PUBLIC SOLUTIONS: MARKET-BASED INSTRUMENTS IN PRACTICE

LESSON OBJECTIVES

01

Evaluate US SO_2 allowance trading program

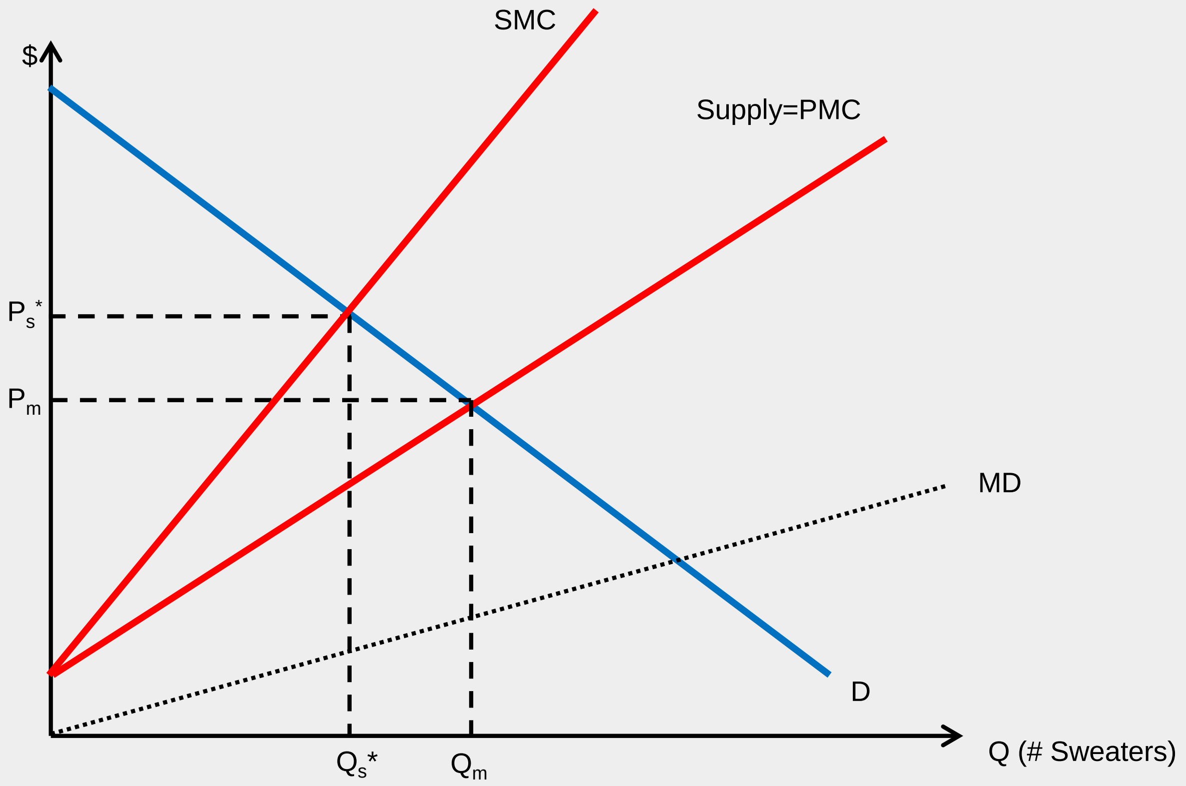
02

Evaluate New Zealand ITQ program

03

Evaluate US municipal water pricing

EFFICIENT VS MARKET EQUILIBRIUM



HOW CAN WE ADDRESS INEFFICIENT OUTCOMES FROM EXTERNALITIES?

Private solutions:

- Coase Theorem
- Social Pressure

Public solutions:

- Standards
- Taxes
- Permits

MARKET-BASED INSTRUMENTS IN PRACTICE

We've evaluated each policy alternative from a theoretical perspective based on its

- Efficiency/cost-effectiveness
- Implementation strengths and weaknesses

Now we will look at how these policies have performed in practice.

We will analyze three policies implemented by governments to address market failure from environmental problems.

1. US SO_2 allowance trading program
2. New Zealand ITQ program
3. US municipal water pricing

We will analyze their successes (or failures) on the basis of their performance (in achieving goal and efficiency) as well as their distributional effects.

01

U.S. SULFUR DIOXIDE MARKET

A BRIEF HISTORY...

We will begin in 1970…

President Nixon signed an executive order establishing the US EPA.

- Response to public concerns about impact of human activity on the environment

Congress passed CAA of 1970

- Followed previous CAAs beginning in 1955 that attempted to address air quality
- Previously, states had their own regulations to address air quality
- CAA of 1970 attempted to unify these state regulations under federal mandate
- Has since been amended in 1977 and 1990

A BRIEF HISTORY…

CAA of 1970 established the National Ambient Air Quality Standards (NAAQS)

NAAQS required EPA to set maximum allowable concentrations of 6 criteria pollutants based on human-health and non-health impacts:

- Sulfur Dioxide (acid rain)
- Nitrogen Oxide (ozone formation)
- Particulate Matter (irritant)
- Carbon Monoxide
- Ozone
- Lead (IQ for children; Angina for adults)

A BRIEF HISTORY…

Throughout the 1980s, there was growing concern over acid rain

Acid rain is caused by SO_2

- Primarily generated by power plants in the Midwest
- A criteria pollutant under the NAAQS

Power plants had primarily been built in 1950s and 1960s and the CAA from the 1970s only covered *new* sources of pollutants

- Grandfathered old power plants (vintage differentiated regulation)

This created a problem:

- Idea was that old plants would retire and new plants would have to follow regulation
- But what happens to the incentive to replace old plants?

