FONDAZIONE ENI ENRICO MATTEI

Adaptation policies to climate change in the Mediterranean region

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QUELLES POLITIQUES D'ADAPTATION AU CHANGEMENT CLIMATIQUE ET DE PRESERVATION DE L'EMPREINTE ECOLOGIQUE DE LA PLANETE?

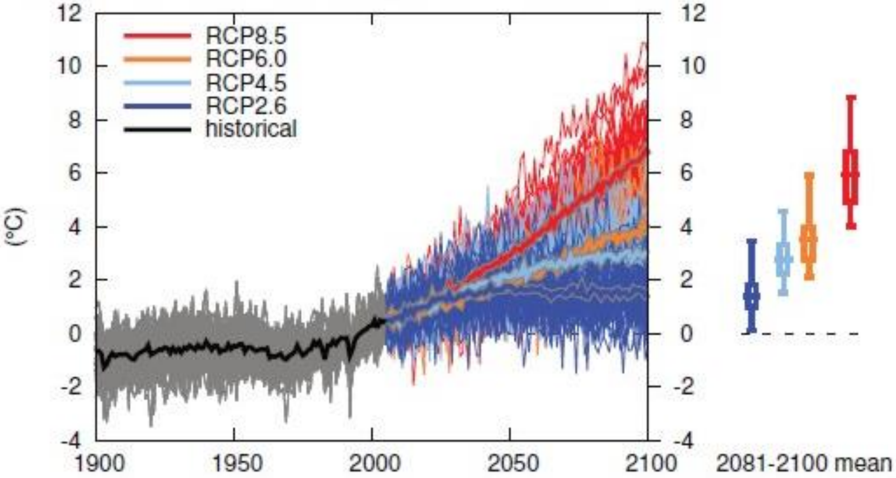
Rabat, 2 May 2016

1. Why adapting?

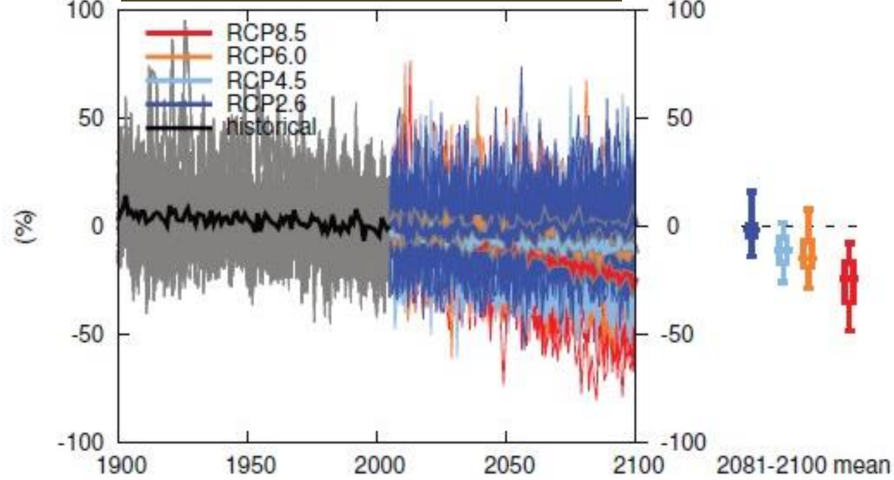
> The Mediterranean basin is one of the most vulnerable regions to CC
  > CC interrelated consequences
  > precarious socio-economical conditions
  > fragile political systems
  > Large ecological footprint
> Δ ºC in the Mediterranean may be higher than globally. Consequences:
  > Sea level rise
  > Extreme events: floods, droughts, heatwaves, fires
  > Socioeconomic impacts: direct (lives, infrastructures), indirect (income, migration)
> Climate change may threaten lives, economic growth and ecosystem services in the area
> Mitigation is necessary
  > Yet, surface temperature is projected to rise over the 21st century under all IPCC emission scenarios

