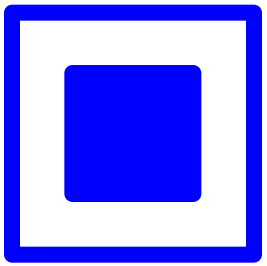
Thinking Inside the Box:

Natural Resource Management in Tata Power Plants and Their Surrounding Communities



Morgan Pecora-Saipe, TISES

Dr. Saxena, Col. Tewari, Mr. Puranik and Mr. Pradhan, Tata Power

Project Objectives

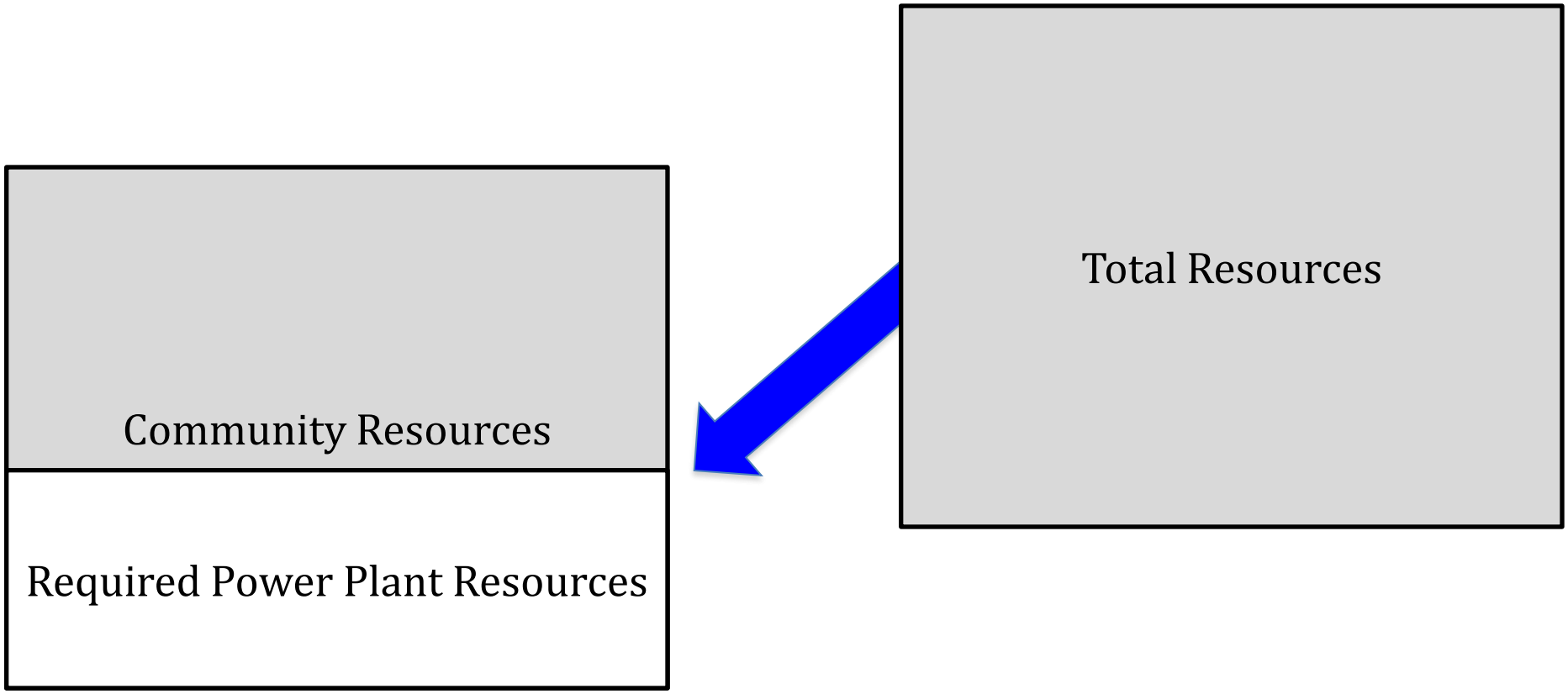
Develop a decision making methodology to quantify and improve resource management in Tata Power Plants and the surrounding communities.

