Managing water stress in water-rich contexts

Lessons from the summer 2003 event in the Po basin

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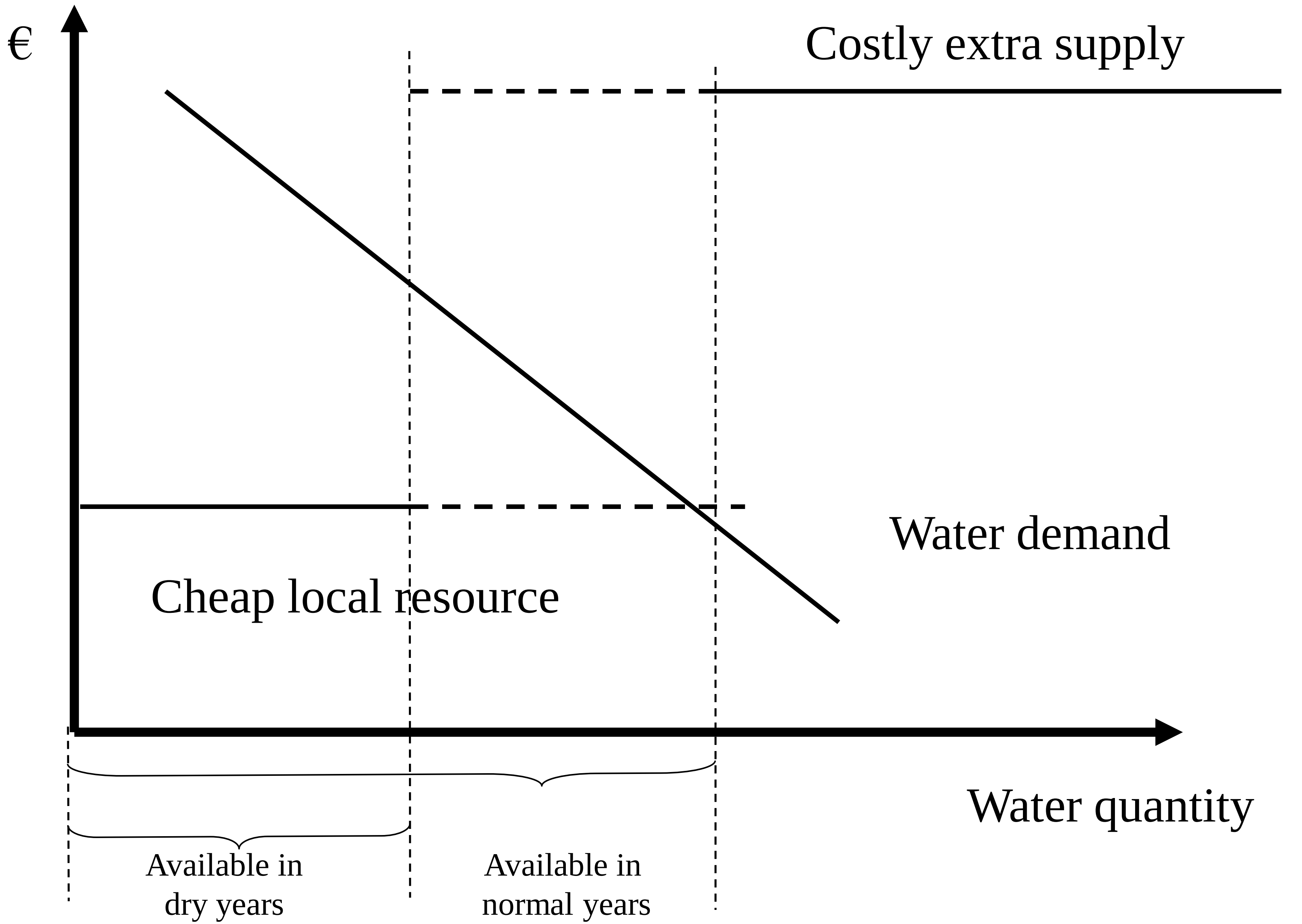
An economic understanding of water stress

