The Value of Information in California's Emissions Inventory

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The Value of Information

- More information -> Better policies

- The value of information varies according to:
  1. How uncertain decision makers are
  2. The value of the resources that are managed, monitored or regulated
  3. The range of options available to the decision maker
  4. Cost of using information
  5. The price of the next-best substitute for the information.

adapted from Maculey (2005)

Emissions Inventory

Table B-3 SO_2, Annual and Averages
(in tons per

SUMMARY CATEGORY NAME	ANNUAL					WINTER					
	2005	2011	2012	2013	2014	2005	2009	2010	2011	2012	2
STATIONARY SOURCES											
FUEL COMBUSTION											
ELECTRIC UTILITIES	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.9	0.9	0.9	
COGENERATION	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	
OIL AND GAS PRODUCTION (COMBUSTION)	2.3	2.2	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.3	
PETROLEUM REFINING (COMBUSTION)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
MANUFACTURING AND INDUSTRIAL	6.0	6.6	6.7	6.8	7.0	6.0	6.3	6.4	6.6	6.7	
FOOD AND AGRICULTURAL PROCESSING	1.9	1.9	1.9	1.9	1.8	1.3	1.3	1.3	1.3	1.3	
SERVICE AND COMMERCIAL	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
* TOTAL FUEL COMBUSTION	**12.7**	**13.3**	**13.4**	**13.5**	**13.7**	**12.0**	**12.3**	**12.5**	**12.6**	**12.8**	

Emissions Inventory

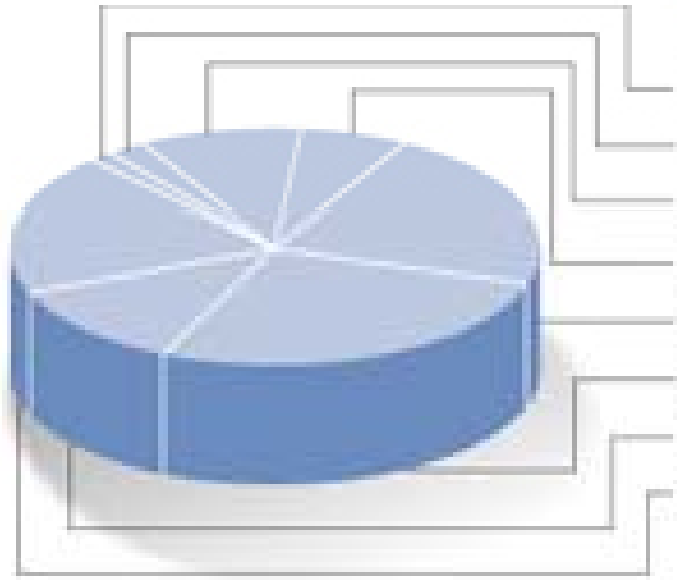
- Created using:
  - travel demand models
  - surveys of point sources
  - biogenic models for emissions from plants
  - regressions from population or other proxy for area wide sources (dry cleaners, etc.)

Air Pollution Basics

- The EPA sets standards for 6 common pollutants
- The National Ambient Air Quality Standards (NAAQS) are based on impacts to human health
- If a monitor registers pollution below the standard, it is in “attainment”
- If a state or a community is not making progress on air pollution, the federal EPA can step in

EPA, ARB and SIPs, oh my!

