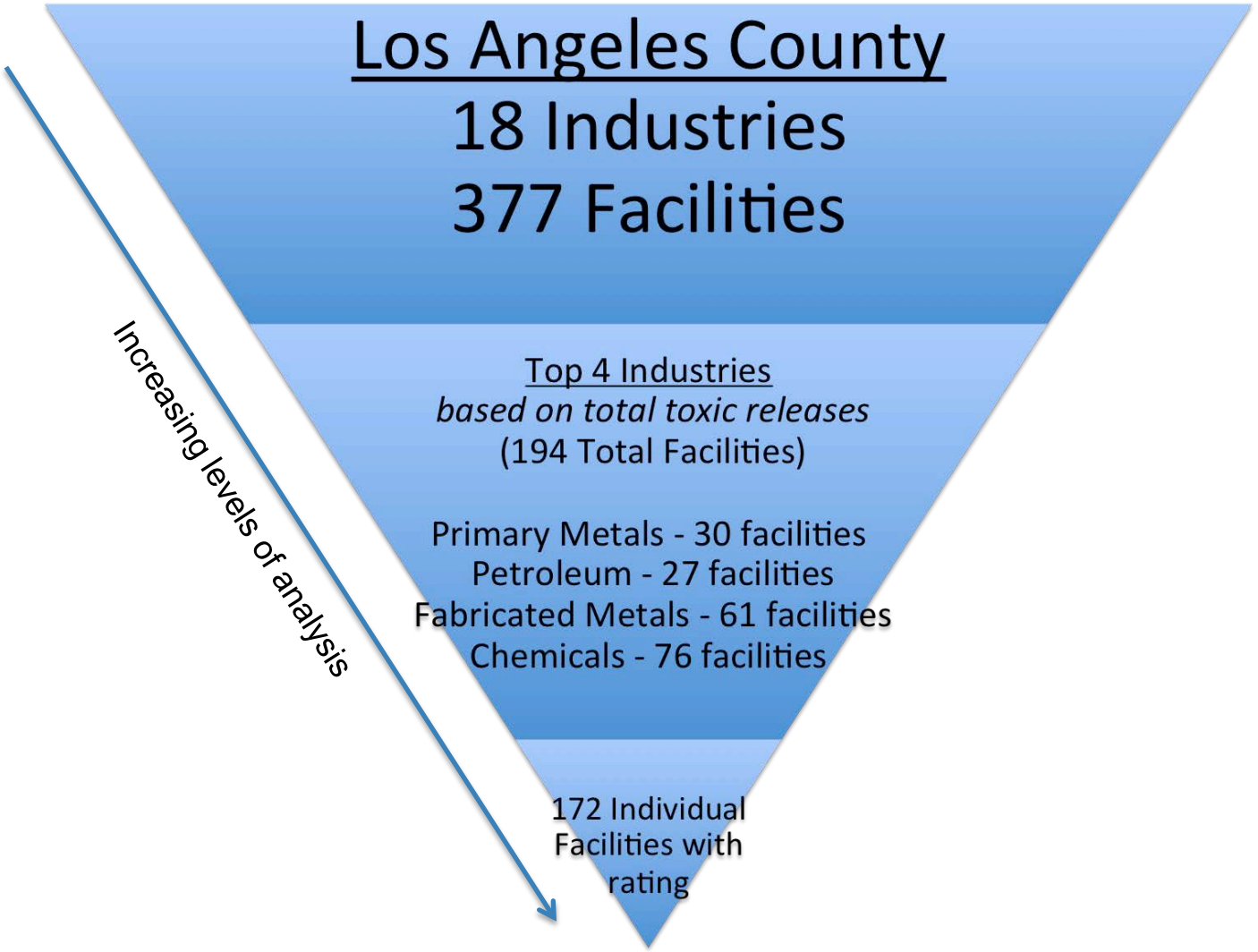
EPA TRI University Challenge: UCLA Project Results