- Water stress $\neq$ water scarcity
  - Mis-match between supply and demand
  - May occur in water-rich contexts if demand is high and not easy to manage in the short run
- Asymmetric situation …
  - If water is scarce and difficult to mobilize, the high cost encourages a water-efficient model (high productivity of water)
  - If water is abundant and easy to mobilize, the low cost encourages a water-inefficient model (low productivity of water)
  - Since productivity cannot be enhanced at once, an unpredicted shortage faces a very rigid demand
  - If unpredicted shortages are rare enough the trade-off between (i) investing for increasing productivity of water and (ii) accept the losses as a stochastic event (ev. develop insurance against risk) is not straightforward
- … leads to different outcomes and problems in case a drought occurs
  - The system has already invested for improving water efficiency; elasticity of response to economic instruments higher
  - In water-rich contexts, demand is far less elastic in the short run; even a moderate seasonal drought can cause problems

Water stress: the policy dilemma



Implications of the dilemma

- Difficult to expand the infrastructure
  - Expansion of supply not affordable nor economically efficient
  - Expansion feasible but requires new institutional developments (eg for delegating management to professional systems)
  - Conflicts about the new governance of management systems
- Unsustainable to maintain the status quo
  - Status quo encourages a dissipative use of available resources (unless an effective regulation of all impacts is provided)
  - Conflict among users

Alternative strategies - I

- Expand supply ⇔ doing more with more raw water
  - very costly, most of the times inefficient
  - Subsidizes also uses that do not need to be subsidized
  - Usually not affordable if FCR (and not even for the state)
  - requires that other communities are affected and forced to share problems with the water-stressed one
- Increase productivity ⇔ doing more w/ same raw water
  - Eg reduce leakage, wastewater reuse, adopt water saving appliances, treatment of polluted water
  - saving water ≠ saving money (it actually costs a lot of money)
  - how will this extra cost be shared? need to ensure that low-value uses are not excluded and extra cost remains affordable
  - need for public subsidies at least in the initial phase
  - Requires professional managing systems ⇔ delegation + regulation + confidence

Alternative strategies - II

- Segmentation of uses
  - Force new users to adopt more costly systems in order to reserve cheap water for "incumbents" and "politically preferred" ones
  - Eg: force touristic resorts and industry to build desalinators; force urban supply to buy long-distance supplies and leave local resources to agriculture and hydropower; force new developers to pay higher conection fees
  - Economically inefficient
  - Affordable only for high value uses
  - Not necessarily equitable (incumbents are preferred to new uses), but often acceptable as a second-best solution
  - Does not guarantee that pressure factors are addressed (except for high-value uses)
- Phase-out some uses: doing less with same raw water
  - "irrigar los turistas vale mas que irrigar los campos"
  - socially or politically difficult; enforcement problems if based on C&C
  - drivers of demand should be addressed as well (eg pressure for urban development)
  - compensation can alleviate political opposition

The Po basin

- Po versus Europe
  - Water-rich basin
    - Precipitation high but very irregular (mediterranean climate)
    - Profile of outflows more regular (summer flow = snow melting + lakes)
  - High per-capita availability
  - Very high per capita use:
  - Very high water intensity
- Breakdown of uses
  - More than ¾ of consumptive uses: irrigation (concentrated between spring and early summer)
  - Infrastructure developed since middle age; low cost, low price (gravity, open-air canals, infiltration, very high losses etc)
  - Intense hydropower + cooling of thermopower
  - Summer flows are almost entirely used up

Water use in the Po basin

	Total quantity (hm^3/year)	Surface	Groundwater
Public water supply	2.500	20%	80%
Industrial (excluding energy)	1.537	20%	80%
Irrigation	16.500	83%	17%
Total consumptive uses	20.537	63%	37%
Energy	-	100%	0%