PROBLEM

Growing acid rain problem

Source plants were not being retired as expected

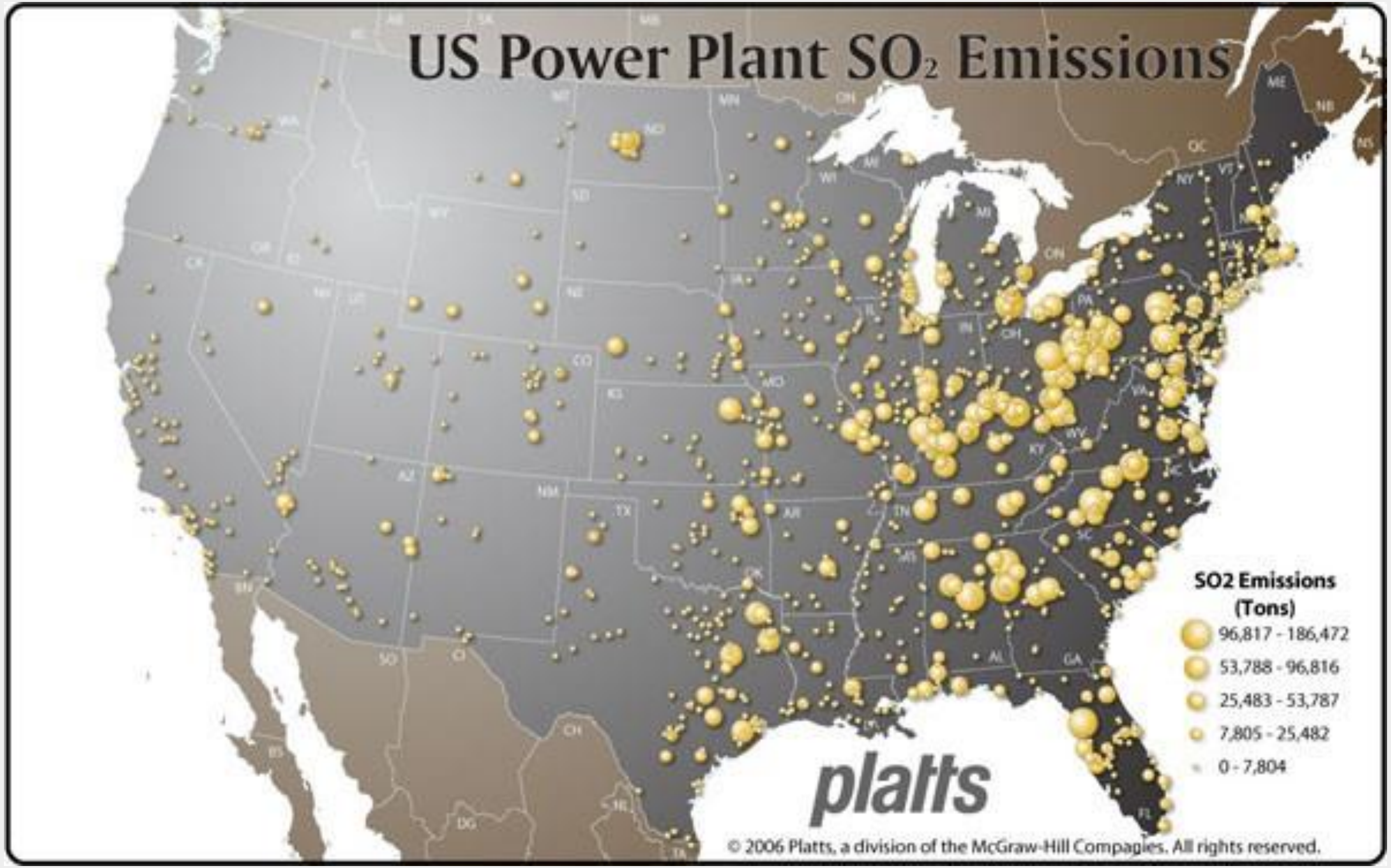
How to regulate these old plants?

SOLUTION?

Previously, CAA used a command-and-control approach

- Will these be efficient?

Growing movement for emissions trading and leveraging market-based principles in the academic and policy circles in late 1980s


US Power Plant SO2 Emissions
SO2 Emissions
(Tons)
96,817 - 186,472
53,788 - 96,816
25,483 - 53,787
7,805 - 25,482
0 - 7,804
platts
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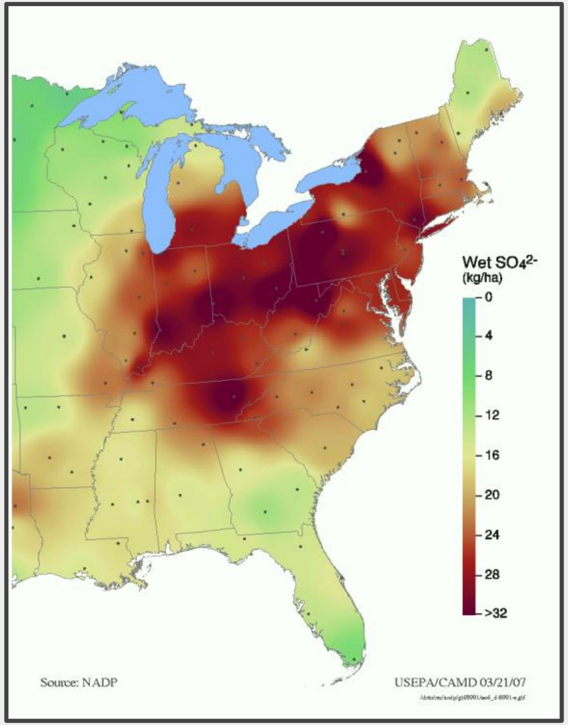
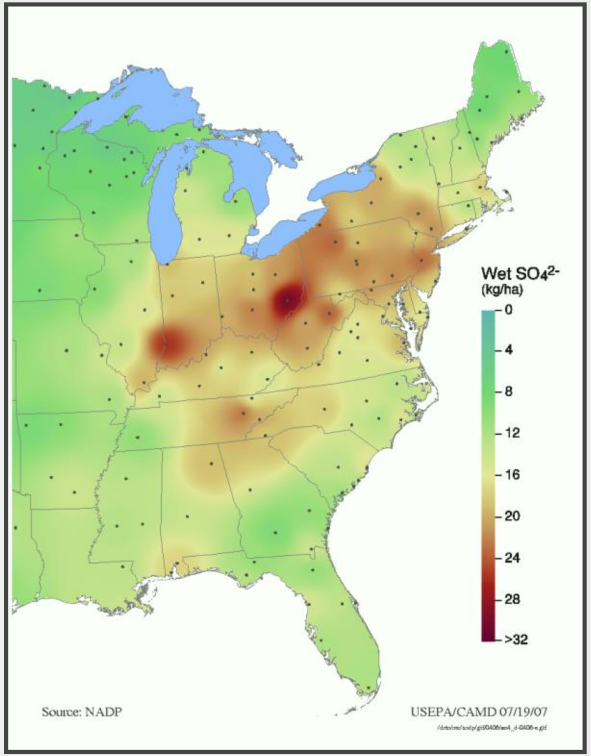
ACID RAIN


Wet SO4²⁻
(kg/ha)
0
4
8
12
16
20
24
28
>32
Source: NADP
USEPA/CAMD 03/21/07


Wet SO4²⁻
(kg/ha)
0
4
8
12
16
20
24
28
>32
Source: NADP
USEPA/CAMD 07/19/07

CLEAN AIR ACT AMENDMENT (CAAA) OF 1990

Result of alliance between president George H. W. Bush and EDF

Proposal set goal of reducing SO_2 emissions by 10 million tons per year from 1980 levels by 2000

First time federal authority over emissions from plants built before 1971

Allowed for first major cap-and-trade (permit) market

- Phase I: (1995-1999) included only the "big dirties" (110 of dirtiest plants).
  - Total pollution capped at 6.3 million tons of SO_2 per year
- Phase II: (2000-) almost all plants come into the market
  - Total pollution capped at 9 million tons of SO_2 per year
- Allowed banking of allowances
  - Permit handed out in 1996 could be used that year or saved for later use

HOW DID THE PERMIT MARKET PERFORM?

PERFORMANCE OF SO2 MARKET

Let's examine the performance of the SO_2 allowance trading program on two dimensions:

1. Did it achieve its goal?
2. Was it efficient?

Did it achieve its goal?