Advisor: Dr. Magali Delmas
Ha Hyun Chung
Carmen Ehlinger
Fannie Hsieh

Leanna Huynh
Larry Lai
Amy Tat
Audrey Vinant-Tang

Project Objectives

- Complementing the TRI with ecological areas, population density, revenue data, and health risk assessments to determine trends across industries, the Los Angeles County, and California
- Development of a robust methodology to evaluate and rate environmental performance of TRI facilities in the Los Angeles County
- Sharing environmental performance evaluations with TRI facilities to better facilitate intra-industry comparisons of toxic chemical trends and data
- Interactive mapping of TRI Facilities in the Los Angeles County to communicate results with general public


Los Angeles County
18 Industries
377 Facilities
Top 4 Industries
based on total toxic releases
(194 Total Facilities)
Primary Metals - 30 facilities
Petroleum - 27 facilities
Fabricated Metals - 61 facilities
Chemicals - 76 facilities
172 Individual Facilities with rating
Increasing levels of analysis

Variable Name	Database	Units
Total Toxic Releases, On- and Off-Site	TRI.Net 8.1 Total On and Off Site Releases	lbs
Toxicity of Total Releases, On-Site	TRI.Net Total On Site Releases (toxicity x pounds)	lbs x toxicity
Toxic Releases per $1000 of Revenue	ReferenceUSA, Hoovers, Orbis	lbs / $1000
Waste Managed through Recycling, Energy Recovery, and Treatment	TRI.Net Section 8.2 - 8.7	lbs
Regional Contribution to Lifetime Cancer Risk from Air Emissions	TRI.Net: Total Air Releases (Toxicity x Pounds), OEHHA Cancer Potency, EPA, US Census Bureau, American Geophysical Union	number of cancers in a million people

Total Toxic Releases

Variable Name	Database	Units
Total Toxic Releases, On- and Off-Site	TRI.Net 8.1 Total On and Off Site Releases	lbs
Toxicity of Total Releases, On-Site	TRI.Net Total On Site Releases (toxicity x pounds)	lbs x toxicity

Goal: To evaluate significant environmental and public health effects of toxic emissions into the environment

Toxic Releases per $1000 Revenue

Variable Name	Database	Units
Toxic Releases per $1000 of Revenue	ReferenceUSA, Hoovers, Orbis	lbs / $1000

Goal: Measure facility efficiency by standardizing total toxic release to annual revenue

$$\frac{Total\ Toxic\ Releases}{\$1000\ of\ Revenue} = \left(\frac{lbs}{\$1000}\right)$$

Waste Managed through Recycling, Energy Recovery, and Treatment

Variable Name	Database	Units
Waste Managed through Recycling, Energy Recovery, and Treatment	TRI.Net Section 8.2 - 8.7	lbs

Goal: Measure the facilities' efforts at managing waste through preferred waste management practices and preventing direct releases into the environment

Regional Contribution to Lifetime Cancer Risk from Air Emissions

Goal: To communicate a facility's environmental impact in terms of health

Preliminary Research:

- ***TRI "…Releases (Toxicity x Pounds)"****:*
  - Unitless, difficult to communicate
- ***Risk-Screening Emissions Inventory (RSEI) "Health Score"****:*
  - Unitless, relative significance only
- ***MATES III Study****:*
  - 10^{-6} cancer risk, difficult to isolate TRI facilities

Conclusion: Conservative estimate of 10^{-6} cancer risk from facility's air releases

Regional Contribution to Lifetime Cancer Risk from Air Emissions

Variable Name	Database	Units
Regional Contribution to Lifetime Cancer Risk from Air Emissions	TRI.Net: Total Air Releases (Toxicity x Pounds), OEHHA Cancer Potency, EPA, US Census Bureau, American Geophysical Union	number of cancers in a million people

Main Assumptions and Limitations:

- The Los Angeles Basin is well-mixed and in a constant state of inversion
- Exposure time of 70 years to 2012 TRI releases
- Not used to infer individual risk on a local level

Regional Contribution to Lifetime Cancer Risk from Air Emissions

Calculation:

TRI.Net "Total Air Releases"
pounds

→ OEHHA "Toxic Equivalency Potential"
pounds benzene-equivalent

→ **pounds benzene-equivalent**

→ **cancers in a million people**

$$\text{Cancer Risk (cancers in a million)} = \frac{Total\ On-Site\ Air\ Releases\ (lbs.\ of\ benzene\ equivalents)}{lbs.\ of\ benzene\ for\ a\ one\ in\ a\ million\ cancer\ risk}$$