2. Climate change in the Mediterranean

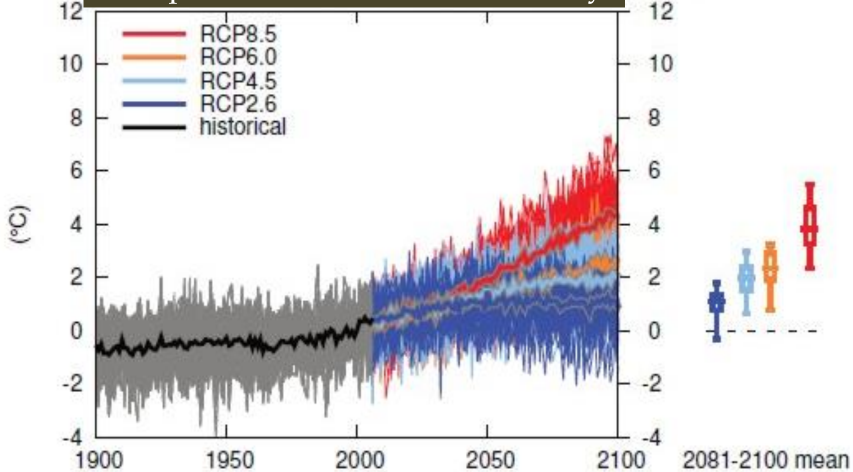
Temperature June - August



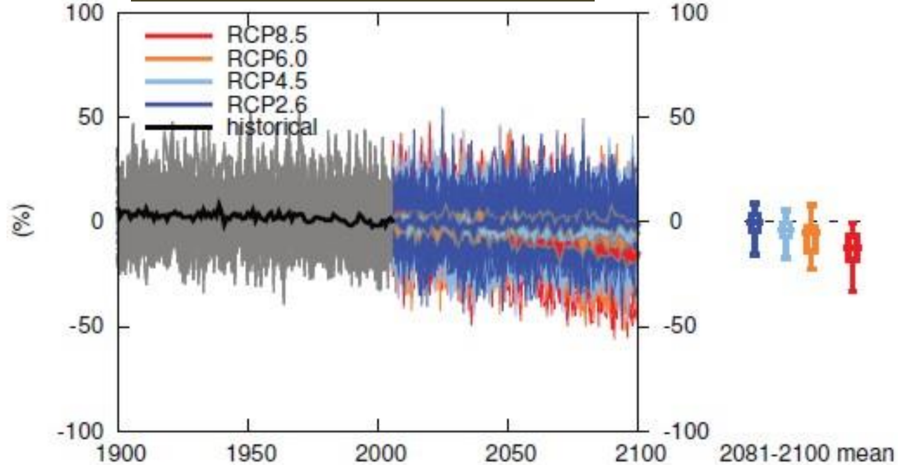
Precipitation April - September



Temperature December - February

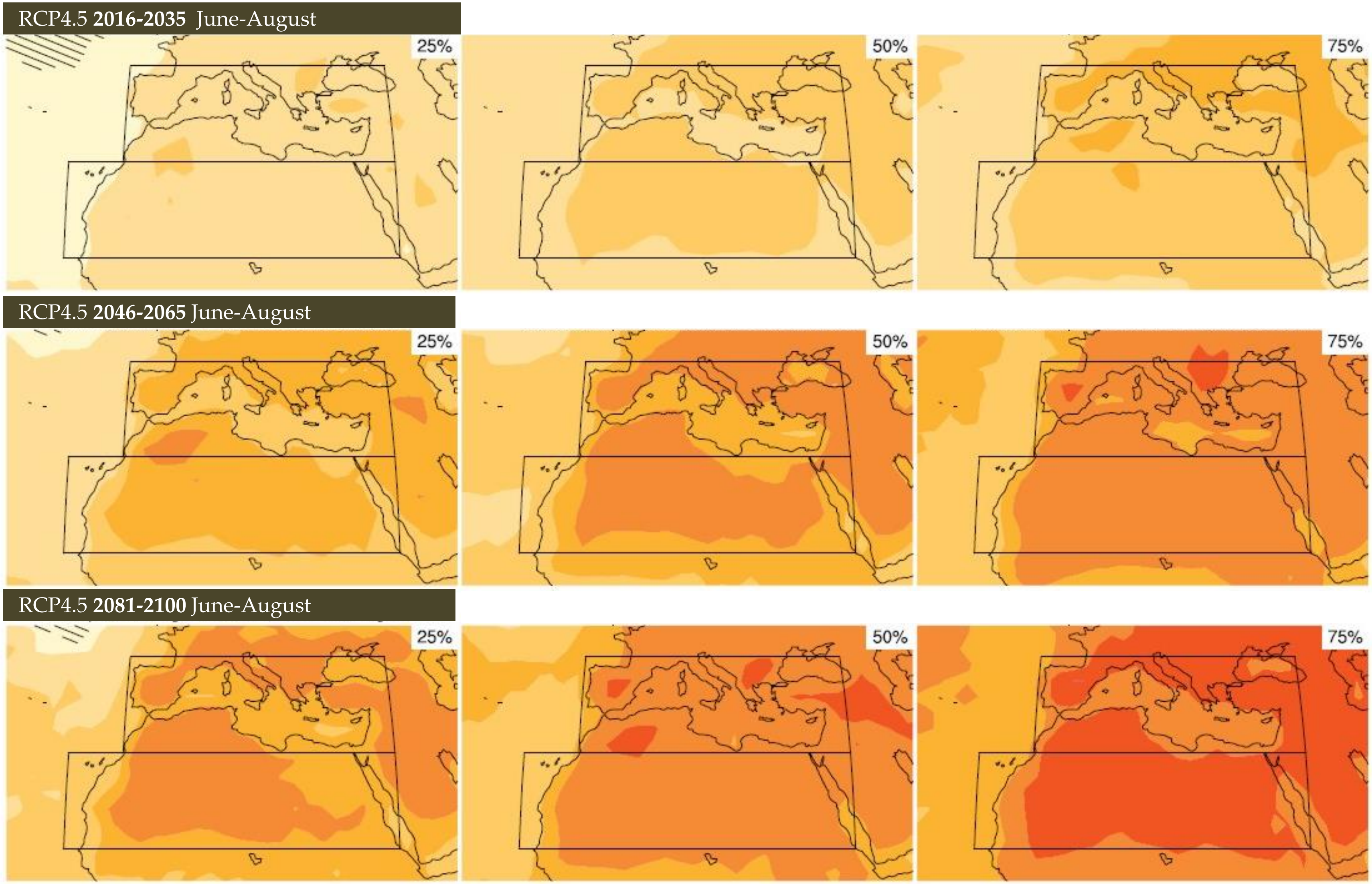


Precipitation October - March

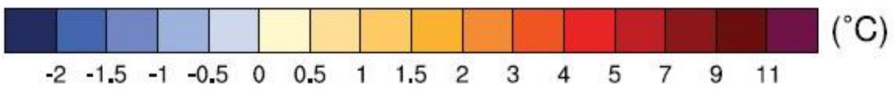


IPCC, 2013: Annex I: Atlas of Global and Regional Climate Projections. In: Climate Change 2013: The Physical Science Basis. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