(a) Land and water use by Tata Power Plants

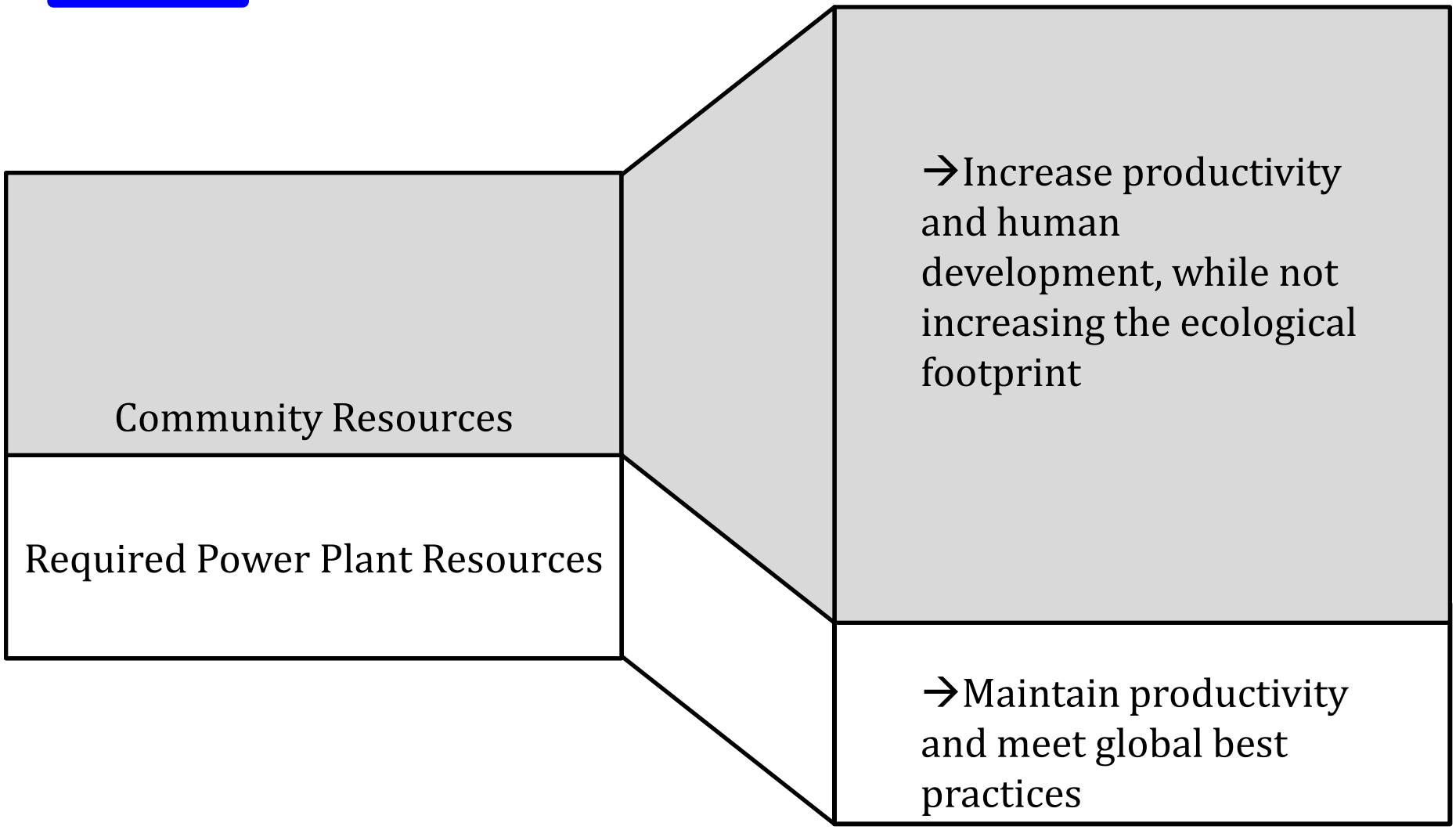
(b) Ecological footprint and HDI of surrounding communities