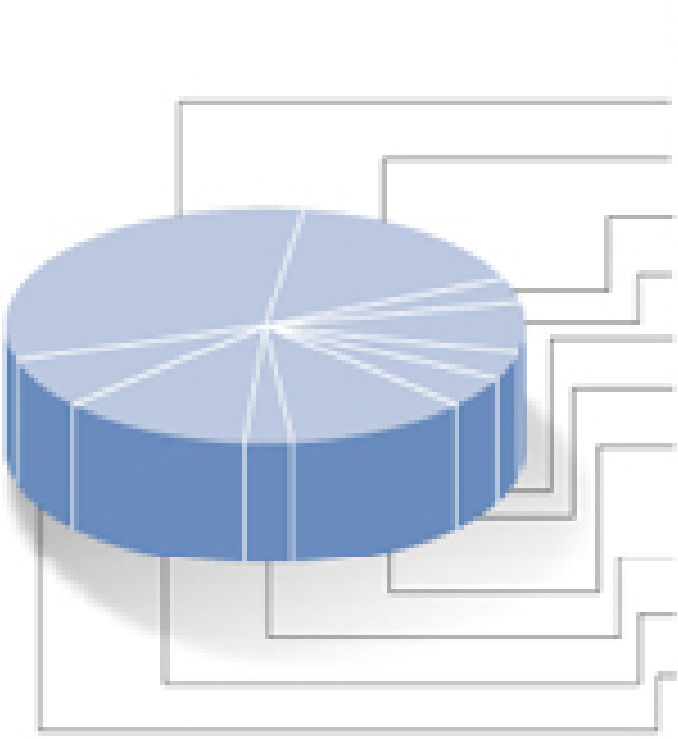
Local Air District Funding



Where General Fund money comes from:

Transportation	1%
Toxic "Hot Spots"	2%
Grant/Subvention/Other Federal Revenue	10%
Other	6%
Emission Fees	19%
Annual Operating	29%
Permit Fees	15%
Mobile Sources	18%

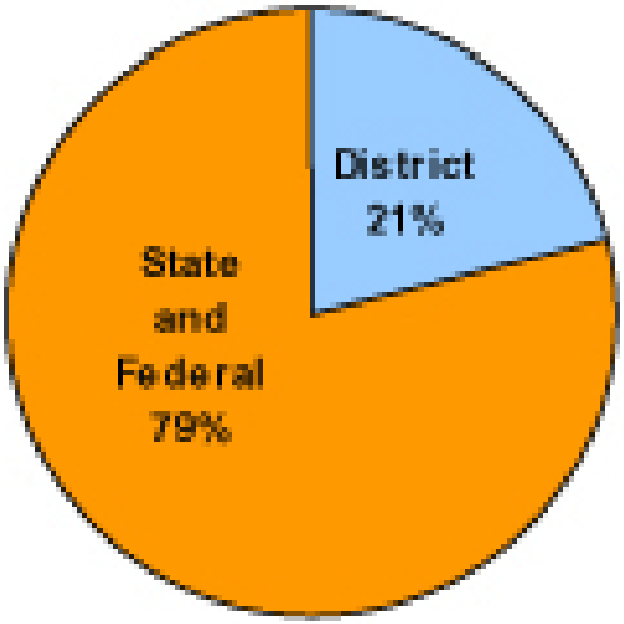
Local Air District Expenditures

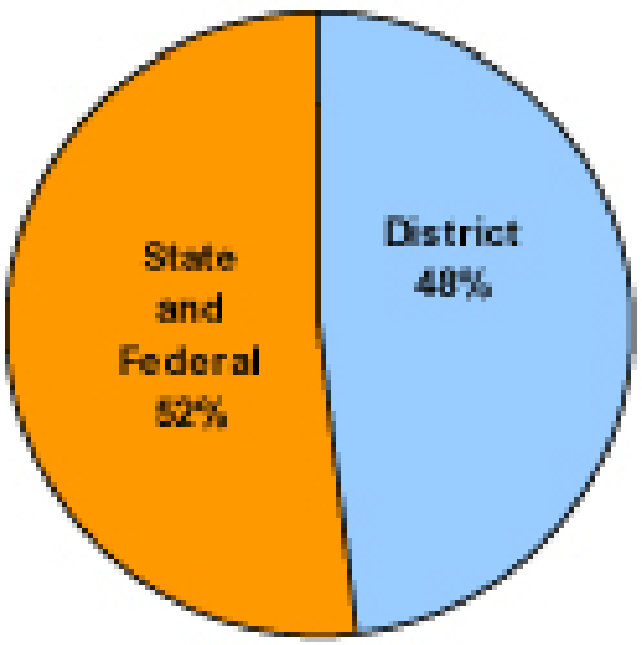


Where the money goes:

Engineering & Compliance	29%
District General	17%
Executive/Governing & Hearing Boards	3%
Public Affairs	5%
Finance	4%
Administrative & Human Resources	4%
Planning, Rule Development & Area Sources & Transportation	12%
Legal	4%
Science & Technology Advancement	15%
Information Management	7%

SJV Jurisdictional Puzzle





The Model

Air districts spend “effort” to reduce emissions

Subject to being 95% certain they are under the exogenous emissions target

Static Model: Output Uncertainty

$$\underset{e_1, e_2}{Min}\ e_1 + e_2$$

$$s.t.\ P(f_1(e_1) + f_2(e_2) \le \bar{s}) \ge 0.95$$

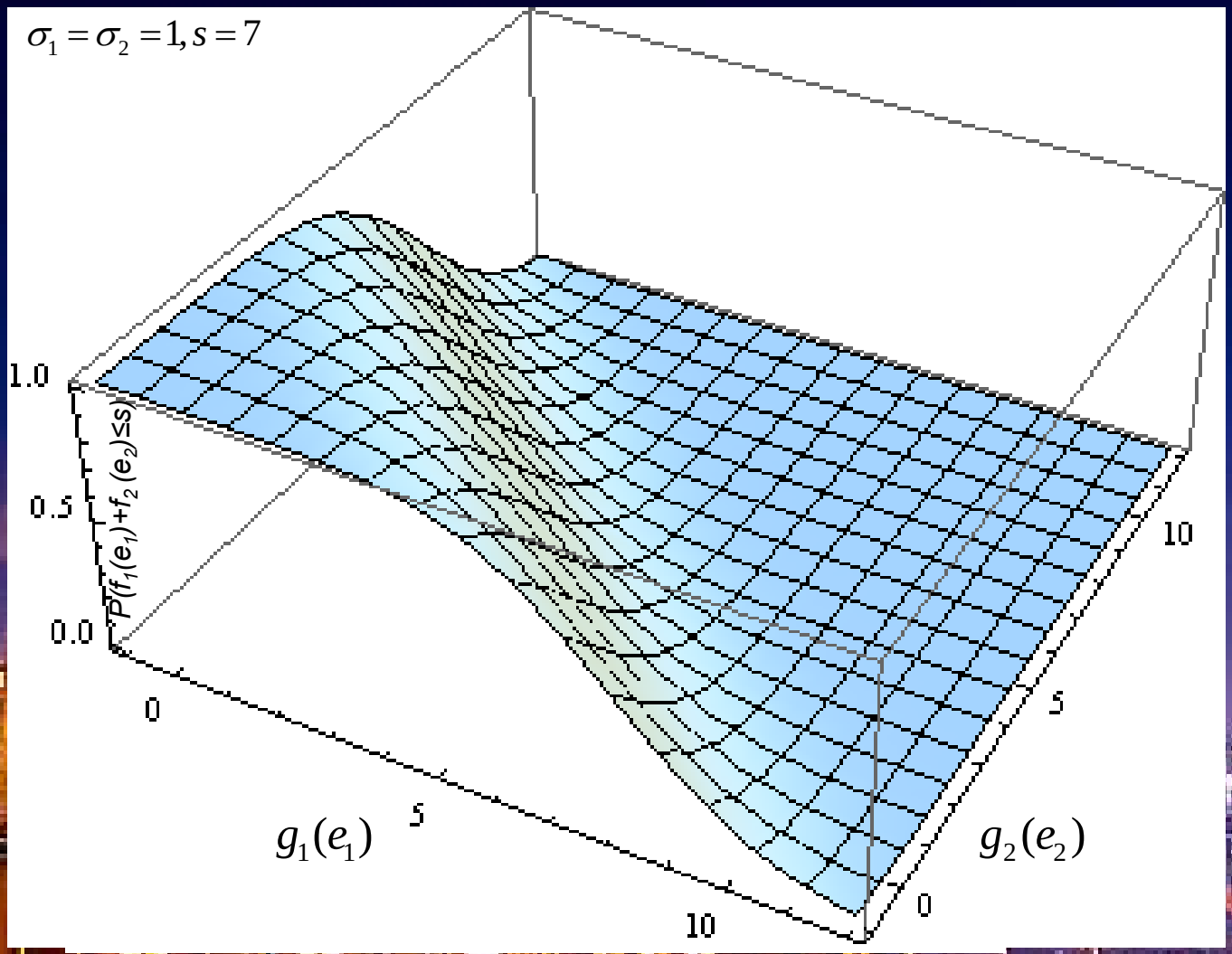
where $f_1(e_1) = g_1(e_1) + \varepsilon_1$