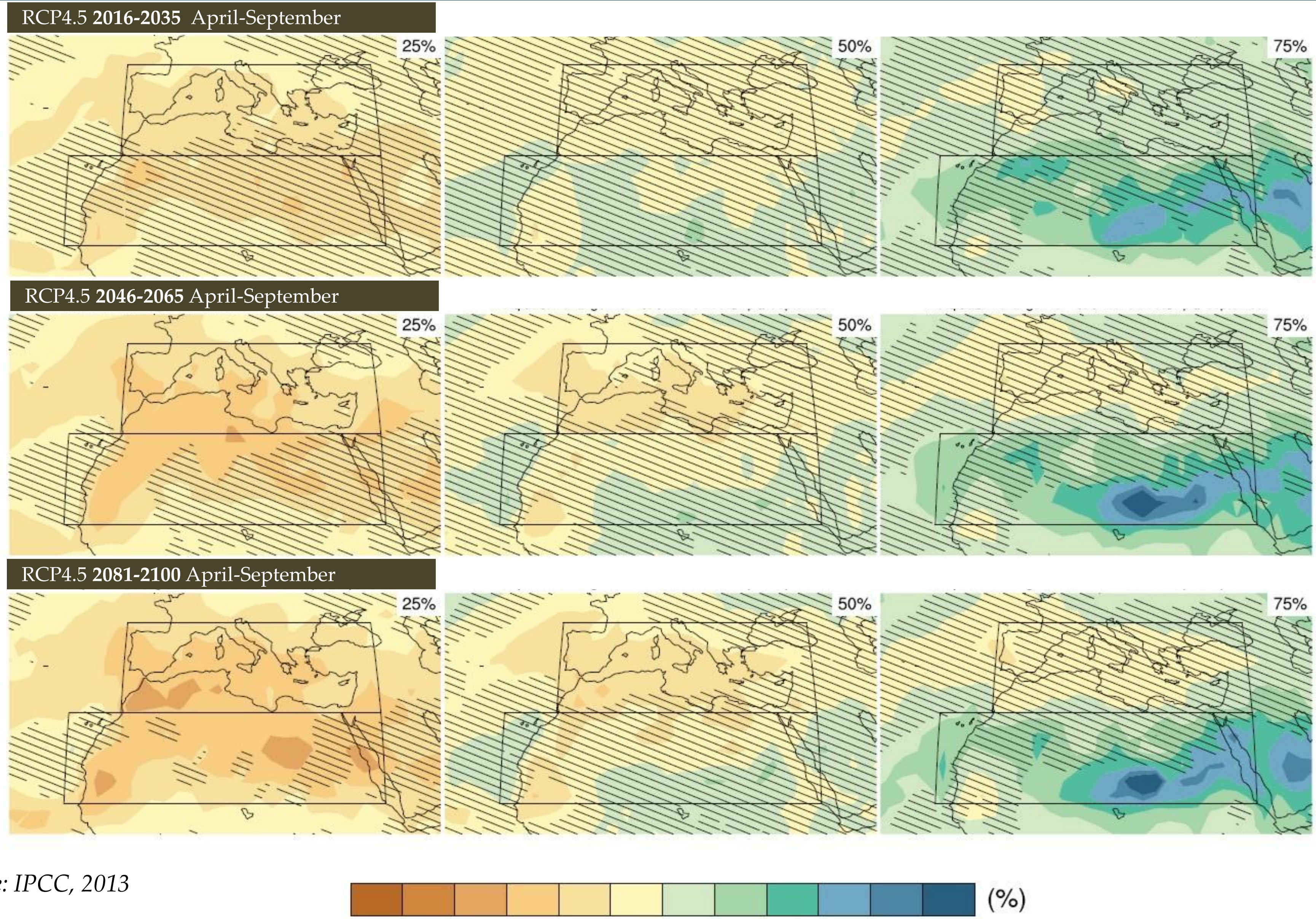
3. Temperature



Source: IPCC, 2013



4. Precipitation

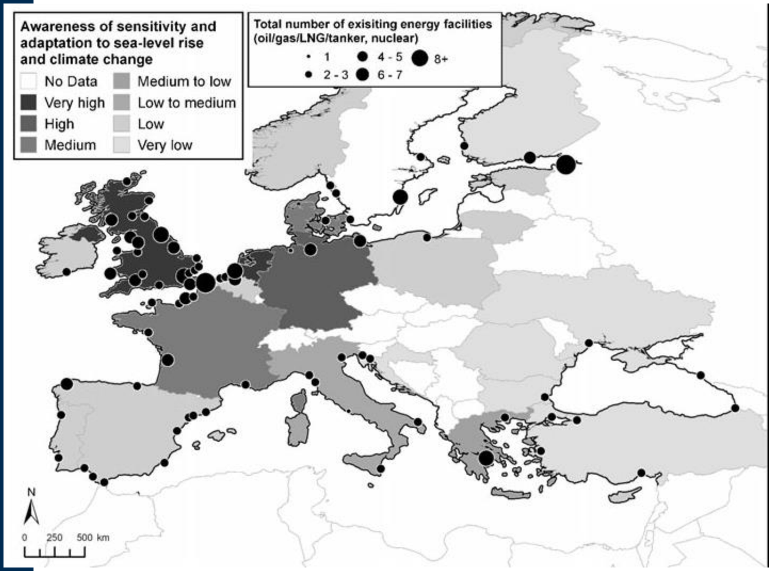


Source: IPCC, 2013

5. Economic repercussions of CC: sea level rise

> Flooding and erosion -> infrastructural disruptions

> 158 major oil/gas/LNG/tanker terminals + 71 operating nuclear reactors on the coast -> indirect impacts



Sea level rise economy-wide impacts on Italy, in % of GVA, Italian regions (NUTS2)

	A1B	A1FI	A1T	A2	B1	B2
Piedmont	**2.32**	**2.80**	**1.84**	**3.43**	**1.71**	**1.80**
Aosta Valley	2.51	3.03	1.99	3.65	1.85	1.95
Lombardy	**1.80**	**2.18**	**1.42**	**2.61**	**1.32**	**1.39**
Trentino Alto Adige	1.51	1.86	1.17	1.85	1.07	1.14
Veneto	-5.13	-5.94	-4.53	-12.06	-4.41	-4.41
Friuli V. G.	-2.01	-2.94	-1.63	-5.41	-1.48	-1.56
Liguria	0.27	0.30	0.17	0.89	0.13	0.15
Emilia Romagna	-11.93	-13.95	-9.53	-14.54	-8.72	-9.33
Tuscany	-2.44	-3.38	-1.60	-2.70	-1.41	-1.57
Umbria	1.81	2.18	1.45	2.73	1.36	1.42
Marche	0.36	0.54	0.24	0.93	0.22	0.23
Lazio	-2.04	-2.72	-1.36	-2.19	-1.15	-1.32
Abruzzi	1.11	1.39	0.84	1.91	0.47	0.81
Molise	1.15	1.40	0.91	1.95	0.82	0.88
Campania	-0.72	-1.06	-0.18	-0.55	-0.18	-0.18
Apulia	-1.71	-2.09	-1.31	-1.66	-1.18	-1.29
Basilicata	1.05	1.26	0.84	1.69	0.78	0.82
Calabria	-1.45	-1.34	-1.53	-1.27	-1.54	-1.54
Sicilia	-0.43	-0.34	-0.52	-0.14	-0.55	-0.54
Sardinia	-0.85	-1.71	-0.74	-1.18	-0.72	-0.80
Italy	-1.51	-1.83	-1.20	-2.16	-1.11	-1.17

Source: Standardi et al., 2015 & Brown et al., 2013

6. Economic repercussions of CC: droughts

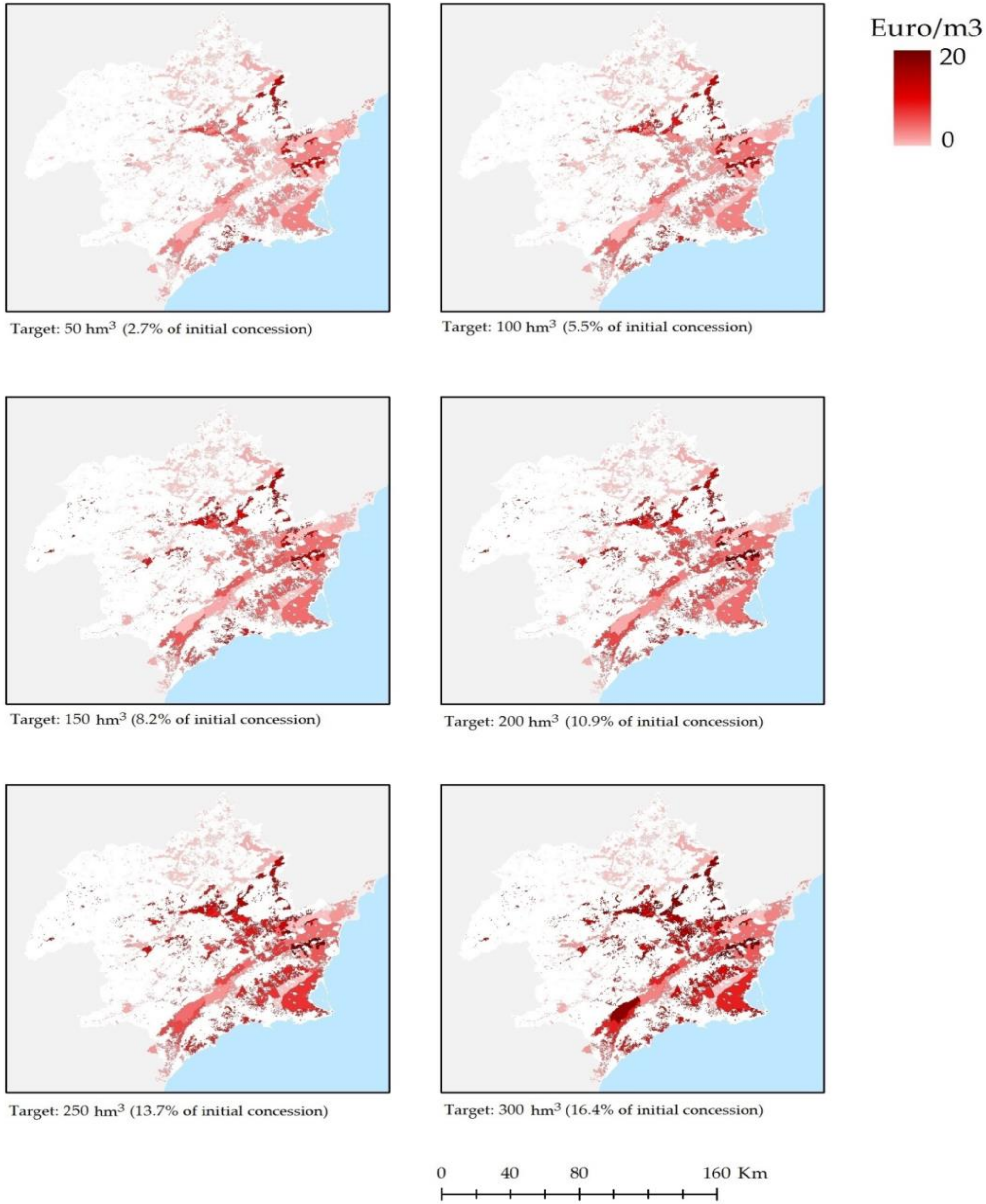
> Water crises are perceived as the most relevant global risk in terms of impact

> Irrigation represents 70% of total water withdrawals worldwide

> CC will reduce supply. Demand for crop irrigation is expected to increase by more than 40% up to 2080

> > Absolute scarcity is a reality already

> What are the consequences of irrigation restrictions?