Following the start of the program, markets for permits began to appear

- Brokerage companies competed to track and arrange trades
- Forward markets, loans, swaps, and other financial derivatives appeared

In expectation of a tightening cap, electric utilities abated *more* than they were required

- Abated roughly 2 million tons/yr above requirement (~1/3 of total allocations)

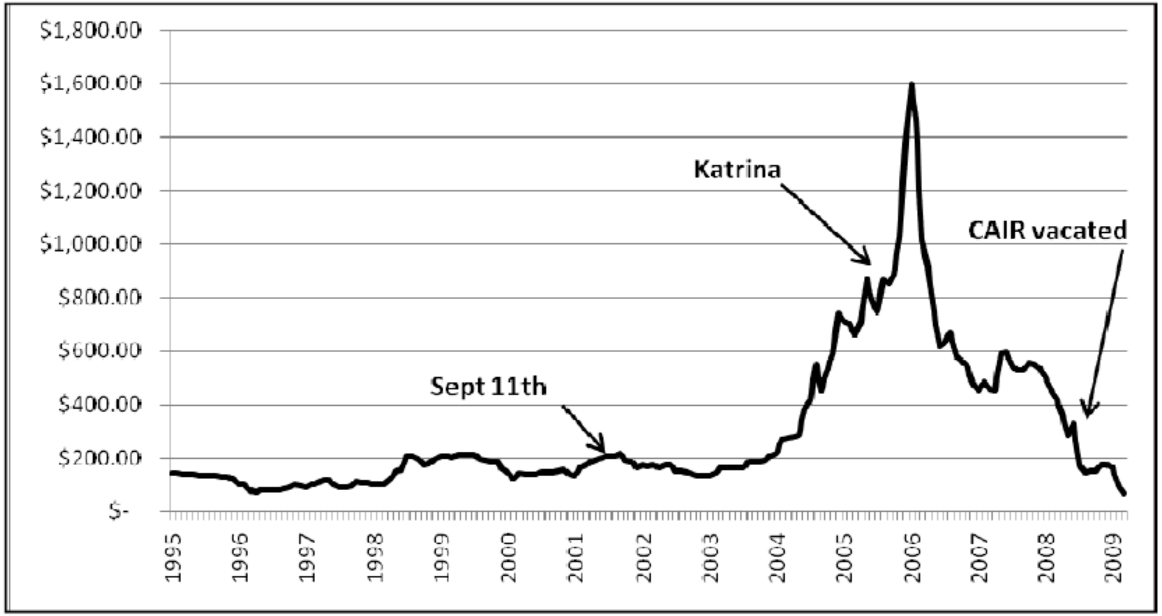
By 2008, 250,000 tons of emissions traded in the market with a price of $325 per ton

Costs of abatement were lower than expected, leading to a tightening of the cap in 2005

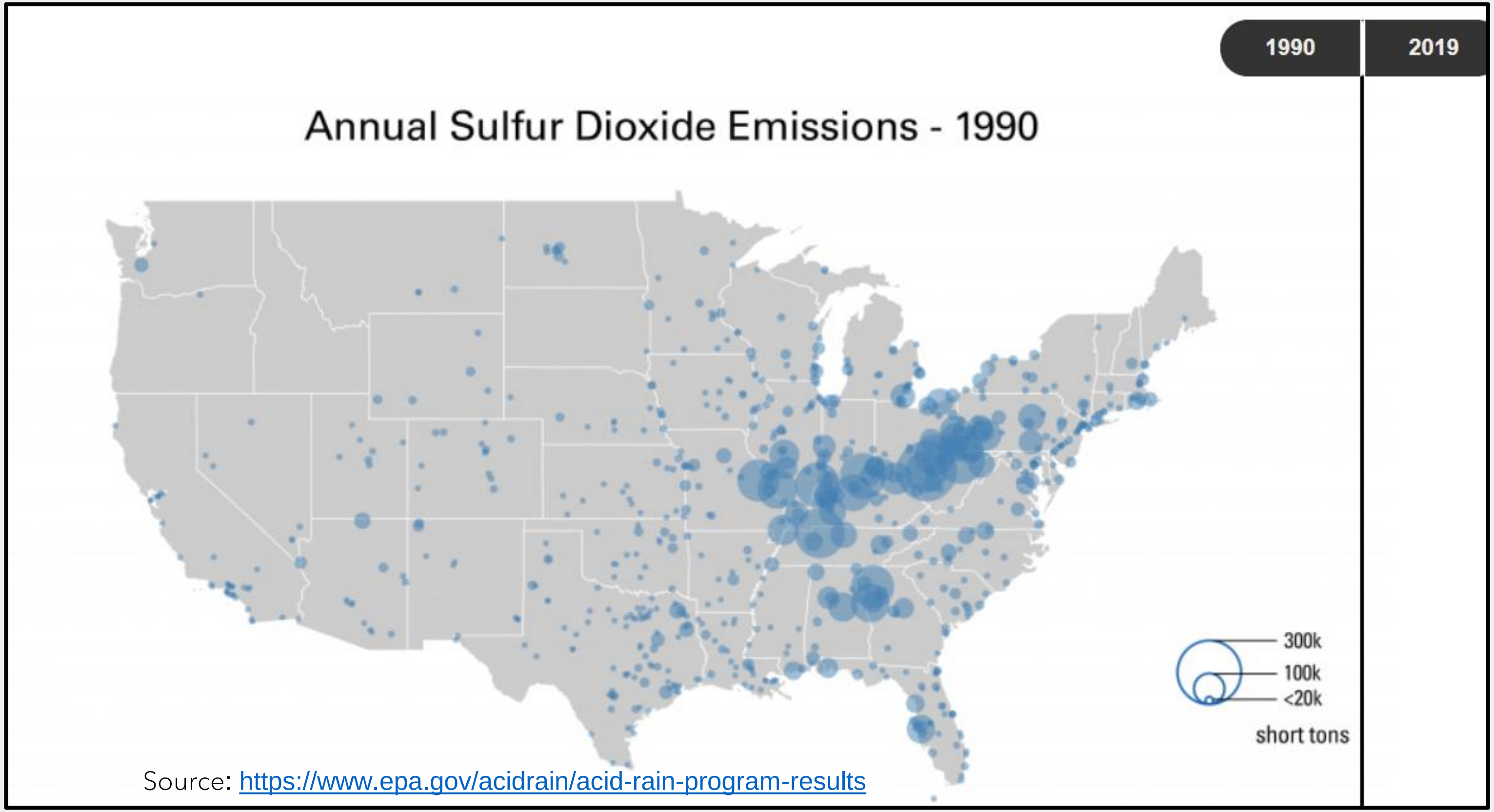
Further revisions occurred under President Obama, eventually leading to the market becoming defunct

Overall, it appears that the SO_2 program was successful in achieving the goal!