(c) Return on investment

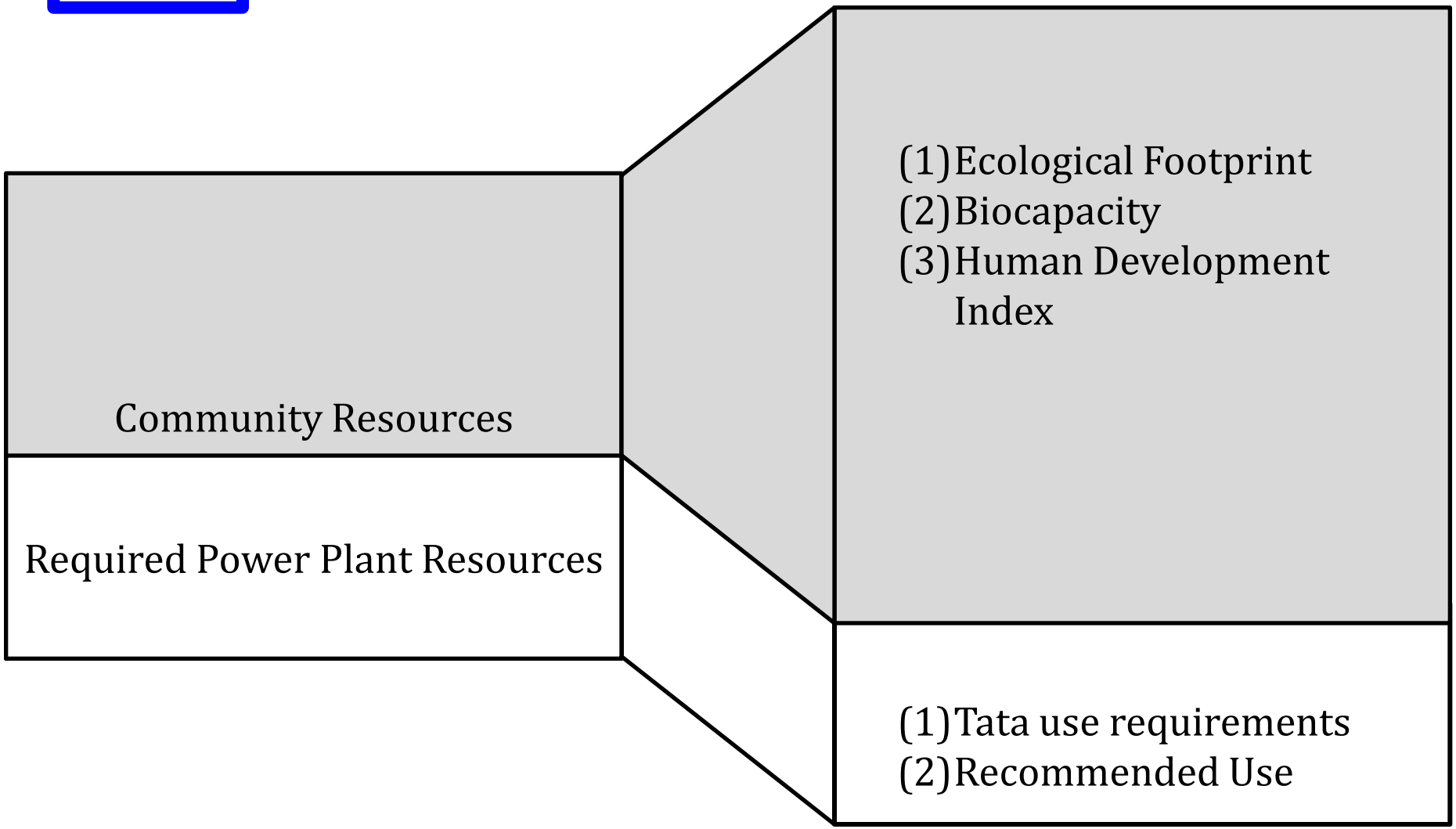
Division of Total Resources



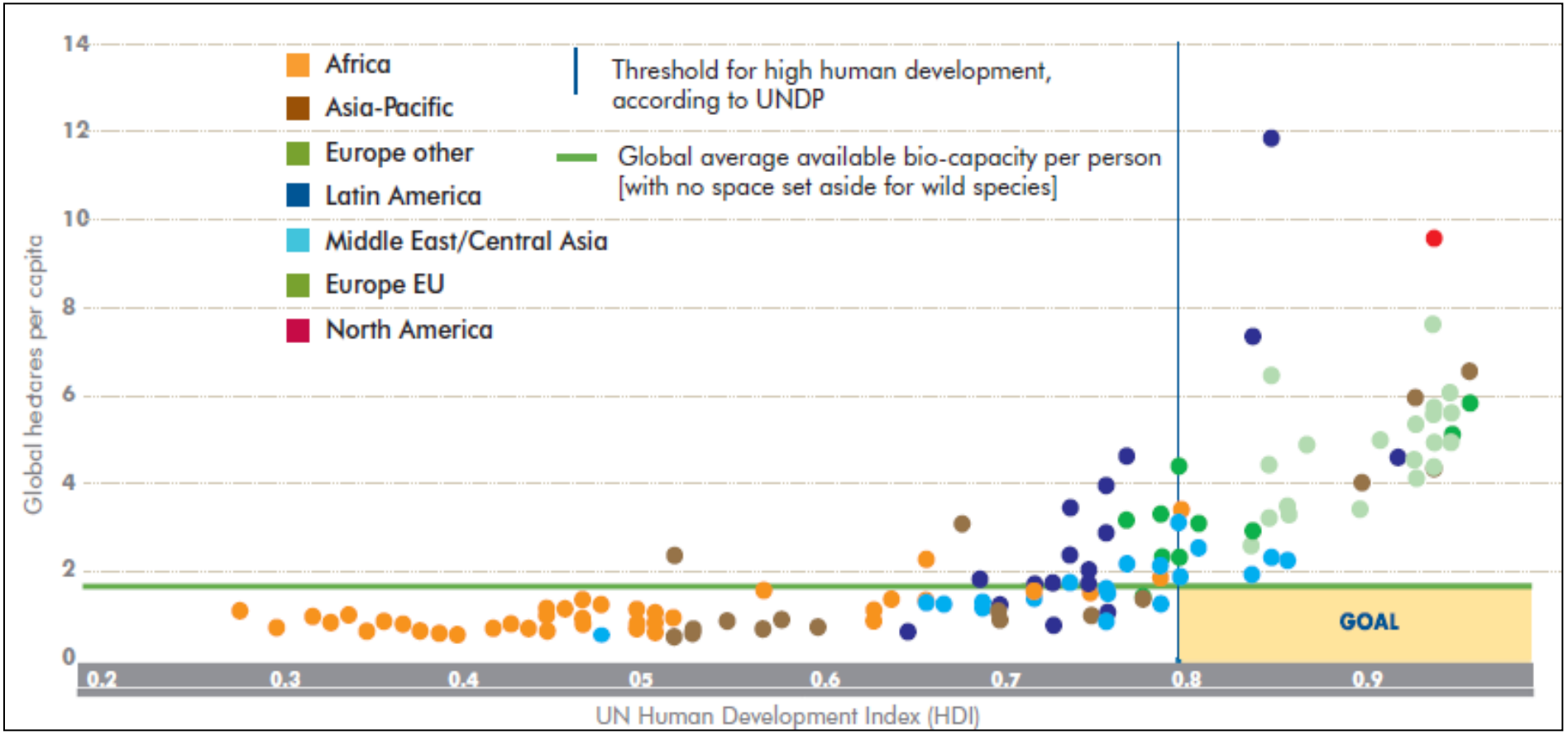
Resource Goals



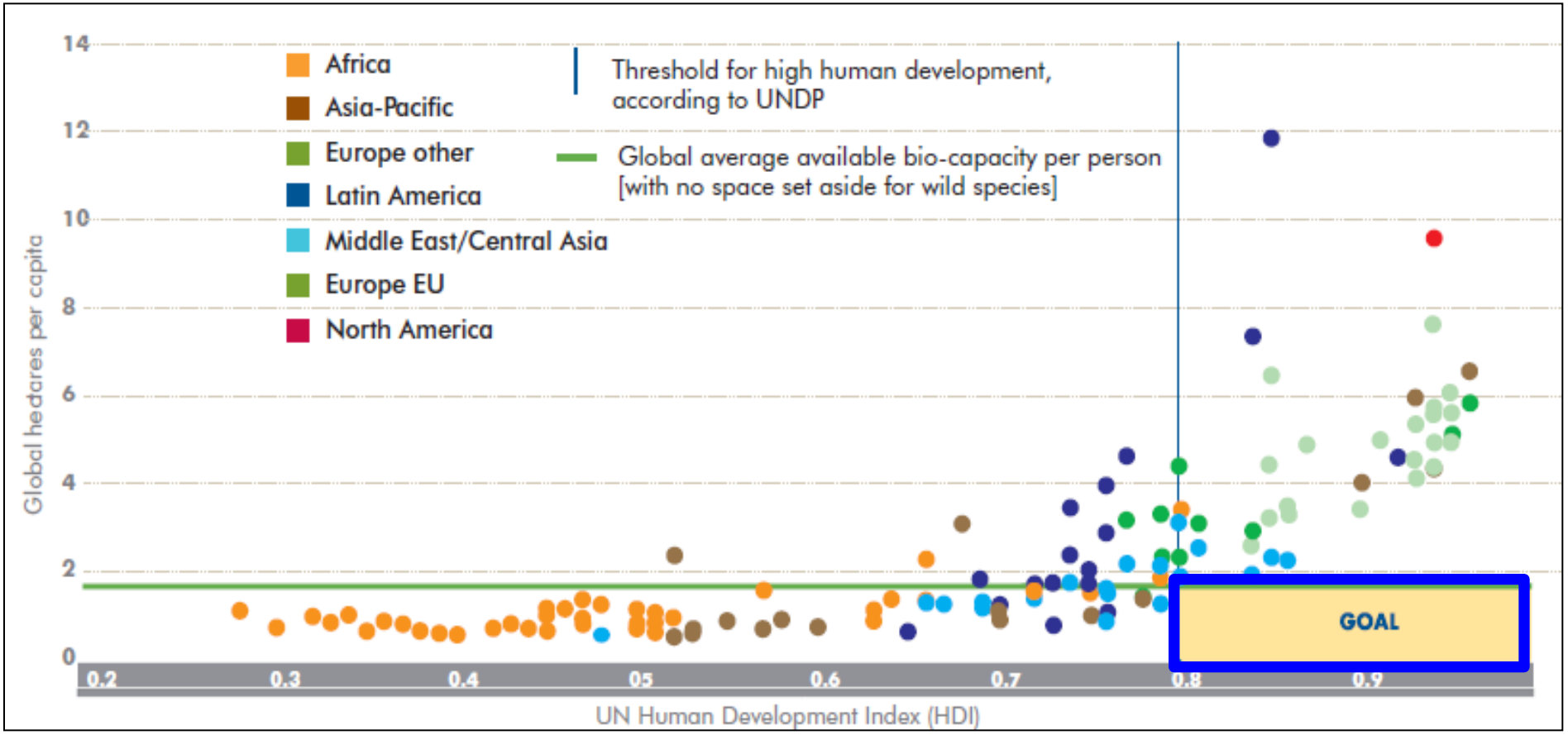
Method Outline



Biological Capital and Human Well-Being