CAL ECO MAPS

Regional Contribution to Lifetime Cancer Risk from Air Emissions

Calculation:

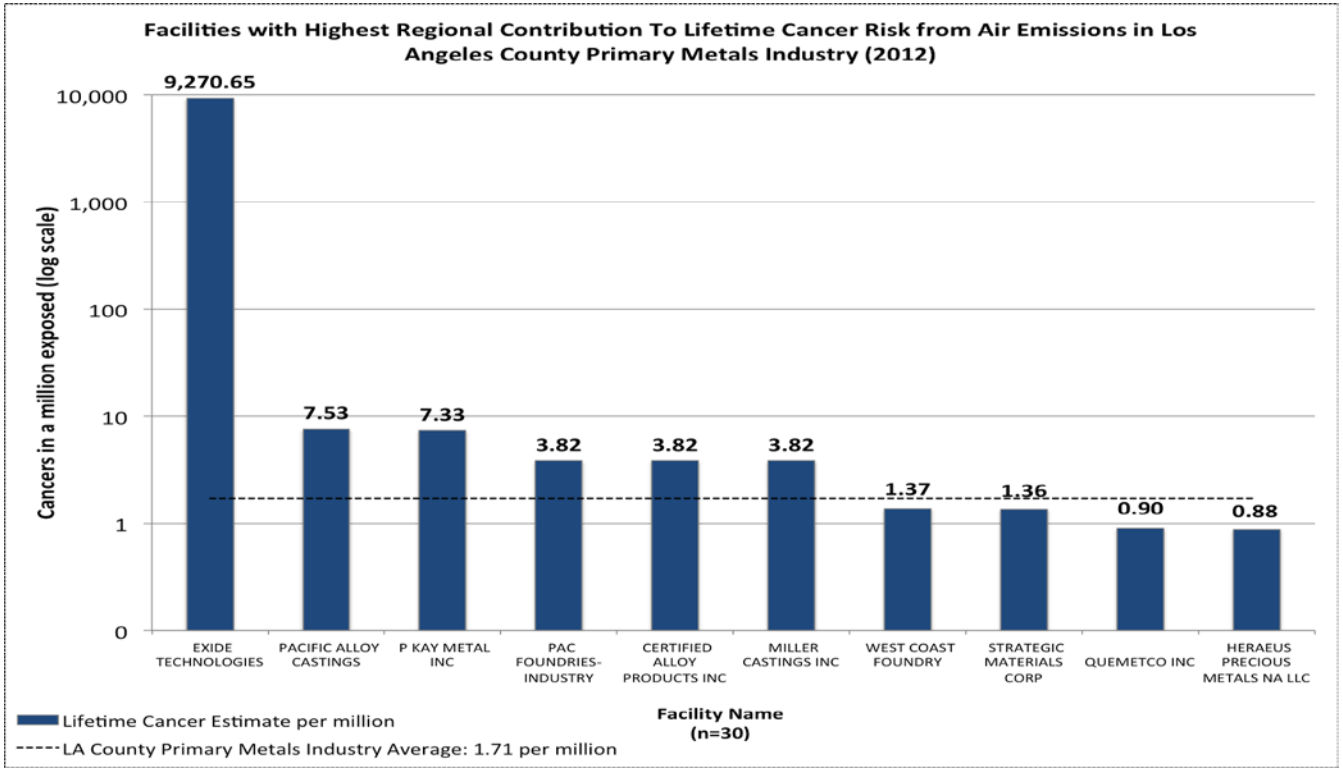
$$\frac{Chem.}{Conc.} = \frac{Cancer\ Risk \times Averaging\ Time}{Potency\ Factor \times Inhalation\ Rate \times Exposure\ Freq. \times Duration}$$

$$\frac{lbs.\ of}{benzene} = \frac{Risk \times 70\ yrs \times L.A.\ Basin\ Area \times Avg.\ Inversion\ Layer\ Height}{Benzene\ Potency \times Avg.\ Inhalation\ Rate \times Exposure\ Freq. \times Duration}$$