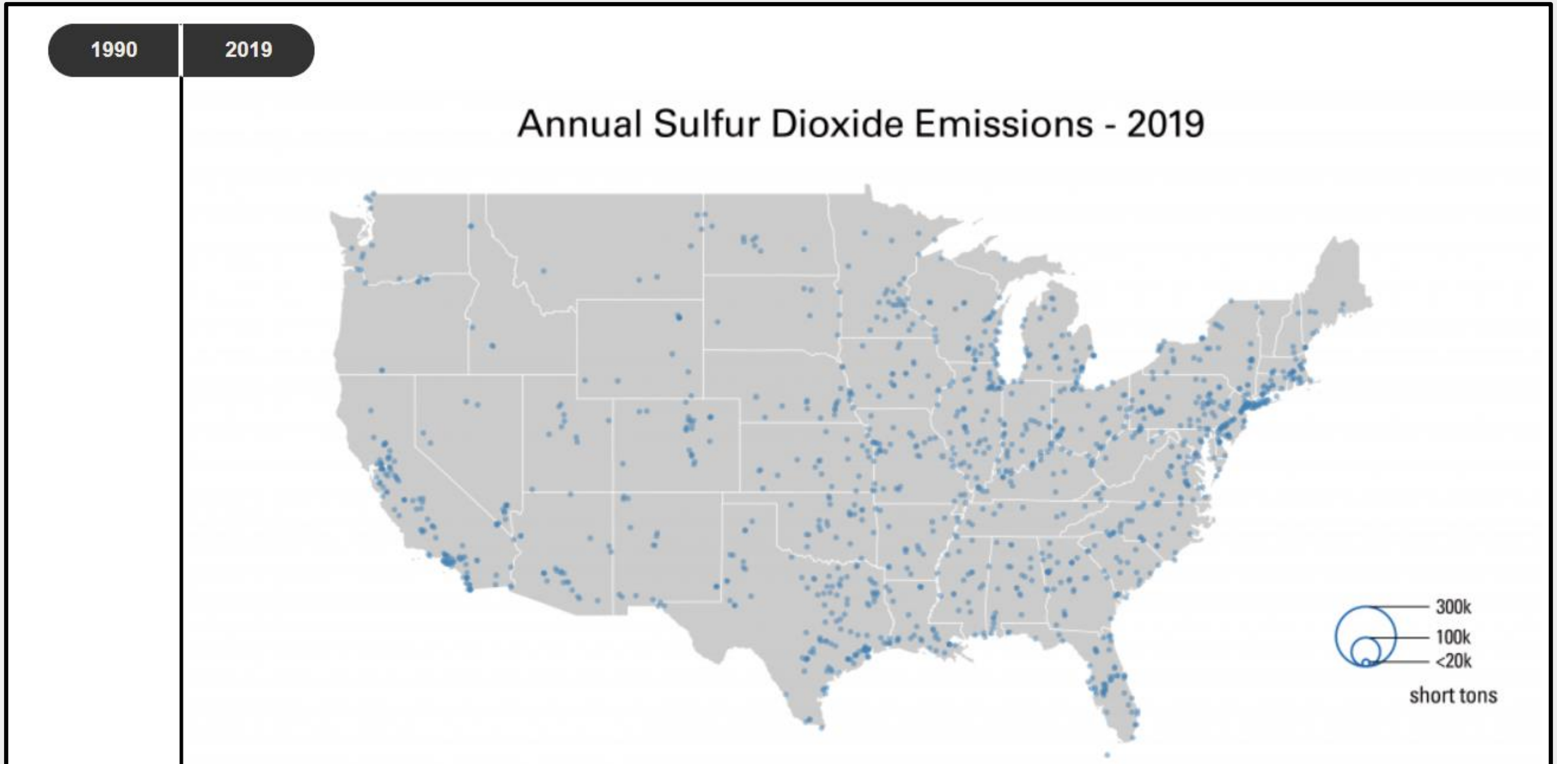
Figure 1. Monthly SO_2 Emissions Allowance Prices



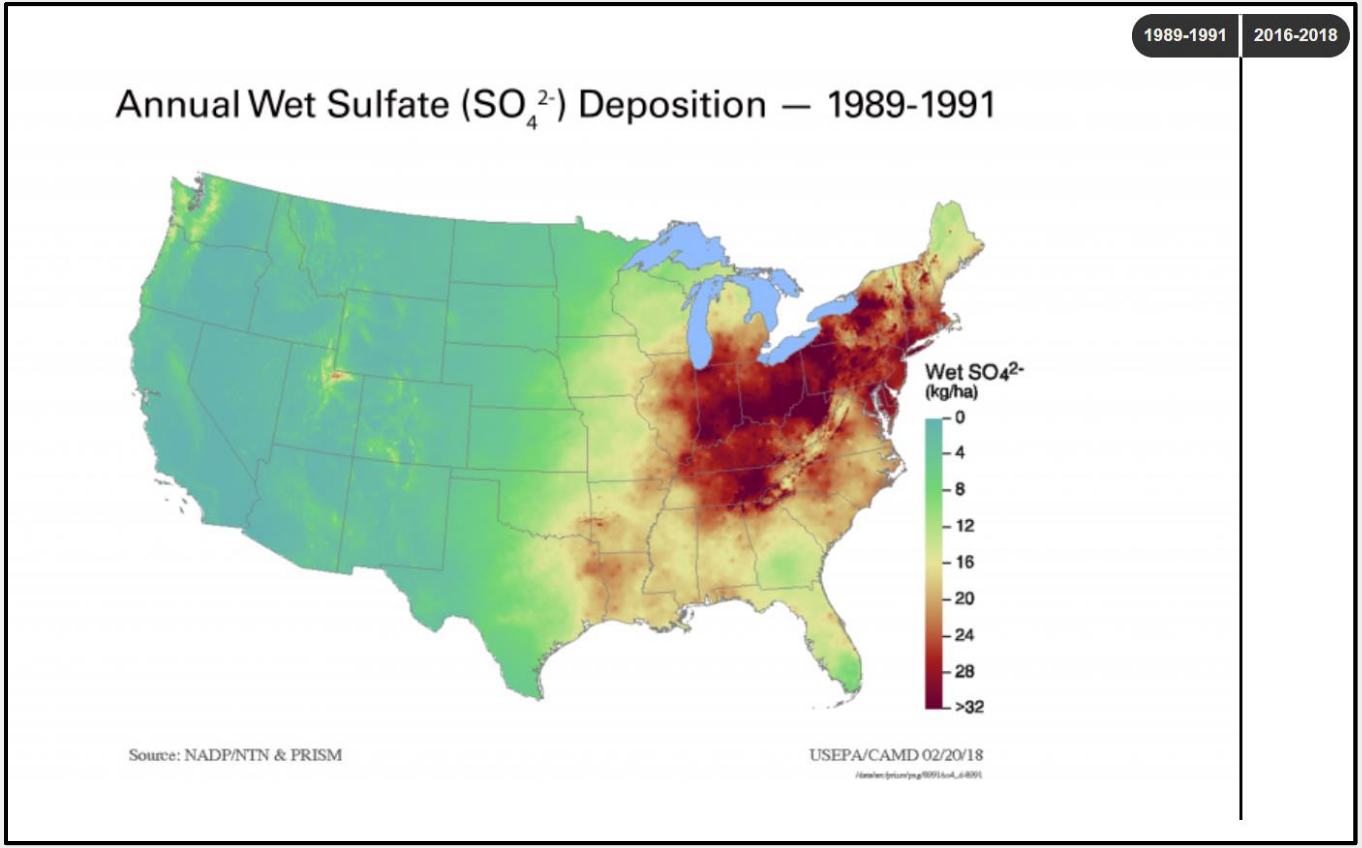
Source: Data provided by Gary Hart of ICAP Energy.

