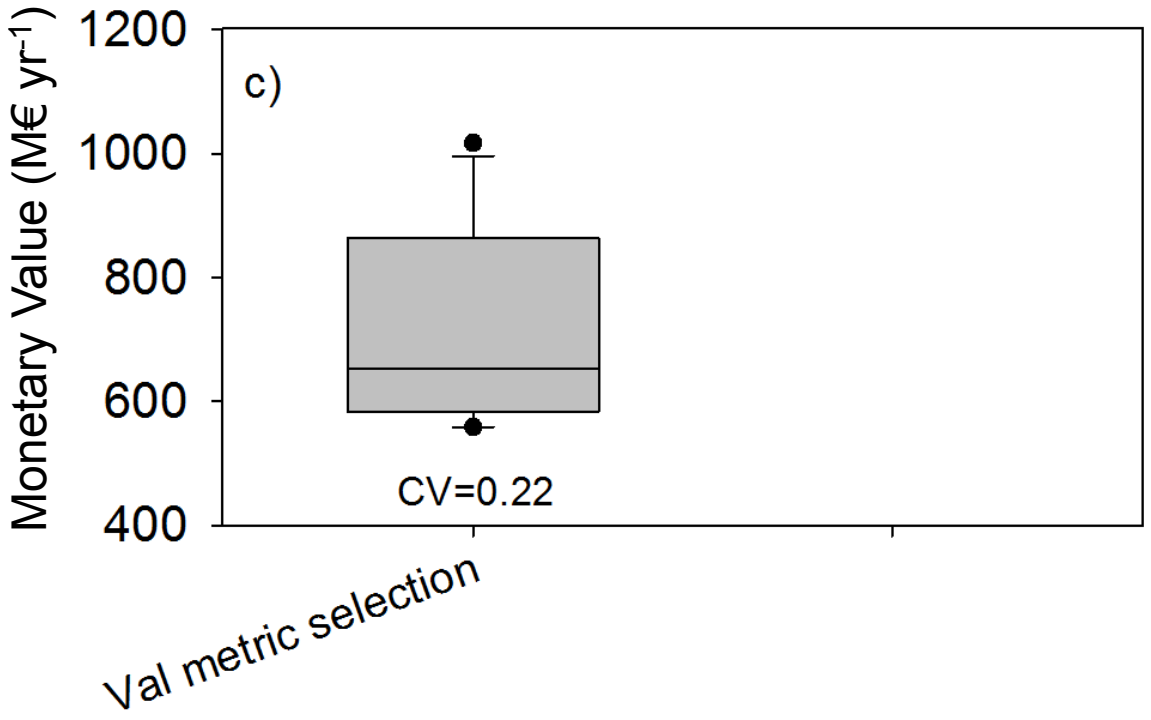
Structural Uncertainty

Including more than one beneficiary/benefit also reduces significantly the uncertainty (C.V. drops 50% from 1 to 2 benefits)



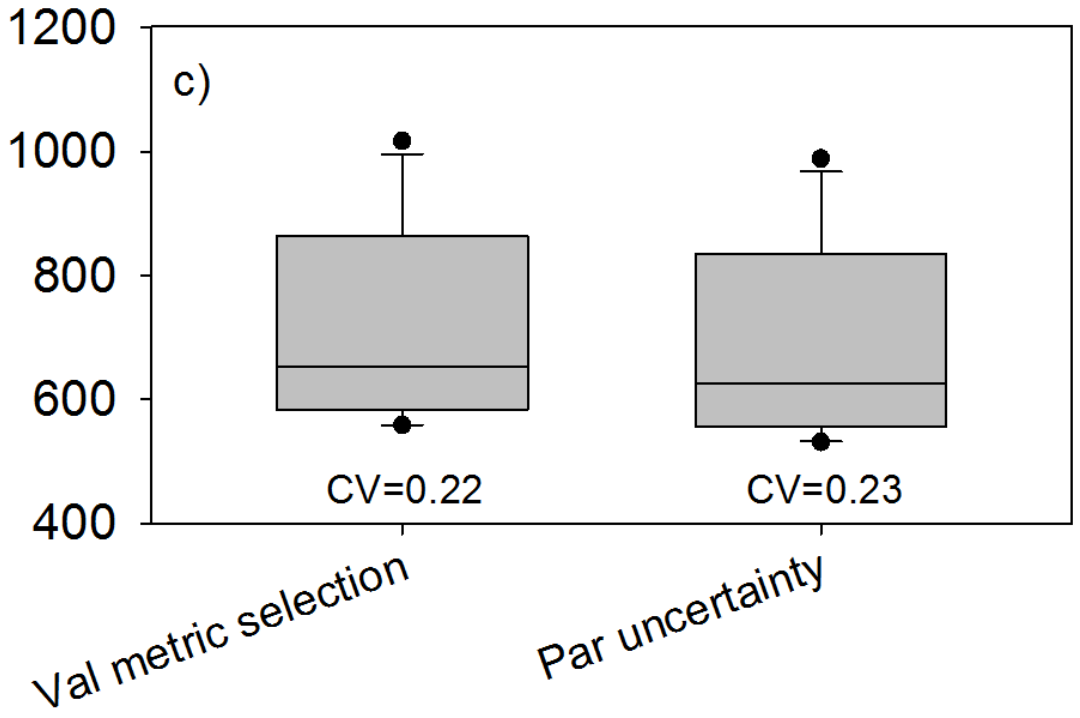
Structural Uncertainty

Using 128 combinations of valuation metrics, that uncertainty is 3rd in rank compared to single service (C.V. = 0.57) and single benefit (C.V. = 0.47) …



Parametric Uncertainty

… and in par with the uncertainty arising from valuation metric parameters (assuming uniform pdf within reasonable range)



Conclusions

Quantifying the uncertainty in monetary valuation step of ecosystem services assessment is important

Structural uncertainty was more significant than parametric uncertainty in this case study

We recommend including at least two ecosystem services and two benefits/beneficiaries (taking care to avoid double counting) per service

- Most available models (e.g. InVEST) do not meet this requirement