NPV of agricultural losses (in EUR/m3) in SE Spain for alternative water conservation targets (50-300 M m3)

Source: Pérez-Blanco and Gutiérrez-Martín (work in progress)

7. Economic repercussions of CC: floods

> Account at the global level for the greatest share of natural disasters' inflicted damage (EAD 6.4 billion Euro)

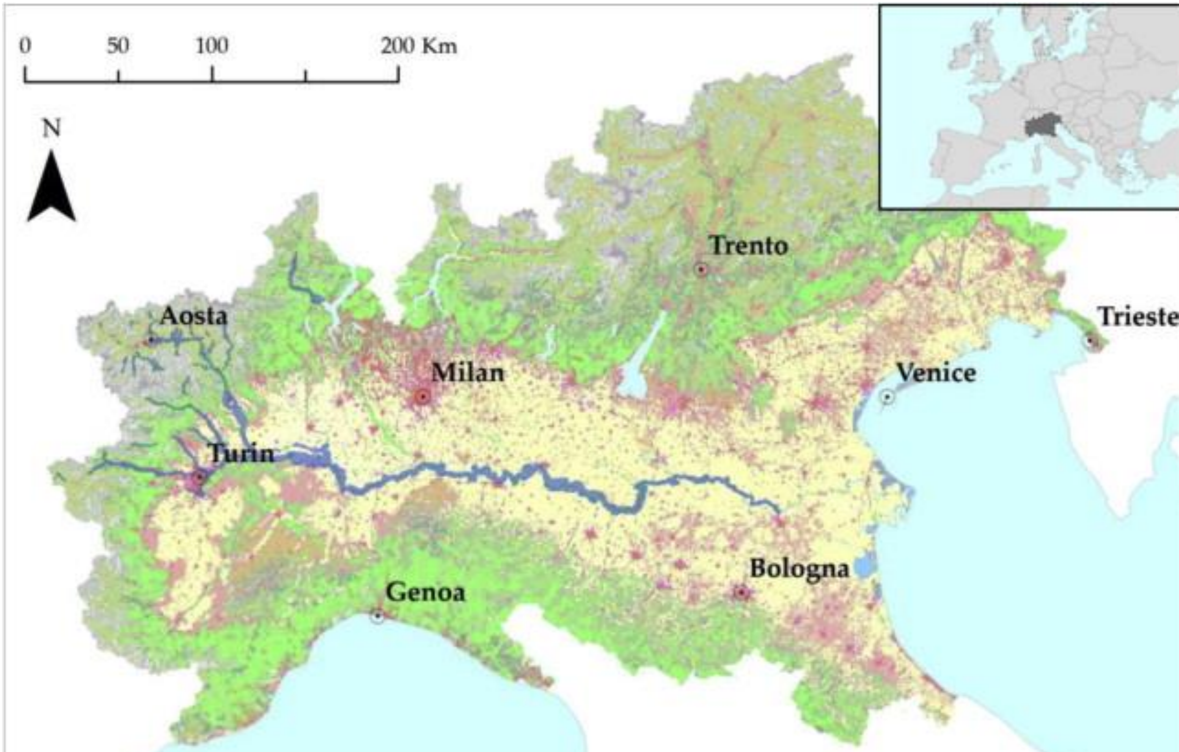
> Growing population and capital density, unsustainable development, inappropriate land use and climate change

> EAD estimations by 2100: 14–21.5 billion Euro, up to 97 billion Euro

> Rarely the accounting of flood losses includes indirect economic impacts

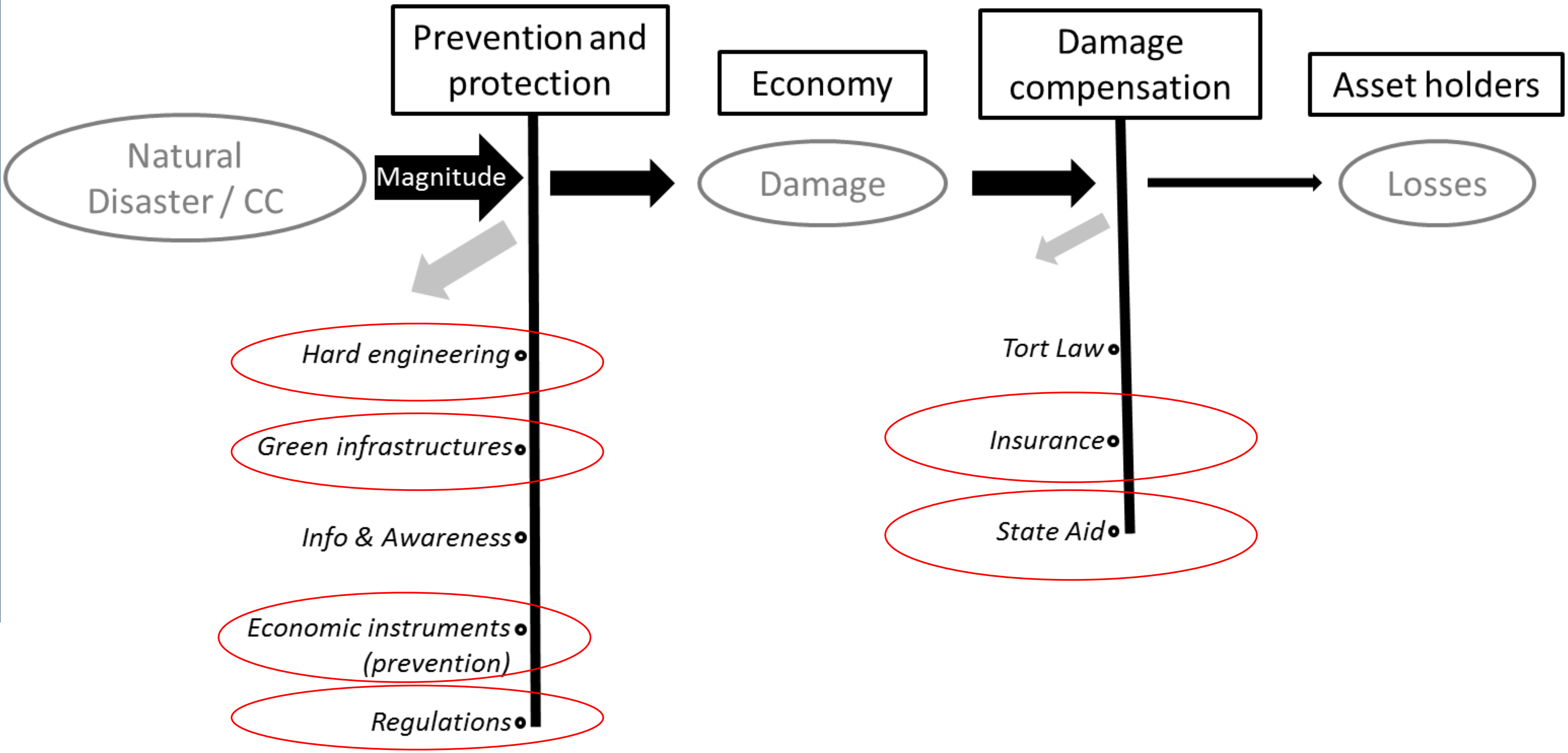
> Indirect losses can represent 19-22% of direct losses

Po river 2000 flood extension (in blue) in Northern Italy, represented using Corine Land Cover map 2000. Red is mainly constructed area while yellow is agricultural land.