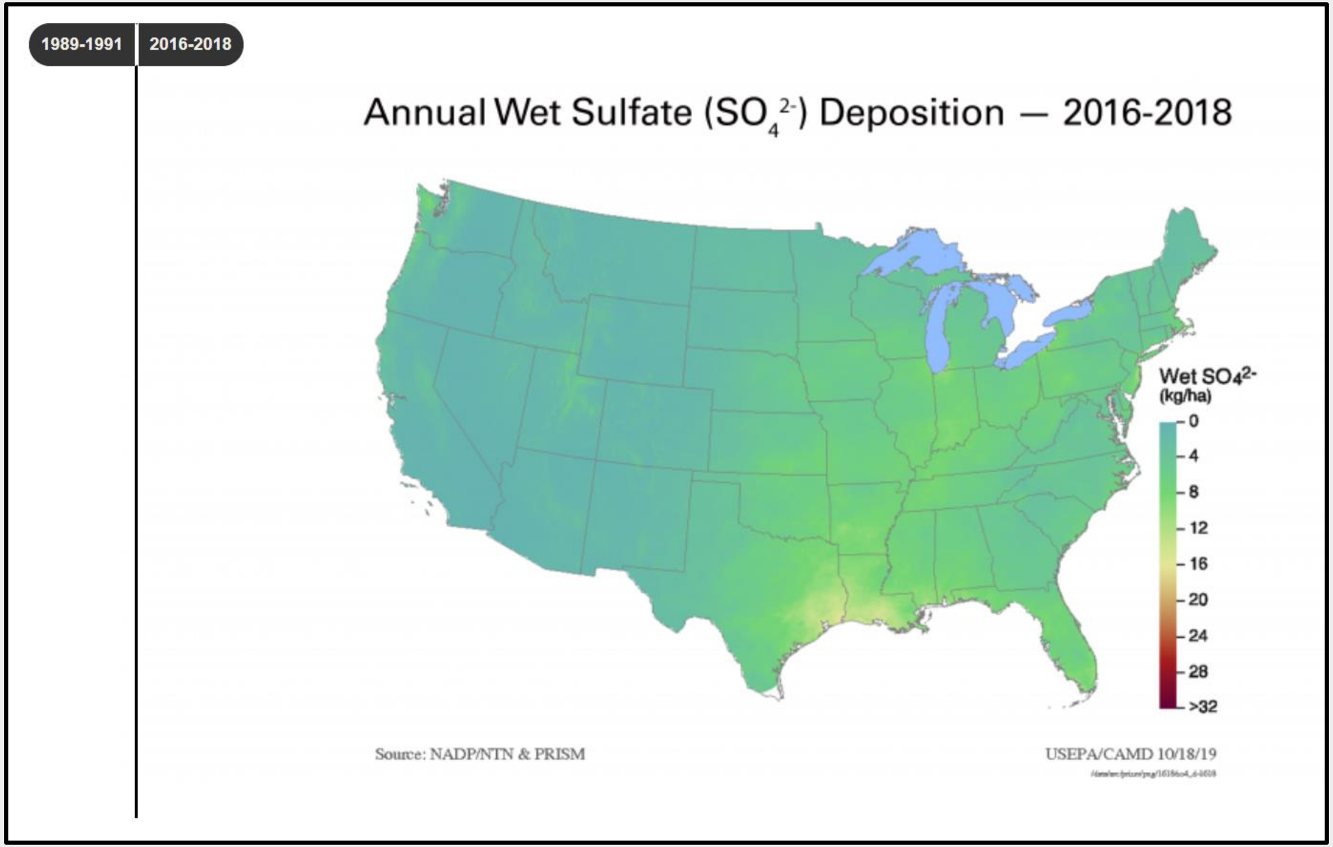


Source: https://www.epa.gov/acidrain/acid-rain-program-results



Source: https://www.epa.gov/acidrain/acid-rain-program-results


1989-1991
2016-2018
Annual Wet Sulfate (SO_4^{2-}) Deposition — 1989-1991
Wet SO_4^{2-} (kg/ha)
0
4
8
12
16
20
24
28
>32
Source: NADP/NTN & PRISM
USEPA/CAMD 02/20/18


1989-1991
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Wet SO4^2-
(kg/ha)
0
4
8
12
16
20
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28
>32
Source: NADP/NTN & PRISM
USEPA/CAMD 10/18/19

WAS THE PROGRAM EFFICIENT?

Was the target correct?

SO_2 program was initially developed due to ecological concerns
Economic analyses have found that more than 85% of the benefits are health related

- Reduced sickness and mortality

At a national level, the health benefits for the US are estimated at $3,300/ton
The costs are estimated to be around $270/ton.

Ecological benefits are found to be similar to estimated costs of the program

WAS THE PROGRAM EFFICIENT?

Was the program cost-effective?

How did the cap-and-trade policy perform relative to if an alternative policy had been implemented?

- Compare to a counterfactual (a hypothetical) scenario

Table 10.1
Estimated Costs of Various Alternative Policies to Achieve the Same Emission Reduction as Phase I of the 1990 Clean Air Act Amendments

Scenario	*Estimated annual cost (millions)*	*Cost difference from baseline (millions)*	*Cost increase*
Theoretical least-cost outcome	$315	–$432	–57%
Baseline cap-and-trade program (actual policy)	$747	—	—
Uniform emission rate standard	$900	$153	20%
Technology standard	$2,555	$1,808	242%

Source: Estimates taken from Nathaniel O. Keohane, "Cost Savings from Allowance Trading in the 1990 Clean Air Act," in Charles E. Kolstad and Jody Freeman, eds., *Moving to Markets in Environmental Regulation: Lessons from Twenty Years of Experience* (New York: Oxford University Press, 2007), 194–229.

Compare counterfactuals to actual costs

What costs could have been with perfect foresight and cost-minimizing decisions

What costs could have been with a uniform performance standard

What costs could have been with a uniform tech standard

WHAT ABOUT GOVERNMENT COSTS?

Benefits estimated to outweigh private compliance costs

What about monitoring and enforcement costs

Government costs were negligible compared to compliance costs

- Orders of magnitude smaller

Firms were fined $2,000/ton (well above permit price) for noncompliance

- 100% compliance found
- Likely due to high price of non-compliance and truing-up period

DISTRIBUTIONAL OUTCOMES

Allocation of allowances

- Government revenues from auctioning permits can be used to offset distortionary taxes
- Approximate revenues could have be estimated using the permit price times the total allowance

  $135 x 6.3 million = $850 million (~0.13% income tax revenues in 1996)
- SO_2 permits were freely allocated

Where pollution ended up

- SO_2 is not a uniformly mixing pollutant
- Emissions from midwestern plants travel downwind to Northeastern urban areas (high external damages)
- Emissions from mid-atlantic plants travel out to sea (low external damages)
- Largest reductions occurred at midwestern plants (Ohio, Indiana, etc.)
- Net gains could have been larger with a *differentiated* trading program based on marginal damages

02

NEW ZEALAND IFQ PROGRAM

OPEN ACCESS FISHERY PROBLEM

Open access fishery will not internalize the scarcity cost associated with harvesting a renewable resource

- Leads to overfishing (economic and possibly biological)
- Inefficient outcome!