Biological Capital and Human Well-Being



Thinking Inside the Box!

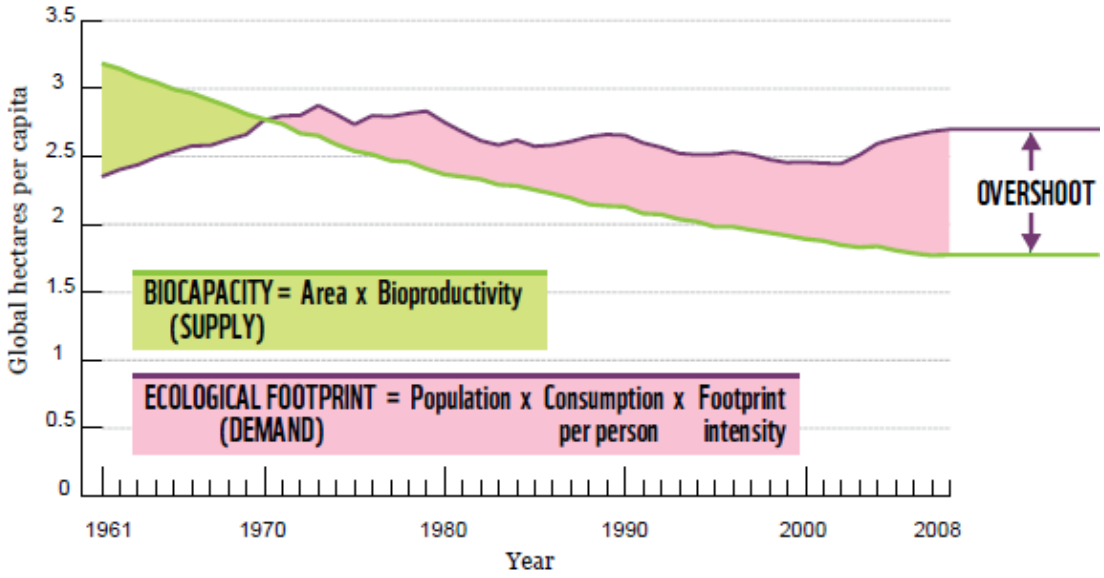
Ecological Potential

Biocapacity - Ecological Footprint =

Ecological Overshoot (-)

OR

Ecological Reserve (+)