Source: Carrera et al., 2015

How to adapt?


Prevention and protection
Economy
Damage compensation
Asset holders
Natural Disaster / CC
Magnitude
Damage
Losses
Hard engineering
Green infrastructures
Info & Awareness
Economic instruments (prevention)
Regulations
Tort Law
Insurance
State Aid

9. A tale of engineering



> CC and weather extremes challenges traditionally addressed through **hard** engineering:

> > Dykes, reservoirs (floods)
>
> > Drilling wells, desalination (droughts)
>
> > Efficiency improvement (e.g. heating and cooling demand)

> **Success** in harnessing environment for economic growth

> In the face of CC, this model is unsustainable

> > Financial crisis increases opportunity costs
>
> > Environmental costs are overcoming financial benefits
>
> > CC demands ever-increasing investments
>
> > Some of the solutions have backfired (e.g. irrigation modernization in Mediterranean areas)

Box 1: Irrigation modernization in Spain

> Total investment (2002-2008): 7 368 M€, of which:

> 60.1% public

> 39.9% private

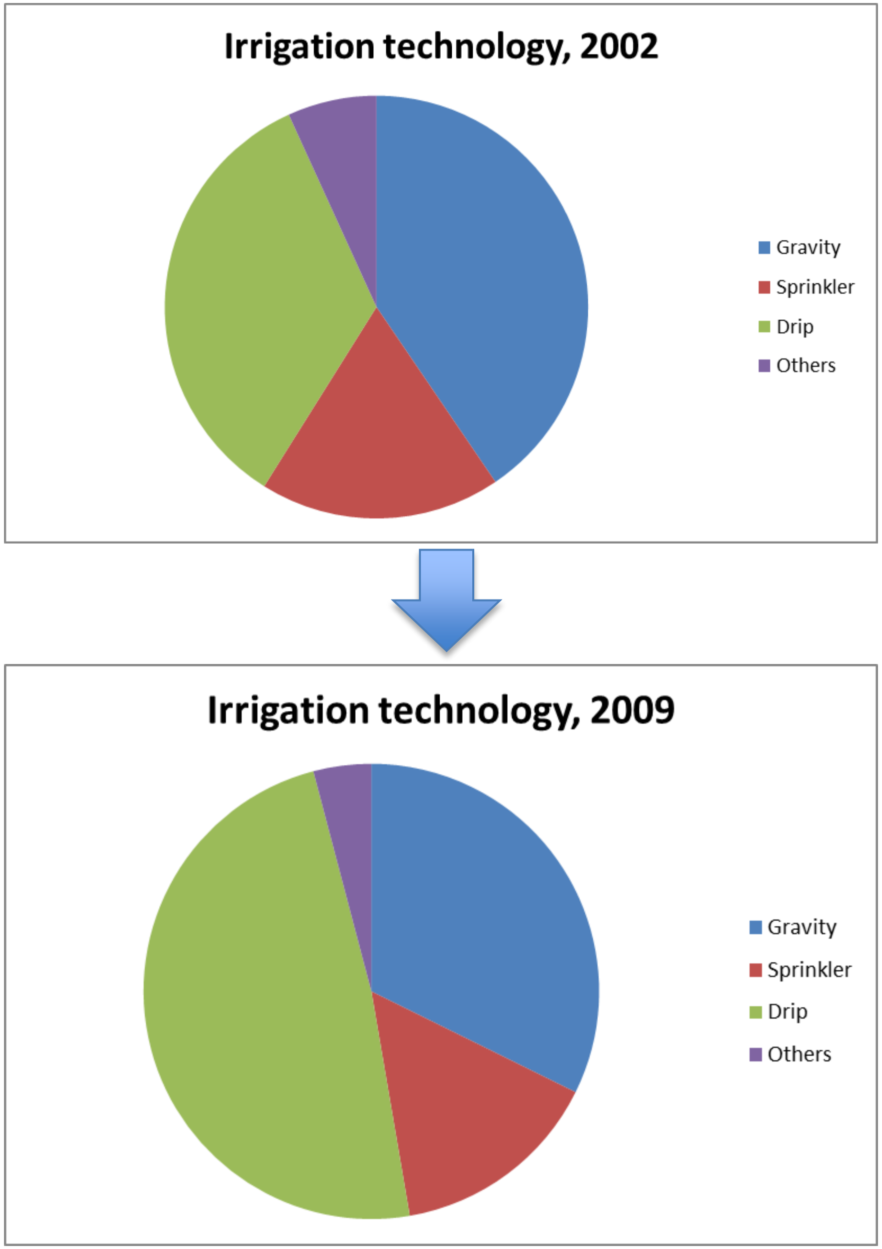
> Expected water savings: 3 662 hm3/year (*double efficiency, halve water use*)

> Evidence: water consumption and use may have increased in some areas

> Why?

>Lower water returns (*Hydrological Paradox*)

> The shift to more water intensive crops and the increase in use in dry periods (*Jevons' Paradox*)



Box 2: Drill rush in Malta

> Water resources / inhabitant < 1000 m3

> Total demand: 50.5 M m3

> > 33.5 M m3 from groundwater (mostly free)
>
> > 17 M m3 is desalinated (expensive, limited to drinking water)

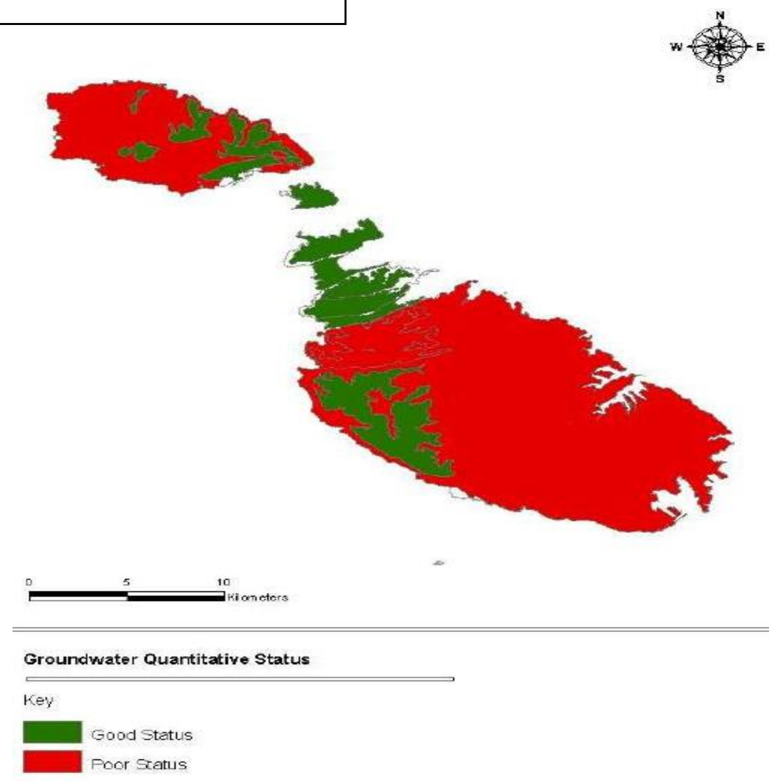
> Renewable GW supply: 25 M m3

> GW deficit: 8.5 M m3/year

> > 12.5 M m3/year according to recent estimates

> Challenges:

> > Irrigation is free and rapidly depleting aquifers (19 M m3/year)
>
> > Drinking water: expensive (up to 5€/m3), subsidized, loss-making



The costs of drinking water

Year	M&O Costs (M€)	Cost recovery (%)	Deficit (M€)
2005	55.89	52.0%	26.85
2006	54.71	53.1%	25.66
2007	51.88	56.7%	22.49
2008	56.16	64.7%	19.84

Box 3: Idle desalination in SE Spain

> 2000-2010: 400 M€ in the construction and modernization of desalination plants in the Segura River Basin (SRB)

> 2012: 500 M€ loan to bailout the public utility

> Additional 700 M€ for further investments

> Production cost around 1€/m3

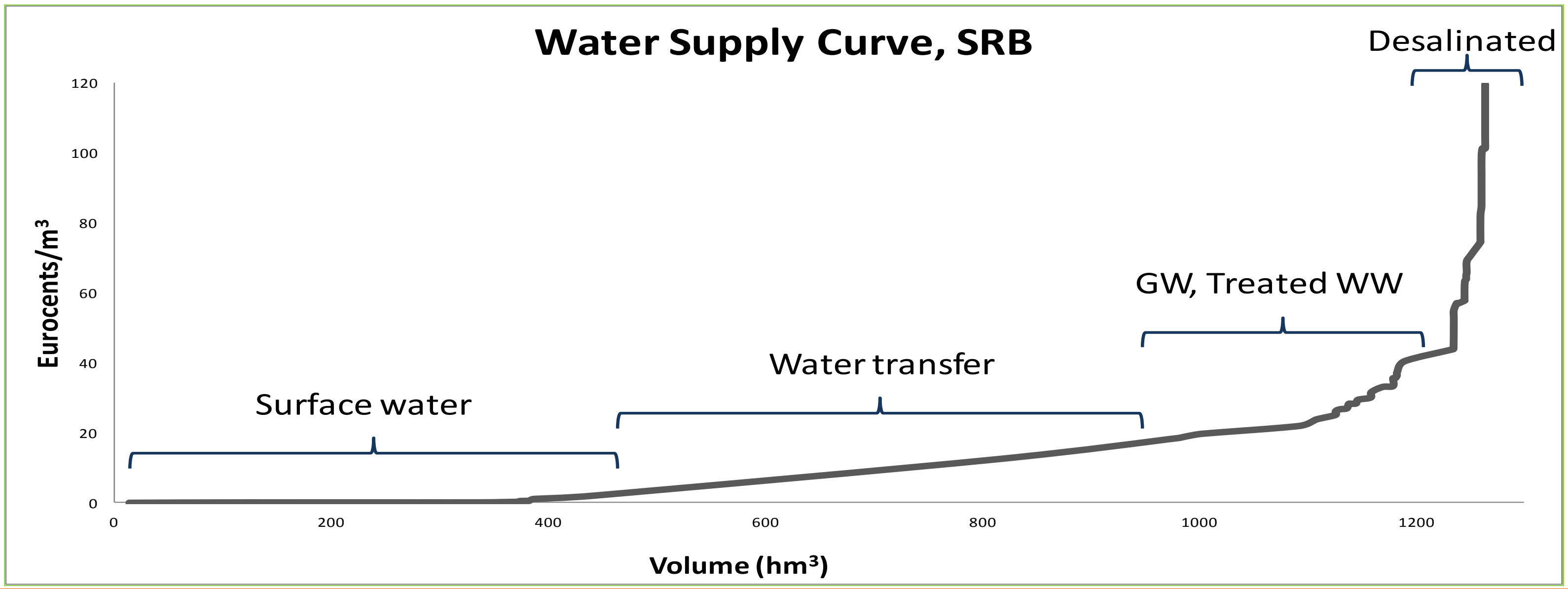
> Subsidized prices: 0.36 €/m3

> Conventional water prices: from 0 (GW) to 0.22 €/m3 (water transfer)

> Desalination plants can supply 1/6 of annual water withdrawals

> > Being used below 20% of their capacity (1/30)

> Desalinated water is an **expensive buffer stock**



Box 4: Flood management in Italy – coupling defenses and emergency responses

> Flood related losses, 2008-2012: 2.2 billion €

> Flood losses are on the rise

  > Climate change

  > Urban development (soil sealing + exposure)

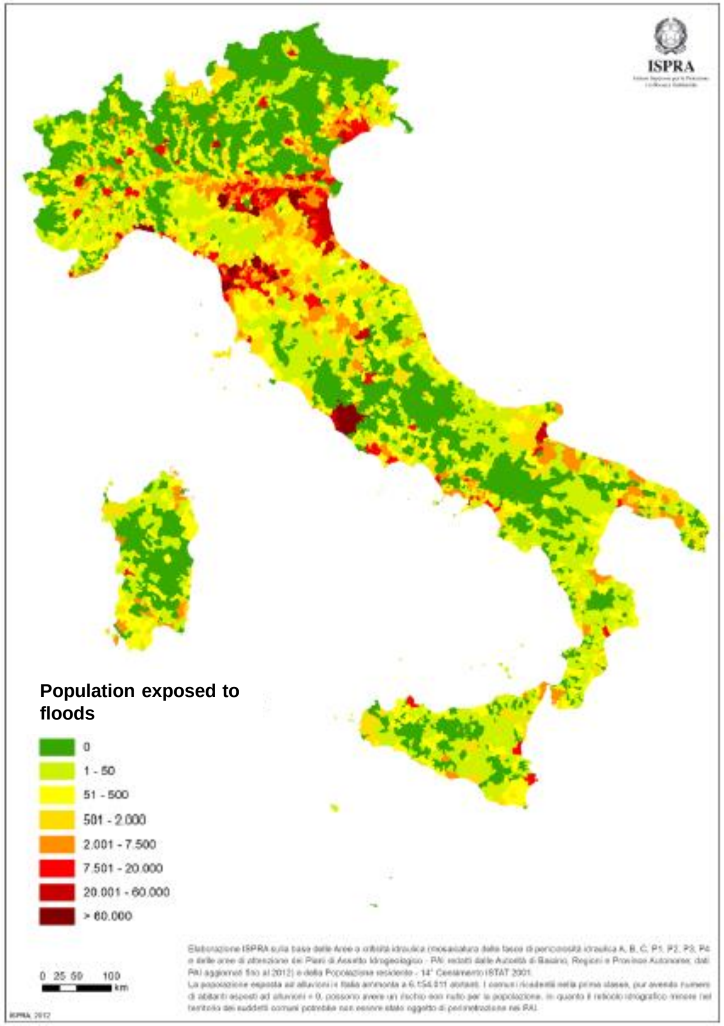
> No insurance

> Budgetary constraints

  > Flood prevention investments fall short of the mark

  > State aid 2008-2012: 1.2 billion €

> The strategy leads to underestimation of potential risks



10. Greening infrastructure

> Flexible, effective, and no-regret GI integrate human activities with the natural processes and ecological systems

> Contribute to CC adaptation & provide ancillary benefits (ES)

> > Afforestation against landslides and runoff
> > Wetlands and sustainable drainage systems to prevent floods
> > Dunes and salt marshes against storm surges
> > Green roofs against heat stress and heavy precipitation
> > Etc.