What policies could be used to achieve the efficient sustainable yield?

D) COMMAND AND CONTROL

Limit effort by

- restricting the number of hours they can fish
- type of boats they can use
- type of gear they can use
- limit the areas and seasons they are allowed to fish the waters
- limit the number of fish allowed to be caught

- Has same drawbacks as C&C from earlier: not likely to be the least cost way to achieve goal.

2) TAXES:

Could tax fishing effort

- Tax boats
- Tax fish caught

Raises the cost of fishing

If increase in cost is equal to scarcity cost, result will be efficient sustainable yield.

This would be efficient, but fishers wouldn't like this alternative because it is directly more expensive.

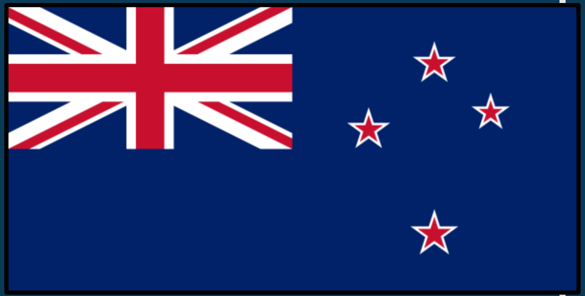
3) Individual Transferable Quotas (ITQs)

Completely analagous to the marketable pollution permit.

A "properly designed" quota has the following characteristics:

1) Quota entitles holder to catch a specified weight of fish of a specified type of fish.
2) The total amount of fish authorized by the sum of the quotas held by fishers must equal the efficient catch for the fishery (government has to get the efficient catch level right)
3) Fishers are able to freely trade the quotas

NEW ZEALAND IFQ PROGRAM



In 1986 New Zealand began the world's largest market for tradable Individual Fishing Quotas (IFQs)

Each year the government sets a total allowable catch (TAC)
- Based on biologically determined maximum sustainable yield
- Fishers taxed on their permits

Quotas are then distributed freely based on historical catch.

Quotas cannot be traded across regions, species, or years
- Initially covered 26 species and by mid-1990s covered 85% of commercial catch within 200 miles of New Zealand

Costal waters are divided into separate management quota regions each with its own market for each species of fish

HOW DID THE IFQ PROGRAM PERFORM?

DID THE PROGRAM REDUCE OVERFISHING?

Program mandated large reduction in annual catch

- In 1986, TAC were ~1/4-3/4 of previous catches
- Varied by region and species

Analysis of 149 individuals stocks (defined by species and region) found:

- 13 were estimated to be smaller than the MSY stock by 1993
- 13 were at or above this level

TACs have been contracted over time for stocks below MSY

Performance is deemed largely successful (especially compared to collapse of fish stocks elsewhere around the world)

WAS THE PROGRAM COST-EFFECTIVE?

How did the program perform compared to counter-factual?

Recent study found 70% of quota owners had traded a permit

Market transactions were largest early in the program as the initial allocation was redistributed

- Provides evidence of increased efficiency!

Quota prices have risen at a rate of around 5-10% over the course of the program

- Consistent with expectation that value of fisheries rise with revitalization
- Higher rates observed in markets with higher initial reduction in TAC

DISTRIBUTIONAL OUTCOMES

A primary concern with IFQs is consolidation

- Quotas reduce number of fishers
- More profitable fishers enter and expand operations while less profitable contract or exit

From an efficiency perspective, this is great!

- Efficiency suggests that higher profitable fishers *should* displace lower profitable fishers

From an equity standpoint though, the implications are less clear

- Concerns that IFQs give an unfair advantage to large firms that can leverage economies of scale
- Cultural concerns

This concerns are a result of the tradable aspect of IFQs

- This trading provides revenues to those who choose to exit and sell their permits

Need to compare IFQ equity impacts to the alternative

ATTENDANCE ACTIVITY

With IFQs, there is concern about the equity between large and small firms.

How could the initial allocation of permits be used to mitigate equity concerns?

Would a change in the initial allocation of permits affect the efficiency of the IFQ?

HOW TO ADDRESS DISTRIBUTIONAL CONCERNS?

Can design IFQs to address or alleviate some of these concerns

Equity

- Can distribute high proportion of permits to small-scale fishers
- Initial distribution should not matter for efficiency

Consolidation

- Can set maximum quota holdings
- Will effect efficiency by reducing gains from trading

GOVERNMENT COSTS

Monitoring and enforcing fishing regulations are costly

- Gear restrictions require on-boat inspections
- Enforcement of fishing seasons and area restrictions requires regulators monitor fishing at sea

IFQs only require auditing at the sale of fish between boats and fish purchasers

- Costs are partly offset by tax on permits

ADDITIONAL CONCERNS

Fishers will respond strategically

- Price dumping – discard fish when prices are low
- High grading – discard lower-value quota species

Concerns about high grading and enforcement have fallen considerably

Bycatch problem

- IFQ may reduce bycatch problem by incentivizing measures to reduce bycatch to avoid need for more permits

03

MUNICIPAL WATER PRICING

WATER USE IN U.S.

Only 0.1% of earth's water is available for human consumption and terrestrial ecosystem functioning.