(a) Power Plant Resources

Land Use

- Approximately 1MW=1 acre
- 1/3 of total area for landscaping and green belt

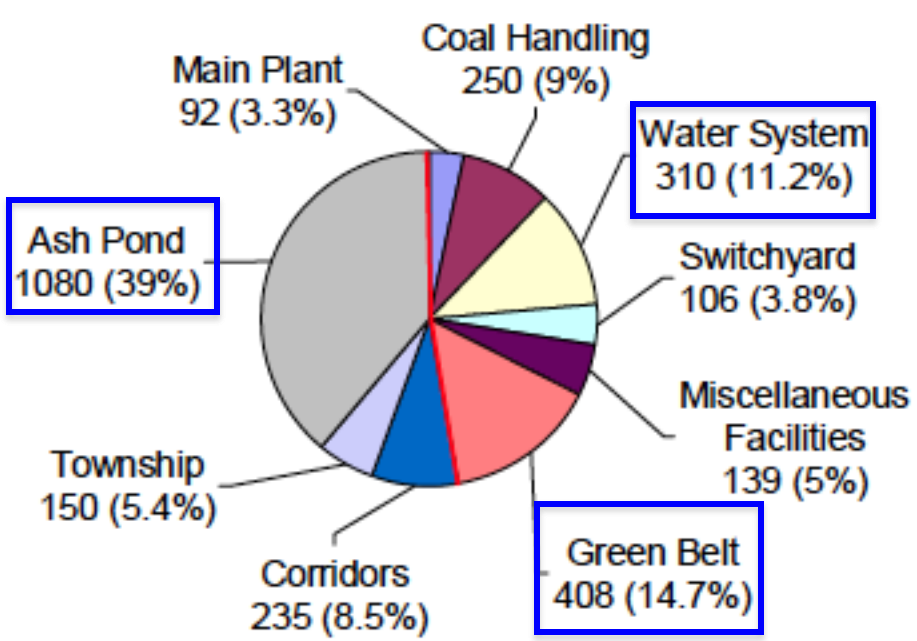
Water Use

- To cool and condense the steam after it exits the turbine, ~80%

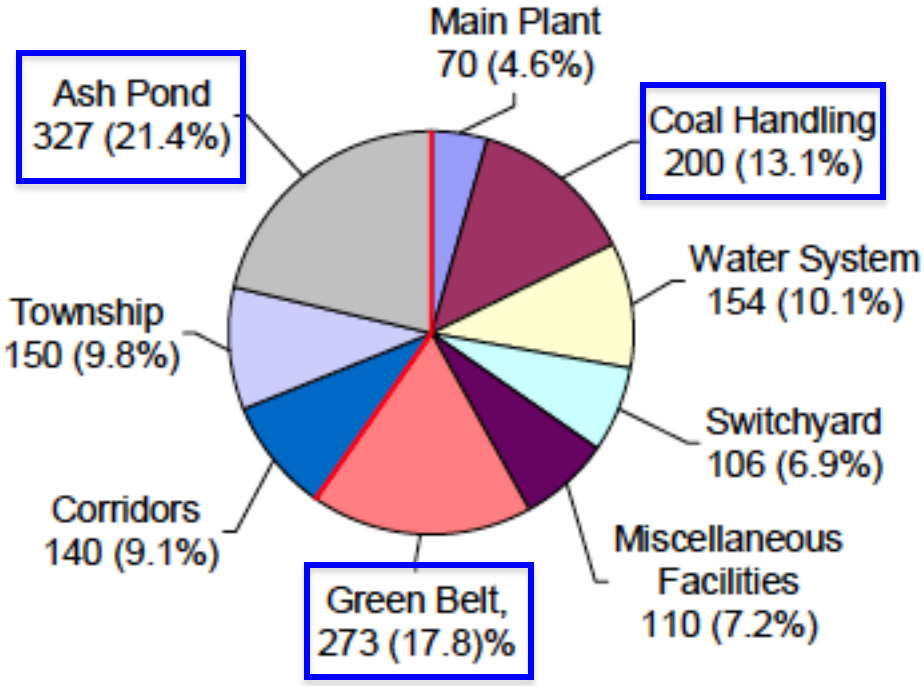
Varies due to: coastal vs. inland, indigenous vs. imported coal, and difference in infrastructure