$f_2(e_2) = g_2(e_2) + \varepsilon_2$

$$g_1' < 0, g_1'' > 0, g_2' < 0, g_2'' > 0$$

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \sim \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_1^2 & 0 \\ 0 & \sigma_2^2 \end{pmatrix} \right)$$

Results from the Static Model



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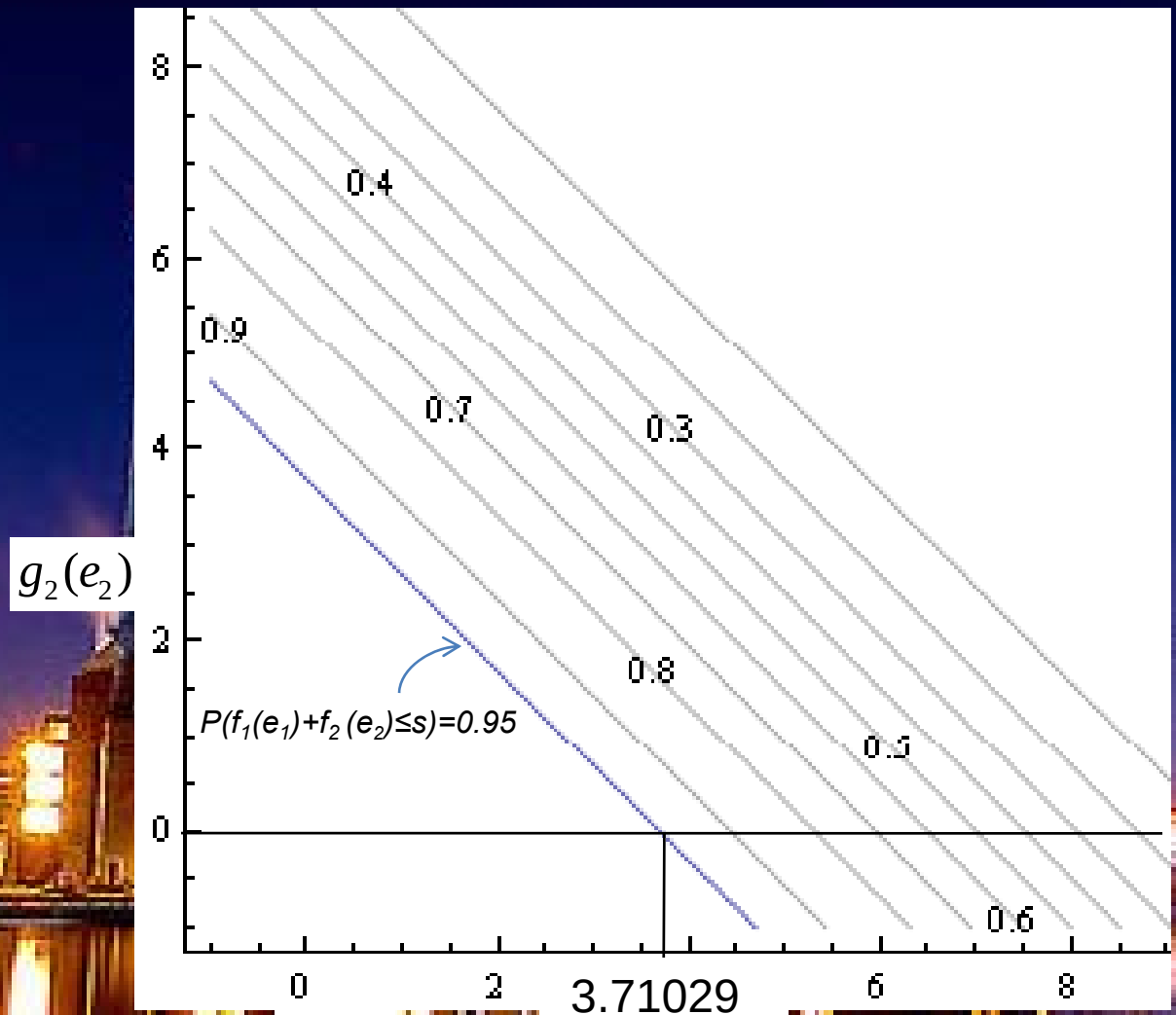