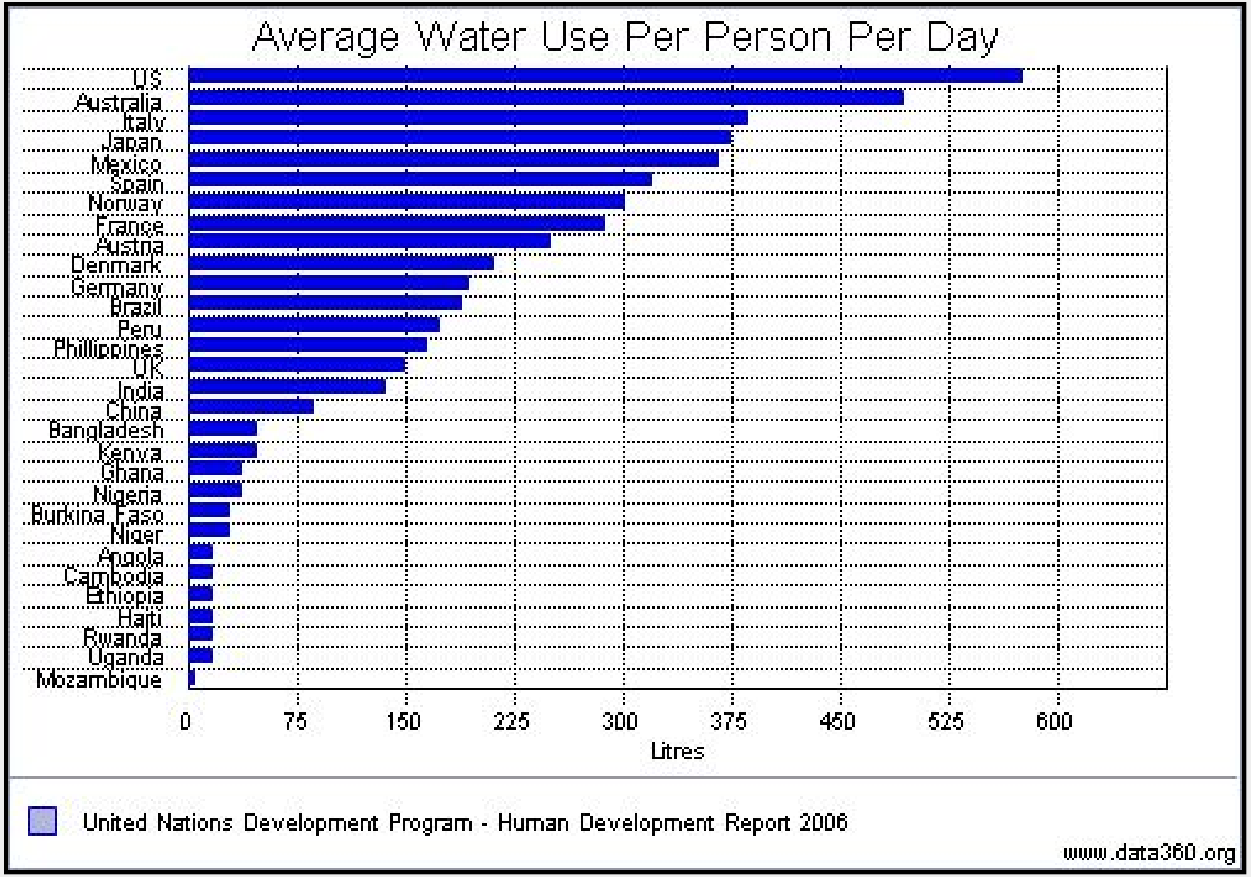
Some estimates are that this supply averages 10x demand, although that is a global average

- To see the problem with this statistic visit Scotland & Southwest US

Water supplies are both renewable (surface & ground) and nonrenewable (ground if recharge is slow/not at all)

Water scarcity occurs when demands>supply

Scarcity occurs even in "water-rich" regimes


Average Water Use Per Person Per Day
US
Australia
Italy
Japan
Mexico
Spain
Norway
France
Austria
Denmark
Germany
Brazil
Peru
Phillippines
UK
India
China
Bangladesh
Kenya
Ghana
Nigeria
Burkina Faso
Niger
Angola
Cambodia
Ethiopia
Haiti
Rwanda
Uganda
Mozambique
0
75
150
225
300
375
450
525
600
Litres
United Nations Development Program - Human Development Report 2006
www.data360.org

WATER SCARCITY: DROUGHT

"Drought" means a moisture deficit bad enough to have social, environmental, or economic effects.

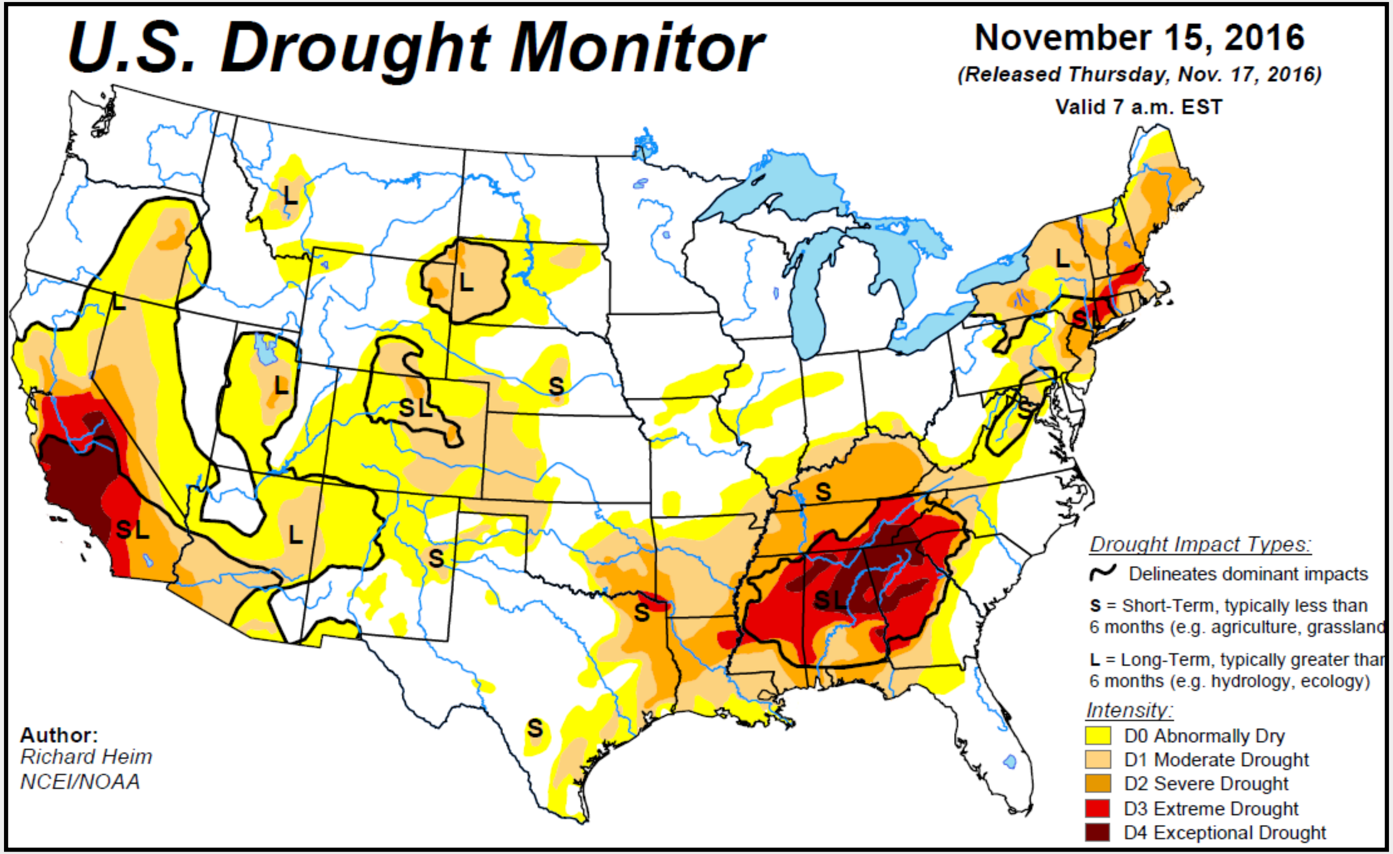
Yellow: Abnormally Dry
- Going into drought – short-term dryness slowing planting, growth of crops or pastures.
- Coming out of drought – some lingering water deficits; pastures or crops not fully recovered