Distribution of Land Requirement in a Thermal Power Plant, 5x800MW

Indigenous Coal



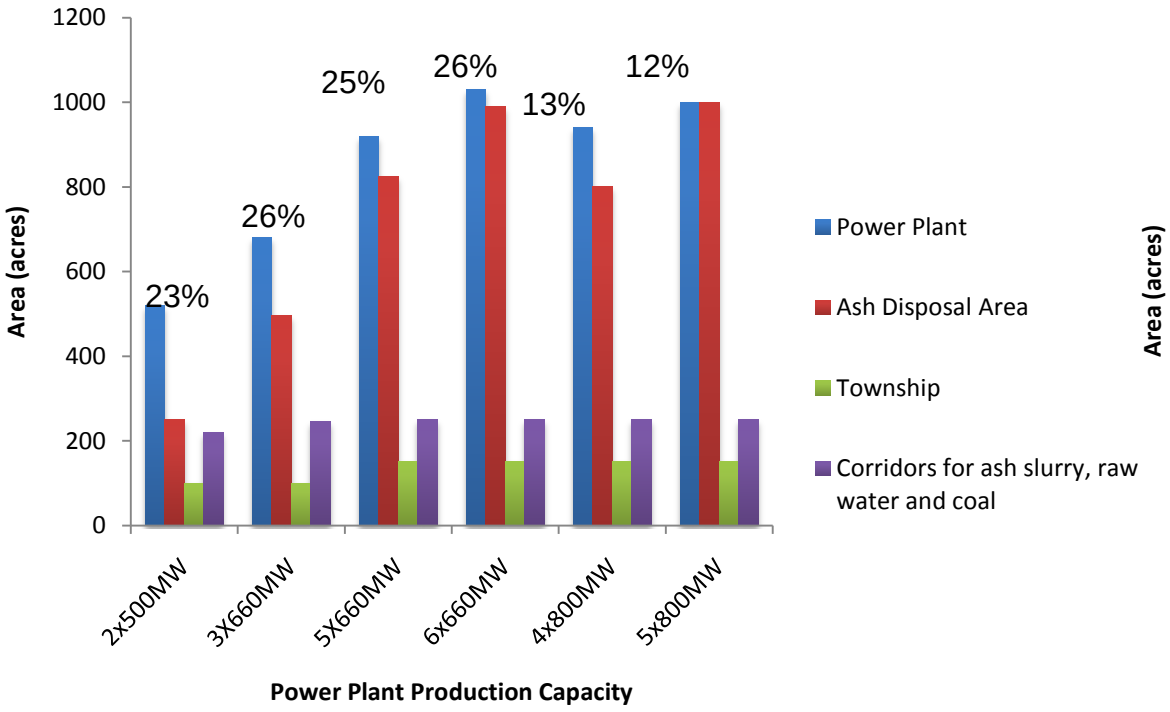
Imported Coal



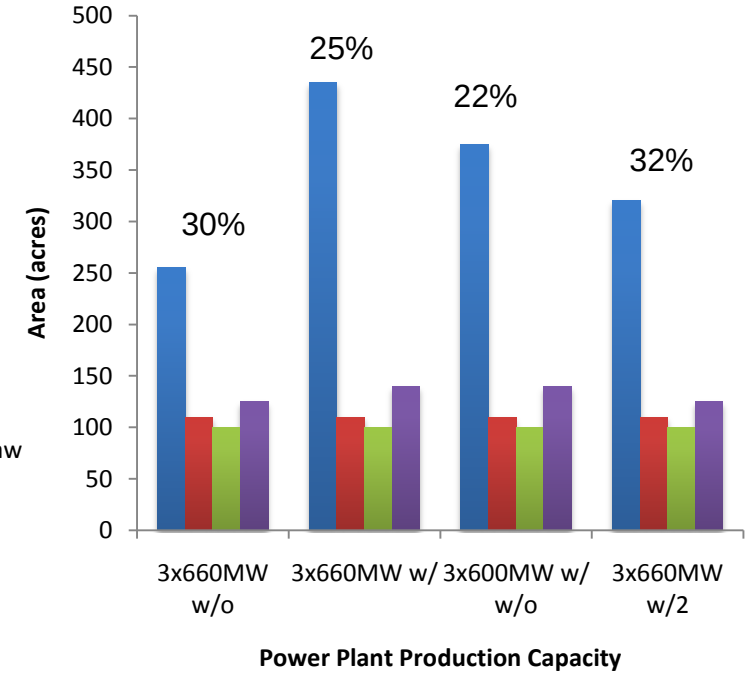
CEA Report, GOI 2010

Proposed Reductions For Total Area 2010

For Indigenous coal plants



For Coastal Imported Coal plants



w/o: With coal conveyor and without cooling tower
w/:With MGR and cooling tower
w/ w/o: with MGR and without cooling tower
w/2: with coal conveyor and cooling tower

CEA Report, GOI 2010

(b) Community Resources

Requested Data		
Demographic	Environmental	
Human Development Index (HDI)	Biocapacity (BC)	Ecological Footprint (EF)

Need to quantify the baseline in order to propose improvements and measure change.

Ecological Footprint (EF)

- Carbon
- Grazing Land
- Forest Land
- Fishing Grounds
- Crop Land
- Built-up Land

Global Hectares (gha) Required for Use

Global Footprint Network
Advancing the Science of Sustainability

Ecological Footprint defined by the Global Footprint Network and images from The Living Planet Report 2012.

Available Calculations of EF

The Global Footprint Network (GFN)

- The National Footprint Accounts provide a framework and equations to calculate the biocapacity and ecological footprint for a country.
  - License would need to be pursued for use.

- **Converts productivity to global hectares (gha) demanded for that use.**

  > The equivalence factor (EQF) is a scaling factor that converts a specific land type into a unit of biologically productive area, a global hectare (gha).

  I.e. Crop Land 2.51 gha per ha
  Grazing Land 0.46 gha per ha
  Built-up Land 2.51 gha per ha

- **Challenges**

  >Extremely detailed inputs required per land use type

  >Functions on the national scale

  >Biocapacity measurement

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Measurement of EF

	EF of Production (gha)	EF of Imports (gha)	EF of Exports (gha)	EF of Consumption (gha)	Biocapacity (gha)
Carbon					
Grazing Land					
Forest Land					
Fishing Grounds				(EF Production + EF Imports)	
Crop Land					
Built-up Land					

Available BC (gha/capita) - EF of Consumption (gha/capita)=
Number of planets demanded at current consumption