Inputs:
L.A. Basin Area and Avg. Inversion Layer Height: American Geophysical Union
Avg. Inhalation Rate: EPA Inhalation Rates by Sex and Age, 2012 US Census for LA County

10^{-6} lifetime cancer risk by inhalation = 348 pounds benzene-equivalent

Regional Contribution to Lifetime Cancer Risk from Air Emissions



Results for Top Four

Range: 0 to 9,270.65 cancers in a million exposed

Mean: 48.71 cancers in a million exposed with outlier

ex. Exide Technologies

- Outlier
- Lead and arsenic violations
- Mean becomes 0.93 cancers in a million exposed without it

Cal EcoMaps Environmental Impact Score

Goal: Score facilities environmental impact based on the five Environmental Impact Indicator Categories

Description:

- Percentile Rank Score (0 - 100)
- Modeled after OEHHA's CalEnvironScreen Version 2.0 CalEnviro Score methodology

Calculation:

- Percentile (and reversed percentile for PWMA) of a facility from each category is added to produce a score out of 500
- Score divided by 5 for a more intuitive Environmental Impact Score out of 100

Cal EcoMaps Environmental Impact Score

Methodology:

- Higher score indicates greater environmental impact
  - Minimize input variables
  - Maximize output variable: smaller reversed percentile contribute to less environmental impact

A. Total Toxic Releases Percentile	B. Toxic Releases per $1000 of Revenue Percentile	C. Toxicity of Total Releases Percentile	D. Regional Contribution to Lifetime Cancer Risk from Air Emissions Percentile	E. Waste Managed Through Recycling, Energy Recovery, and Treatment Percentile	F. Waste Managed Through Recycling, Energy Recovery, and Treatment Reversed Percentile	G. Score Out of 500 (A+B+C+D+F)	*Cal EcoMaps* Environmental Impact Score (Out of 100) (G/5)
92.50	47.70	61.10	0.00	76.10	23.90	225.20	**45.04**

Data Envelopment Analysis

Goal: Determine facility efficiency given its inputs and outputs (from the five Environmental Impact Indicator Categories)

- Score on a scale of 0 - 1 (least to most efficient)
- Efficient firms generate a maximum amount of desirable outputs for a minimum “cost” of undesirable inputs, compared to similar benchmark facilities

Inputs (minimized):

- Total Releases (lbs)
- Total Air Releases (Toxicity x lbs)

Outputs (maximized):

- Amount of Waste Managed Through Recycling, Energy Recovery, and Treatment (lbs)
- Annual Revenue ($)

Data Envelopment Analysis

Limitations:

- Sensitivity to extreme values and large ranges
- Small sample size
- Intra-industry differences

Spatial Analysis (GIS)

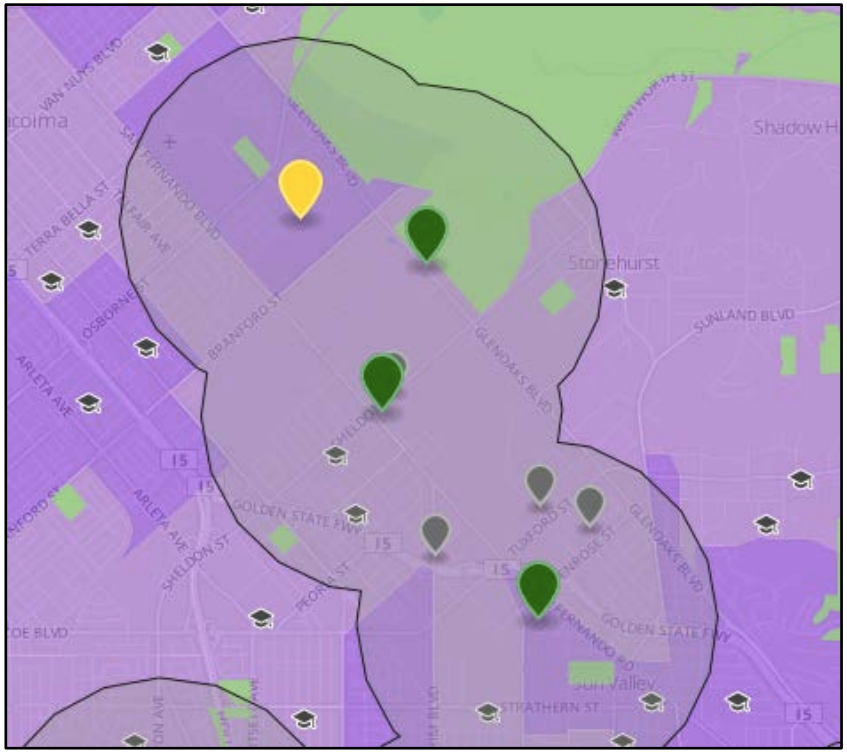
Goal:

To communicate the spatial relationship between facilities and surroundings

Layers:

- ***Sensitive Population Density:***
  - Population count of individuals less than 17 and over 65 years old by census tract
- ***California Protected Area:***
  - Open space conserved by the state for ecology and/or recreation
- ***Schools and Colleges:***
  - Private and public schools for K-12 and colleges

Spatial Analysis (GIS)



Buffer Analysis:

- 1 mile buffer from facility
- Select features of layers within buffer and label as “true”
- Remaining labeled as “false”

Results:

- 84% of TRI facilities have CPA within a 1-mile radius
- 92% have schools

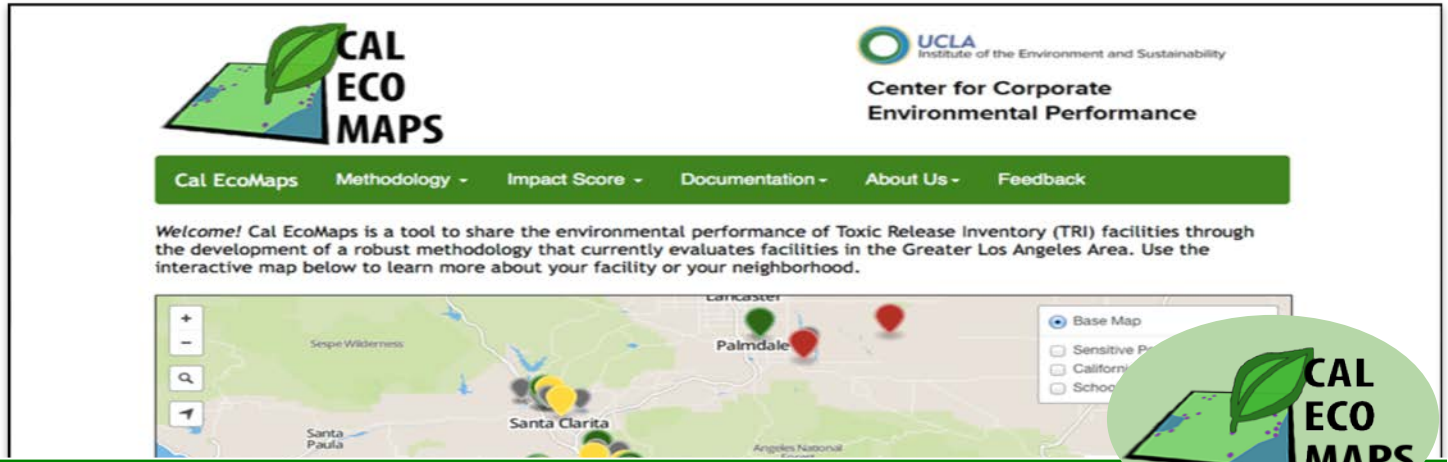
CAL ECO MAPS

Cal EcoMaps Website

Goal: To communicate the environmental and economic impact of TRI facilities in Los Angeles County to facility operators, stakeholders, and the general public.