$\sigma_1 = \sigma_2 = 1, s = 7$

Results from the Static Model

Constraint:

$$P(f_1(e_1)+f_2(e_2)\le \bar{s})\ge 0.95$$

$$g_1(e_1)+g_2(e_2)\le \bar{s}-1.644(\sigma_{11}+\sigma_{22})$$

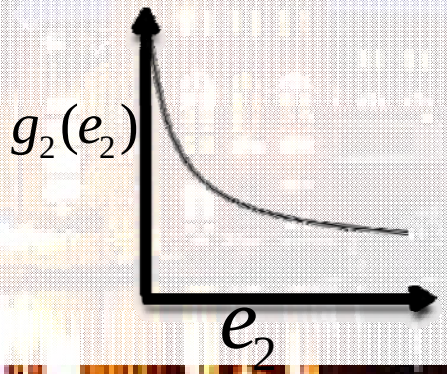
First Order Condition:

$$g_1'(e_1)=g_2'(e_2)$$

Value of Information?

If $g_1(x) = g_2(x)$ then the value of reducing either of the variance terms is:

$$\frac{\partial V(\sigma_{11}, \sigma_{22})}{\partial \sigma_i} = -0.822 \frac{\partial}{\partial \sigma_i} g^{-1}\left(\frac{\bar{s} - 1.644(\sigma_{11} + \sigma_{22})}{2}\right)$$



More Complex Models

- Explicitly model processes
  - Dynamic processes
  - Transportation demand
  - Air pollution chemistry
    - Lots of non-linear responses
  - Transport
  - Effort Process?

Nordhaus PRICE model

$$\underset{c(t,s)}{Max} \quad V = \sum_{t=0}^{T} \frac{p(s)\,U[c(t,s),P(t,s),s]}{[1+\rho(s)]^t}$$

subject to

Q=f(K,L|A)

How production is impacted by climate change

C=Y-investment

Emissions=f(control, Q)

CO2 in atmosphere

Functions describing temperature and atmospheric chemistry stuff

How damages accrue

Kaplan, Howitt, Farzin 2003

- Budget constrained resource manager.
- Manages sedimentation from multiple sources under uncertainty
- Can allocate resources to abatement or learning about the different damage coefficients from the pollution sources
- How to back out value of information from this?

Questions?

Value Function

$$V(\sigma_{11},\sigma_{22}) = g^{-1}\left(\frac{\overline{s} - 1.644(\sigma_{11}+\sigma_{22})}{2}\right)$$