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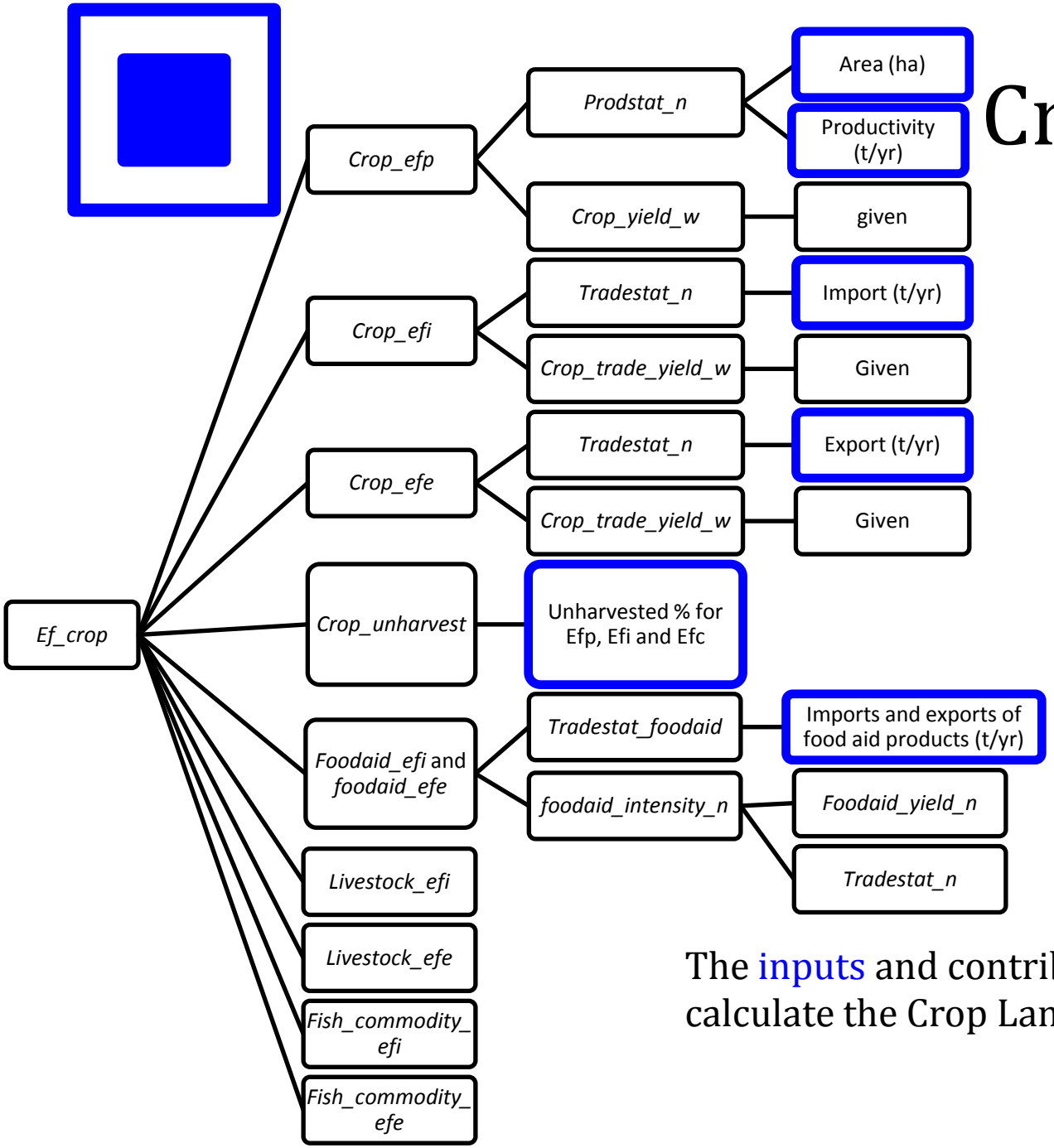
Crop Land EF



The inputs and contributing *worksheets* to calculate the Crop Land EF.

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Cropland EF

$$Ef_p\ (gha) = \frac{\text{Production (t yr}^{-1})}{\text{World Crop Yield (t wha}^{-1}\ \text{yr}^{-1})} \times \text{EQF (gha wha}^{-1})$$

- Calculated per crop for production, imports and exports
- Similar calculations for each land use type—Grazing Land more complicated due to source of livestock feed

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Consumption Land Use Matrix

	Carbon	Grazing Land	Forest Land	Fishing Ground	Crop Land	Built Up land	Total
Food							
Shelter							
Mobility							
Goods							
Services							
Total							

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Cropland EF

$$Ef_p\ (gha) = \frac{\text{Production (t yr}^{-1})}{\text{World Crop Yield (t wha}^{-1}\ \text{yr}^{-1})} \times \text{EQF (gha wha}^{-1})$$

$$\text{Productivity (t ha}^{-1}) = \frac{\text{Production (t yr}^{-1})}{\text{Area (ha)}}$$

>Per crop

>Identify Irrigated crops

>Identify Consumption uses per land use

>Can convert to market value

Data Inputs

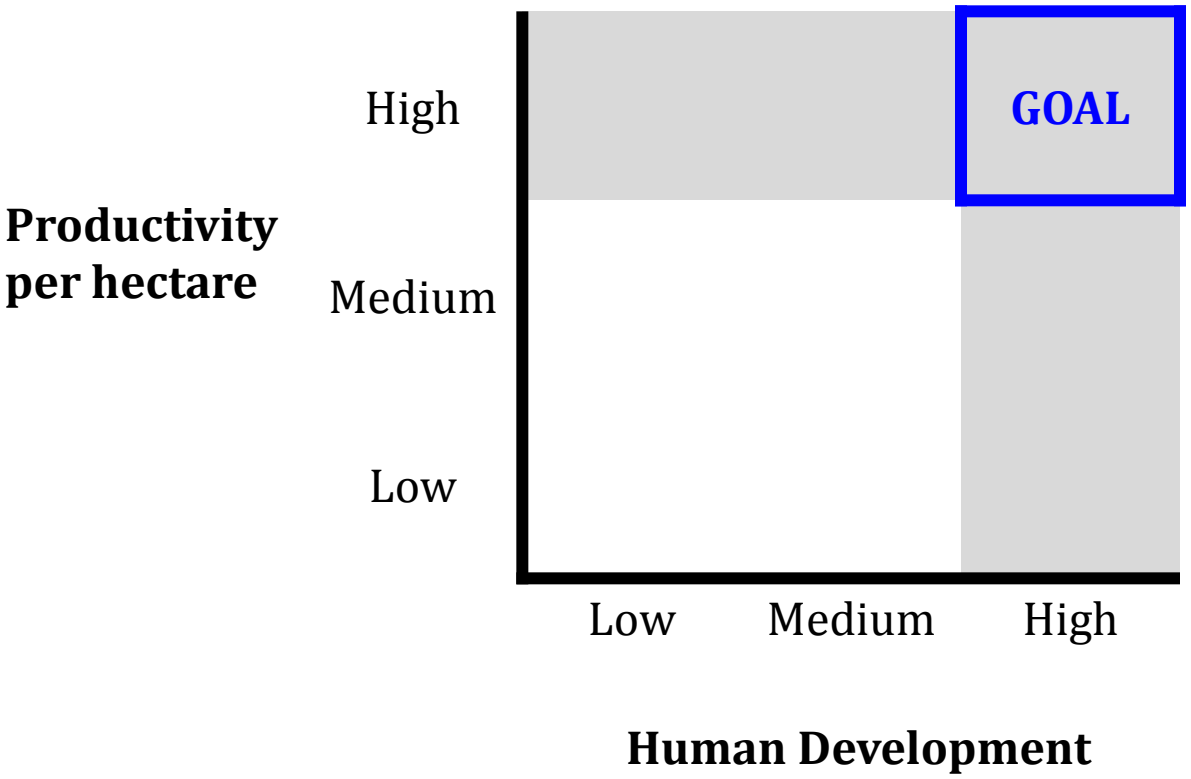
$$\text{Productivity (t ha}^{-1}\text{)} = \frac{\text{Production (t yr}^{-1}\text{)}}{\text{Area (ha)}}$$