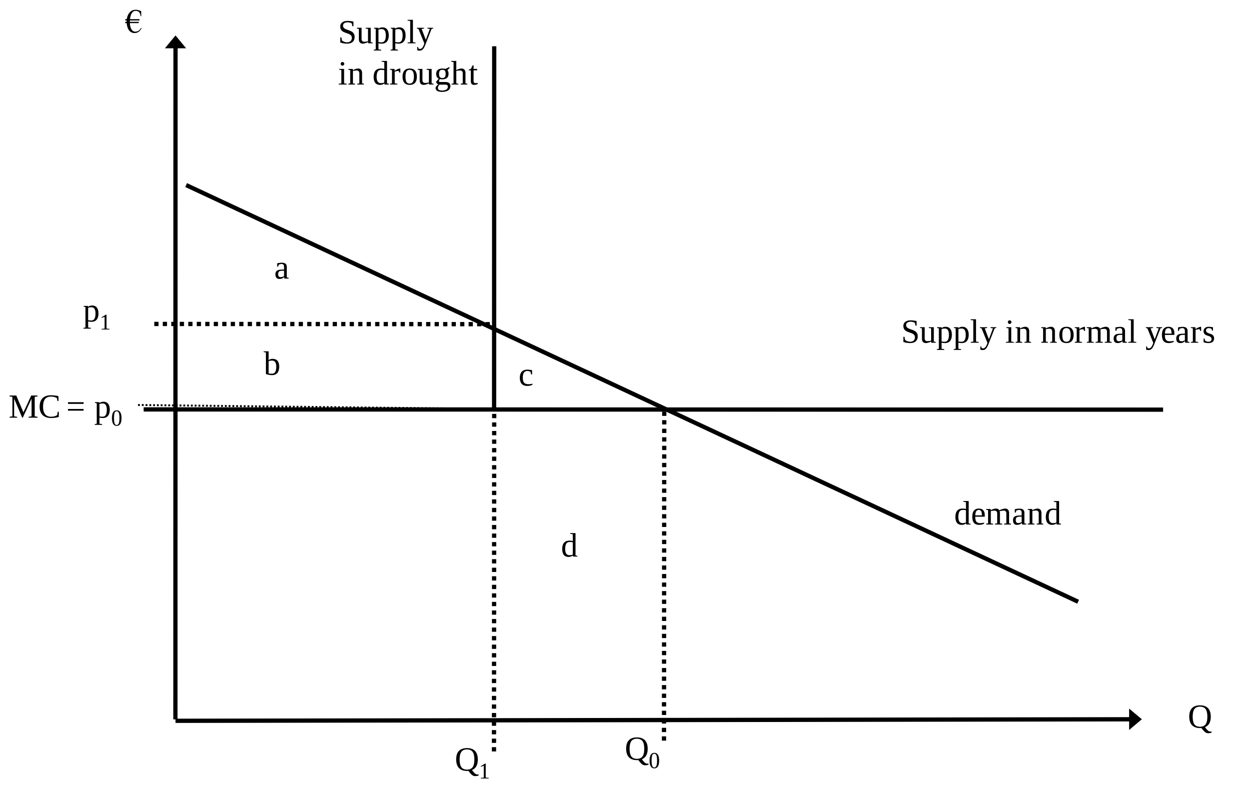
Water stress indicators

	Availability		Use	
	m^3/kmq	m^3/ab	m^3/ab	WEI
Po Basin	775	3.235	1.206	37%
Italy		1.659	730	44%
France		3.192	560	18%
Germany		2.274	430	19%
UK		2.670	250	9%
Spain		2.704	900	33%
Portugal		7.186	860	12%
Netherlands		5.619	560	10%
Europe	317	4.844	550	11%