Description

www.environment.ucla.edu/ccep/calecomaps



Next Steps

- GHG: California EPA Air Resources Board
  - Facility's impact on global warming
  - Complement TRI data with ARB data
- Expand scope to CA and US

Acknowledgements

- Daniel Teitelbaum
- Magali Delmas
- Aanchal Kohli
- Scott Gruber
- Rob Graham
- Yifang Zhu
- Chen Chien-Ming
- Felicia Federico
- Travis Longcore

Appendix: Regional Contribution to Lifetime Cancer Risk from Air Emissions

Table: Inhalation Rate by Age and Sex

Age-Sex Category	Inhalation Rate (m^3/kg/day)
Male 0 to 17	0.315
Male 18 to 44	0.185
Male 45 to 64	0.173
Male 65 and up	0.159
Female 0 to 17	0.332
Female 18 to 44	0.217
Female 45 to 64	0.201
Female 65 and up	0.187

Source: U.S. EPA, 2011. Environmental Factors Handbook.

Equation: Pounds of benzene for a one in a million cancer risk

$$\frac{\text{(Risk)(Averaging Time)(Los Angeles Basin Area)(Inversion Layer Height)}}{\text{(Benzene Potency Factor)(Average Inhalation Rate)(Exposure Freq.)(Duration)}} = \text{lbs benzene}$$

$$\frac{(10^{-6}\text{ risk})(25{,}550\text{ days})(2{,}467{,}843\text{ m}^2)(10.06\text{ m})(2.2\text{x}10^{-6}\text{ lbs/mg})}{(0.054\text{ day-kg/mg})(0.229\text{ m}^3\text{/kg/day})(365\text{ day/yr})(70\text{ yr})} = 348\text{ lbs benzene}$$

Appendix: Data Envelopment Analysis

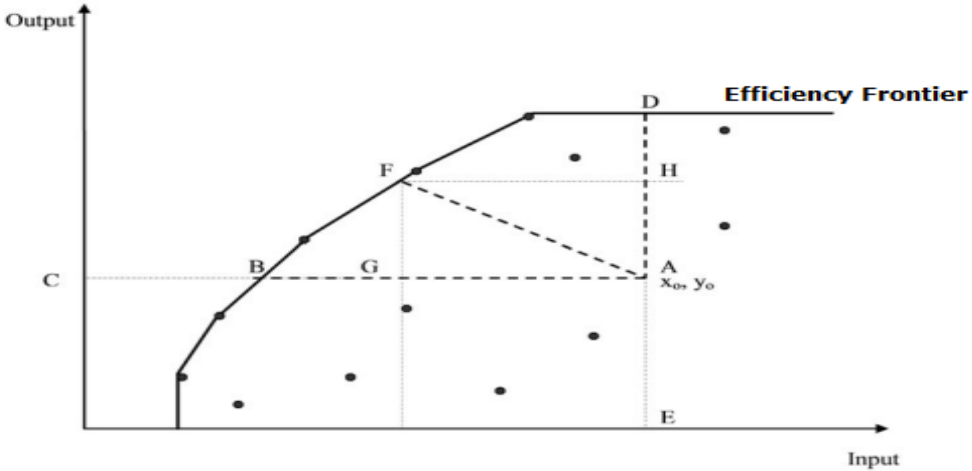


Figure 11 – Facility A is an inefficient facility. Point B represents Facility A's efficiency target for an input-oriented analysis. Point D represents the efficiency target for an output-oriented analysis. Point F represents the efficiency target for a non-oriented analysis.

Appendix: MaxDEA Program

- **Distance:** method of measuring efficiency (facility distance to “efficiency frontier”)
  - *Radial* – Used because measures necessary proportional improvements of relevant factors (inputs/outputs) for evaluated DMU to reach efficiency frontier, without detriment to its output values
  - *Max/min distance to frontier* – maximizes/minimizes the average improvements of relevant factors to evaluate DMU to reach the frontier
- **Orientation:** which input or output factors are increased or decreased; how a facility reaches the efficiency frontier
  - *Input oriented* - Reduce the inputs while keeping the outputs constant
  - *Output orientated* - Increase the outputs while keeping the inputs constant
  - *Non-oriented* – permitting at the same time reduction of inputs and increase of outputs
- **Returns to Scale:** Explains behavior of rate of increase in output to subsequent increase in inputs
  - *Variable* – Used because inputs and outputs are not of linear relationship; suspect that an increase in inputs doesn’t result in proportional change in outputs
  - more facilities become efficient; conservative measure of facility efficiency.
  - *Constant* - linear relationship between inputs and outputs