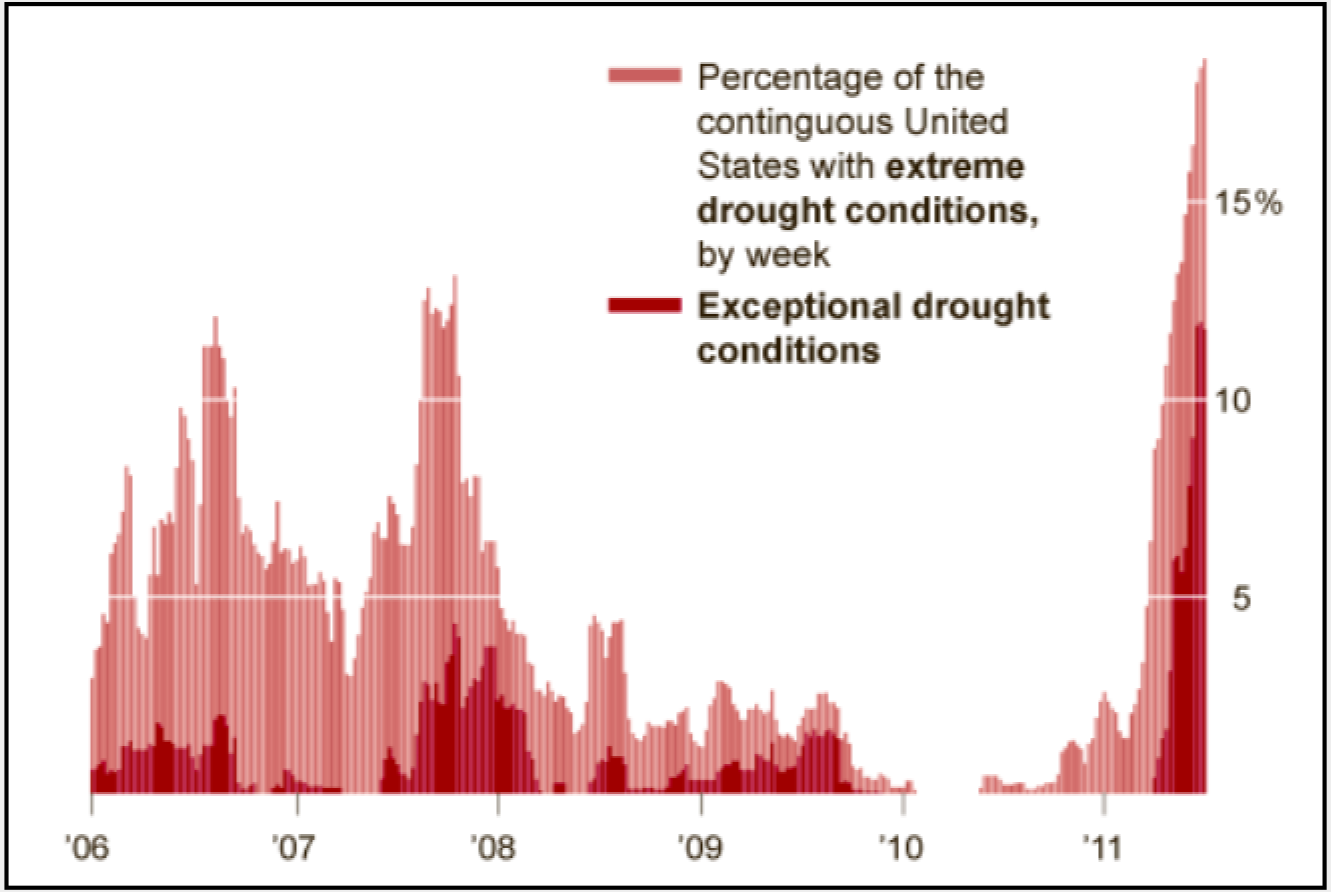
Tan: Moderate Drought
- Some damage to crops, pastures.
- Streams, reservoirs, or wells low.
- Some water shortages developing or imminent; voluntary water-use restrictions requested.

Orange: Severe Drought
- Crop or pasture losses likely.
- Water shortages common; water restrictions imposed.

Red: Extreme Drought
- Major crop/pasture losses.
- Widespread water shortages or restriction.

Dark Red: Exceptional Drought
- Exceptional and widespread crop/pasture losses.
- Shortages of water in reservoirs, streams, and wells creating water emergencies.


U.S. Drought Monitor
November 15, 2016
(Released Thursday, Nov. 17, 2016)
Valid 7 a.m. EST
Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)
Intensity:
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought
Author:
Richard Heim
NCEI/NOAA


Percentage of the contiguous United States with extreme drought conditions, by week
Exceptional drought conditions
15%
10
5
'06
'07
'08
'09
'10
'11

WHAT ARE THE IMPACTS?

NOAA, 9-17-2002

- Average annual costs and losses in the U.S. due to drought are estimated at **$6 to $8 billion**.
- Flooding and hurricanes, are responsible for **$5.9 billion** and **$5.1 billion** in annual damages, respectively.

Agricultural Impacts (a few examples)

- 2011 Texas: $5.2 - $8.7B
- 2008 California: $308M
- 2007 Georgia: $780M
- 2002 South Dakota: $1.4B
- 2002 Missouri: $500M

- 1999 Eastern Drought/Heat Wave: >$1B
- 1998 Southern Drought/Heat Wave: $6 - $9B
- 1995/96 Southern Plains: $5B

DROUGHT PRICING

During droughts, cities often implement voluntary or mandatory limits on water consumption

- Eg. Restrict watering lawns and washing cars
- Require water-saving shower heads or low flush toilets

These *standards* approaches are likely inefficient!

Problem is that price of water is left constant

- Price of a good should reflect its scarcity
- As a good becomes more scarce, price should increase

As a result, those who value water the most (high WTP) will end up consuming more while those who don't (low WTP) reduce consumption

HOW DOES DROUGHT PRICING PERFORM?

COMMAND-AND-CONTROL POLICIES

For command-and-control policies, there is mixed evidence of water conservation

- Water conservation is often less than engineering estimates because of increased use, called the *rebound effect*
- Generally there is evidence of conservation programs reducing residential water use, with stronger effects from mandatory policies

DROUGHT PRICING

Price increases have infrequently been used as a policy tool

Response should depend on price elasticity of demand for water.

- Estimates in the short-run are typically in the range of -0.3 to -0.6

Analysts have simulated hypothetical outcomes using data on actual water use

- Study of 13 California cities found a water tax (price increase) would be more cost-effective than a technology standard
- Study comparing outdoor water restrictions with drought pricing found that equivalent water conservation under pricing leads to welfare gains of around $96/household/summer drought (~29% of avg. households water bill)

DISTRIBUTIONAL IMPLICATIONS

Price-based approach allocates resources to those who are willing-to-pay

- Primary concern with water pricing is that WTP is strongly influenced by ones ability to pay.
- Additionally, there are concerns that the policy will be regressive, particularly if water demand is highly inelastic

Concerns could be alleviated by pairing drought pricing with income transfers

- Akin to tax-and-rebate we saw for carbon pricing

GOVERNMENT COSTS

Costs of enforcement and regulation are likely to be smaller under water pricing than under a command-and-control approach

Command-and-control requires monitoring of household adherence to regulation

- Often relies on self-enforcement or peer enforcement

Drought pricing simply requires an increase of water price!

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