The 2003 event

- The event
  - Extraordinary lower-than-average drought induced early start of irrigation ⇔ lakes below limit early in season could not support downstream flow
  - Pumping from groundwater for compensating lack of rainwater ⇔ low flow
  - Summer flow entirely used up causing problems to downstream power plants (out of service for some time, causing rotating interruptions and planned disconnections)
- The management of emergency …
  - Oblige agriculture to reduce abstractions 10% below the actual level
  - Oblige hydropower facilities upstream to release as much water as they could until reservoirs are emptied
  - Result: flow increased a little above the critical level
- and the final outcomes
  - Loss of agricultural production + increase of commodity prices
  - Disconnection of some consumers of electricity during the out-of-service
  - Soon after the end of the emergency plan, precipitations started again and allowed to fill up reservoirs again ⇔ no damage suffered by hydropower producers

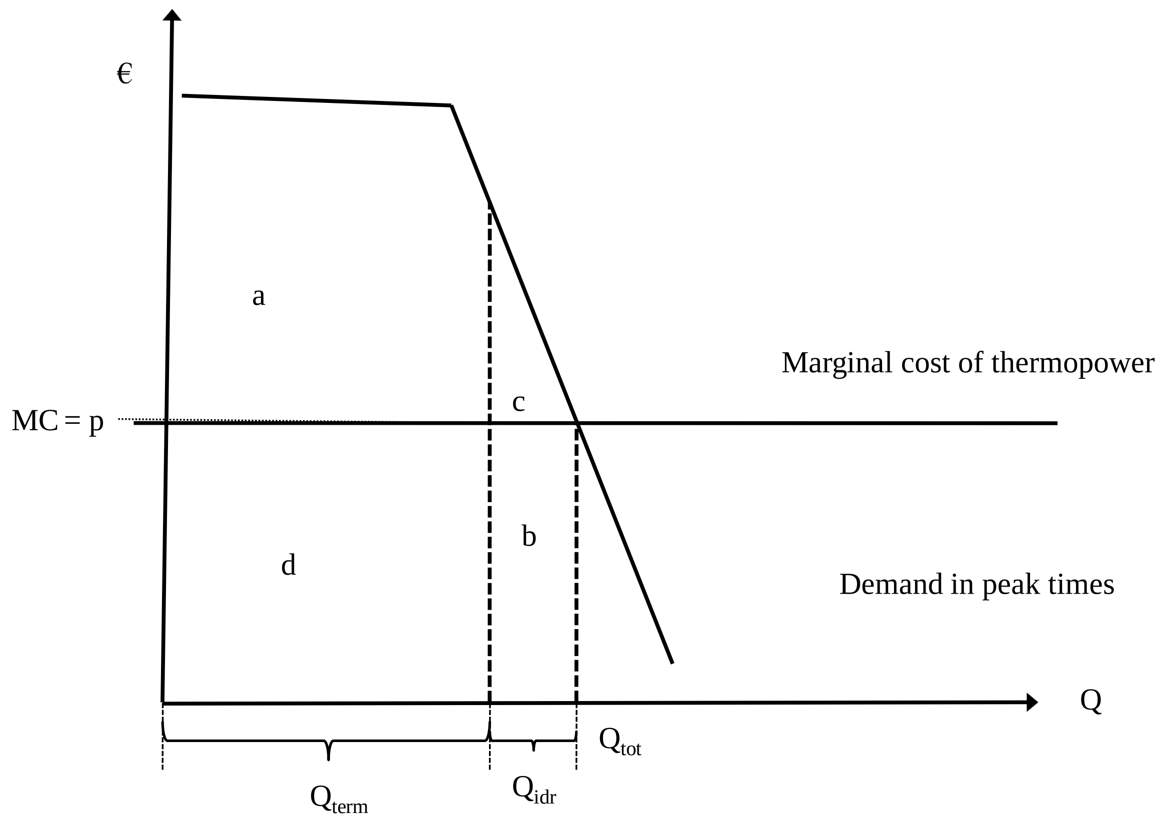
The agricultural sector



Hypotheses:

- In normal years, $Q = Q_0$, $p = MC = p_0$
- The cost (MC) is sustained before the irrigation season
- In case water is not available, producers lose the corresponding cost (area d)
- Quantity becomes Q1 and p = p1; those who manage to save the crop have an extra gain (area b)

The energy sector



Hypotheses:
- normal situation: $Q = Q_{tot}$; $p = MC$ (of the high-cost source, namely thermopower)
- MC of hydropower = 0; hydropower rent = area b
- In case hydropower cannot produce: (i) can be substituted by thermopower ($Q = Q_{tot}$, all supplied by thermopower; (ii) some users have to be disconnected ($Q = Q_{term}$)

Methodology of the analysis

- Agriculture:
  - Production loss: Q_0 => Q_1
  - Price increase: p_0 => p_1
  - Cost already sunk = MC = p_0
  - Loss of production (damage for farmers): area d
  - Loss of consumer surplus: area b+c
  - Effect of price increase for farmers who did not lose crop: area b
- Electricity:
  - Loss of hydropower rent: area b
  - Loss of consumer surplus: area c

Costs of the drought: baseline

Farmers		- 628	
	Loss of production		749
	Price increase		- 1.377
Energy producers		-	-
Consumers		1.516	
	Welfare loss - agriculture		91
	Price increase - agriculture		1.377
	Welfare loss - electricity for industry		22
	Welfare loss - diffused		26
Total		888	

- Baseline scenario: what actually took place
  - Policy: -d10% for agriculture + max release from reservoirs
  - Quantities arising from implementation of above measures left in rivers as enhanced flow

Scenarios

- Agriculture
  - Baseline: -d10%
  - Scenario 1: no reduction in irrigation abstractions
  - Scenario 2: no recuction + allocation to agriculture of extra flows released by reservoirs
  - Scenario 3: baseline + reallocation of available water giving priority to high-value crops
  - Scenario 4: baseline + change of crops
  - Scenario 5: baseline + change of crops + reallocation of water giving priority to high-value crops
- Electricity
  - Baseline – No deficit
  - Deficit compensated by thermopower
  - Deficit uncompensated (disconnection)

Alternative scenarios

Agriculture		Producers	Consumers	Total
	Baseline scenario (d10%)	749	91	840
	No d10%	671	91	762
	No d10% + destination to agriculture of extra release	649	91	740
	Reallocation among crops	327	91	418
	Change of crops	189	91	280
	Change of crops + reallocation	170	91	261
Electricity				
	Baseline (no deficit)	-	48	48
	Deficit compensated by thermopower	86	48	133
	Deficit compensated by disconnections		570 – 770	570 – 770

Implications for policy – short run

- In the short run (when emergency occurs) agriculture has priority
  - Agriculture very vulnerable, but can more than compensate the damage via price increase
  - Useful to create inter-sectoral compensation schemes in order to compensate farmers who lost the crop
  - Consumers are the net loser
  - In emergency, the value of irrigation is much higher than the potential loss to hydropower (provided that blackouts are avoided)
- But it is better not to be in an emergency!
  - Tradeable permits (reallocation of available water giving priority to high-value crops) would reduce damage over 50%
  - Reallocation of crops by reducing incentives to COP would reduce damage by 80%

Implications for policy – long run

- No evidence of a possible gain from investment in water saving techniques
  - Saving water is more costly than phasing-out uses (temporarily or permanently depending on the frequency of "droughts")
  - Marginal value of water for low-value crops is around 0,15 €/m3, while the marginal cost is 0,5 – 1 €/m3 according to circumstances
  - Before investing in new irrigation projects, better understand the economics of irrigation water use and consider more flexible instruments
- Energy
  - The additional cost implied by excess (thermopower) capacity aimed at compensating eventual failures of hydropower are reasonable compared with the potential damage from a blackout
  - Given the interaction between hydropower (upstream) and cooling (downstream), guaranteeing flows downstream has priority