> **Uptake is low**

> > Low visibility of benefits (*externalities*)
> > Costs (including byproducts, e.g. fire risk)
> > Insufficient evidence and experience

11. Managing demand

> CC and socioeconomic dynamics are overcoming existent protection barriers

> This is mostly a **crisis of governance**

> Technical CC and disaster risk management developed to a very large extent…

> …while social, political, institutional and economic aspects are still treated in an incipient form, with major problems persisting

> Can we promote resilient and adaptive behavior?

> **Economic instruments**: *align individual decisions with collectively agreed goals*

> Complementary to engineering

> Not panaceas –case sensitive

> Streamed into the policy mix to solve CC-related problems (not revenue raising –although this is a welcome **byproduct**)

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Box 5: Pricing – a panacea?

“[…] water-pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this directive” (EC, 2000)

> Higher prices reduce use and raise revenue

Potential additional revenues for water-related taxes in Italy, 2016-2025, M€

Tax	Current revenues	2016	2020	2025
Water consumption tax	300	1,858	4,186	4,094
Waste water tax	Not found	197	275	275
Pesticides tax	12	545	1053	1074
Total		**2,600**	**5,514**	**5,443**

Source: Eunomia and Aarhus University, 2014

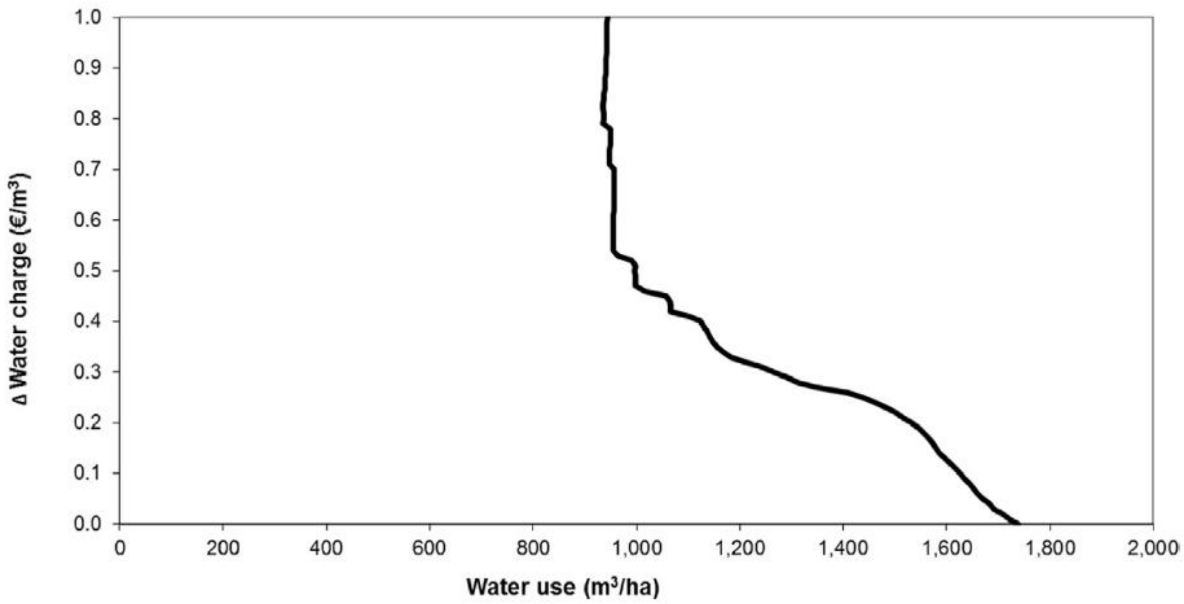
> At what cost? Negative impacts on employment and margins

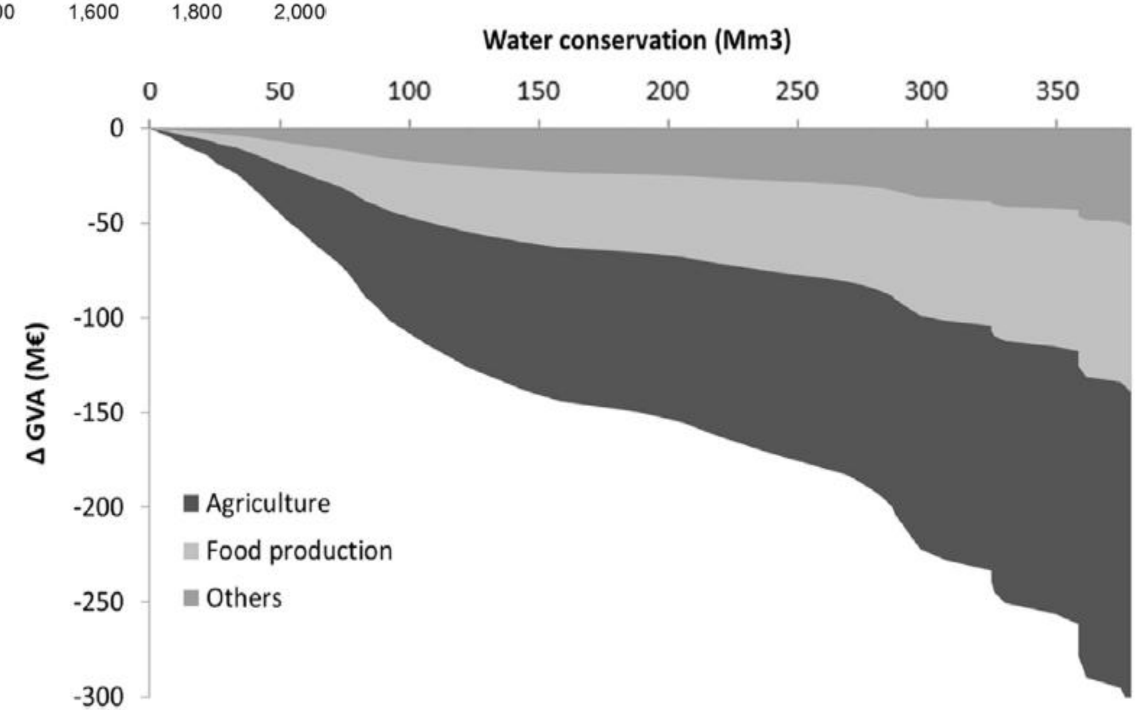
> This ‘tradeoff’ conditions the adequacy of pricing

> Also transaction costs

> Example: Irrigation water pricing in the Po River Basin, Italy

Box 5: Pricing – a panacea?





Box 6: Flood insurance

- > EU flood losses 2000 – 2012: €4.2 billion/year; By 2050: 23 billion €/year
  - > Likely to create **budgetary trouble**
  - > One-in-250-year floods and winter storms can downgrade credit rating and affect creditworthiness and recovery
- > 50% **insurance** coverage can reduce impacts on growth by 40% (vs. no insurance)
  - > Concern: Solvency
- > Risk based pricing **insurance** promotes Disaster Risk Reduction (i.e. adaptation)
  - > Also reduces the cost of public prevention/compensation
- > Caveats:
  - > Affordability: Not everyone can pay the price
  - > Equity: Who's responsible for risk?
- > Public Sector intervenes (through **PPPs**) to balance both sides, with different outcomes:
  - > France CatNat: Solidaristic approach (flat rate)
  - > UK FloodRe: Price incentives based on risk & 'tax bands'

Box 7: Shaking hands for river restoration

> Reservoirs (hydropower generation) modify flood frequency and magnitude

> Proliferation of macrophytes (aquatic plants)

> > Environmental impact (landscape, navigation)

> > Also financial (obstruct water intakes, cleaned mechanically –costly)

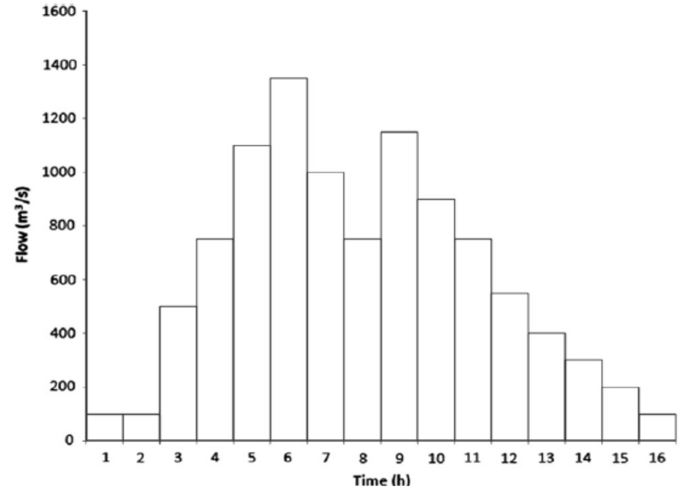
> Reservoirs now used to reproduce the floods of the past (in autumn & spring)

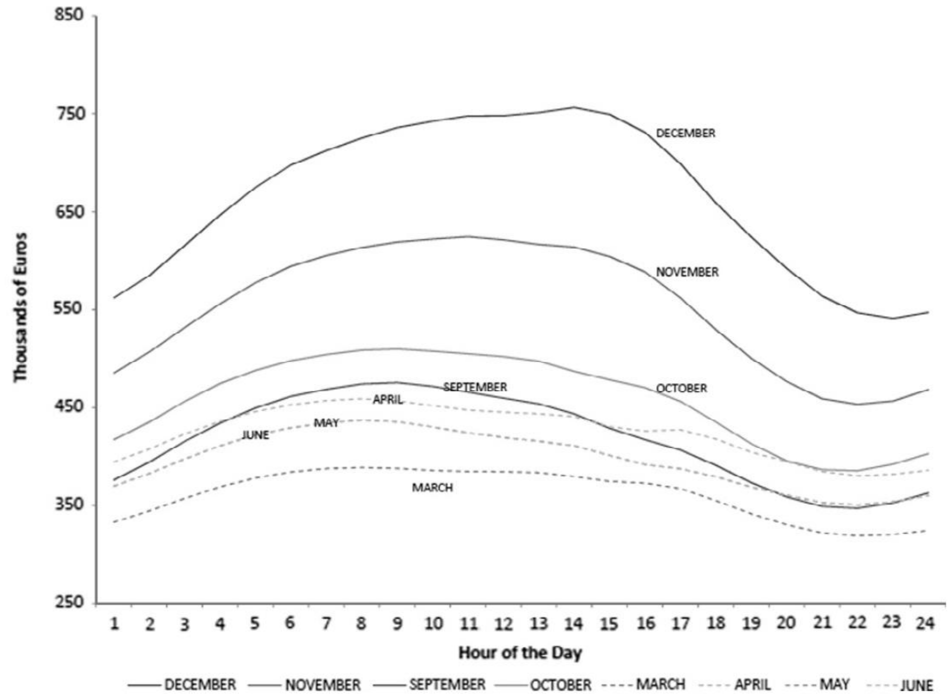
> > 95% macrophyte removal rate

> > Costs: 109 000 €/year (daily revenue: 250 000€) – cheaper than mechanical removal

> **Voluntarily accepted by the operator**

> > Enhances its social responsibility strategy





12. Concluding remarks

> Economic instruments complement supply policies
  > Both are preconditions for a successful policy mix
> Putting all together –be aware of:
  > Institutional setup – the peril of transaction costs
  > Policy mix
  > Sequencing and spillovers
> And remember: there are **no silver bullets**
  > You better learn from other experiences…
  > …but it is the context what ultimately determines the solution

Thanks for your attention

Annex

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The Jevons' Paradox (I)

- Water use (*W*) reacts to improvements in the irrigation efficiency (*E*) in three ways:

Effect over W

  - Less water required to obtain the same products as before (*W* becomes closer to effective water, EW) -
  - The cost of applying water (*c(E)*) with more sophisticated irrigation devices is more expensive (*c'(E)>0*). This increases the water application cost and reduces water use -
  - Water becomes more productive and farmers will probably be willing to use more water +

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The Jevons' Paradox (II)

- The answer depends on the sign of $\frac{\partial W}{\partial E}$
- Given a constant water price: $\frac{\partial P}{\partial W} dW + \frac{\partial P}{\partial E} dE = 0$ then $\frac{dW}{dE} = -\frac{\partial P / \partial E}{\partial P / \partial W}$
- And differentiating the water demand function $(P = f(EW)E - c(E))$:

$$\frac{dW}{dE} = -\left(\frac{W}{E} + \frac{f(EW)}{f'(EW)E^2} - \frac{c'(E)}{f'(EW)E^2}\right)$$

- Multiplying both sides by $\frac{E}{W}$:

$$\epsilon_{W,E} = -1 - \frac{1}{\epsilon_{f,E}} + \left(\frac{\epsilon_{c,E}}{\epsilon_{f,E}}\right)\left(\frac{c(E)}{P + c(E)}\right)$$

- Where:
  - $\epsilon_{W,E}$ is the efficiency elasticity of water demand:

$$\epsilon_{W,E} = \frac{dW}{dE}\frac{E}{W}$$

  - $\epsilon_{f,E}$ is the efficiency elasticity of *f (EW)*:

$$\epsilon_{f,E} = \frac{\partial f(EW)}{\partial E}\frac{E}{f} = \frac{f'(EW)}{f(EW)} EW < 0$$

  - $\epsilon_{c,E}$ is the efficiency elasticity of c (E):

$$\epsilon_{c,E} = \frac{\partial c(E)}{\partial E}\frac{E}{c(E)} = c'(E)\frac{E}{c(E)} > 0$$

The Jevons' Paradox (III)