Land Use Type	Total Area (ha)	Production (t yr^{-1})
Grazing Land		
Livestock Feed Production		
Livestock Grazing Area		
Forest Land		
Fishing Grounds		
Crop Land		
Per Crop		
Built-up Land		No Production

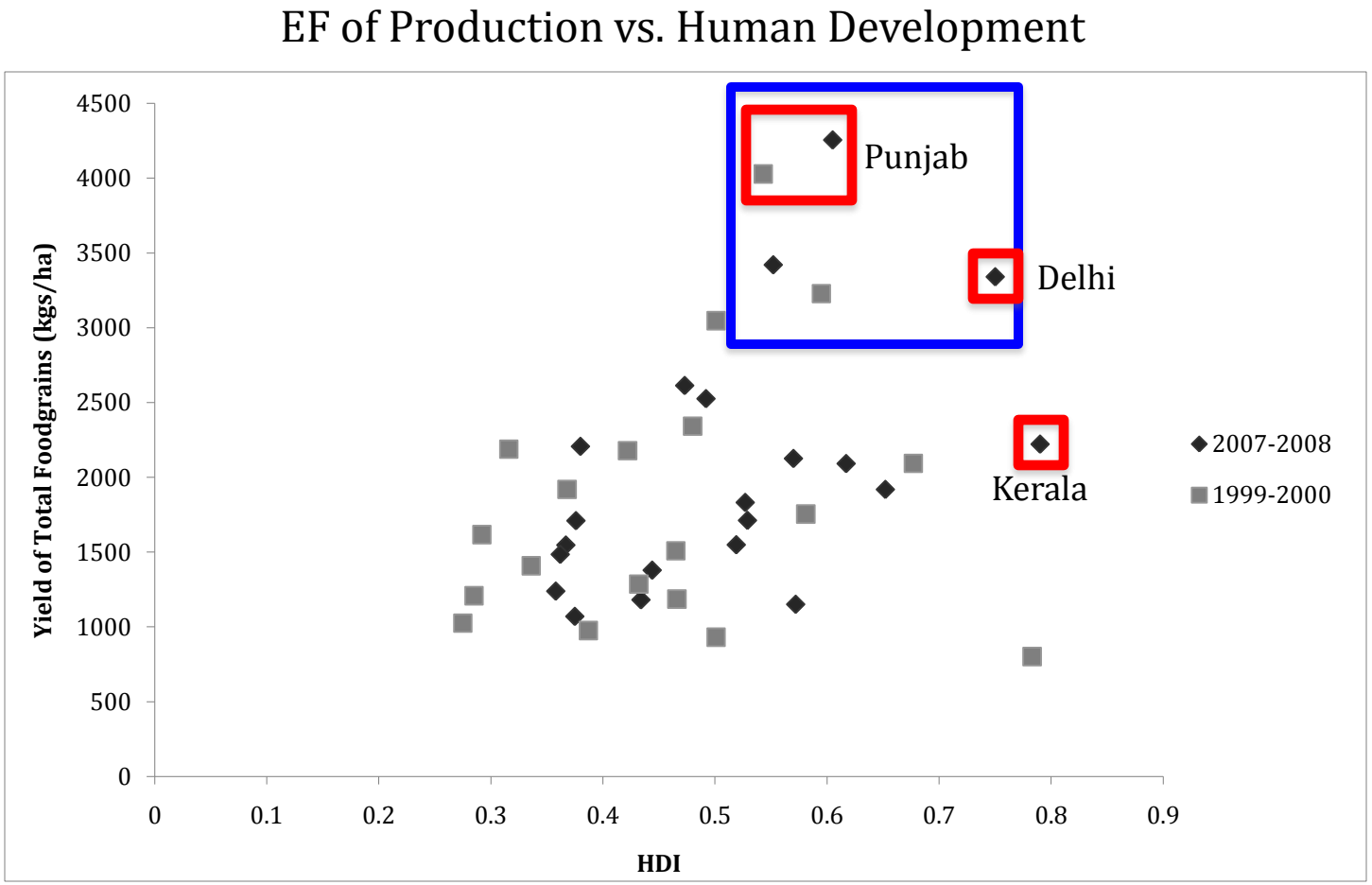
Human Development Index (HDI)

	Education	Health	Economic
HDI Tool from HDR	•Mean years of schooling for ages 25 and above •Expected years of schooling	Life expectancy at birth	GNI per capita (PPP US$)
India Human Development Report 2011	•Literacy	•Female malnutrition rate •Infant Mortality Rate •<5 mortality rate •Total Fertility rate •Child immunization •Toilet facility •Drinking water	•Per capita consumption expenditures •Unemployment rate •Child labor rate •Electricity for domestic use
Village Development Index (VDI)	Literacy Rate	Village proximity to health infrastructure	Percentage of the population above the poverty line

Revised Inside the Box Goal



States of India Inside the Box



(c) Return on Investment

Sustainable Development Return on Investment (SDROI)

$$SDROI = \frac{\Delta HDI * p}{INV * MIT}$$

ΔHDI: Change in HDI over selected time period

p: Population of selected area

INV: Tata's investment costs

MIT: Tata's mitigation costs

Formula from The Global Footprint Network

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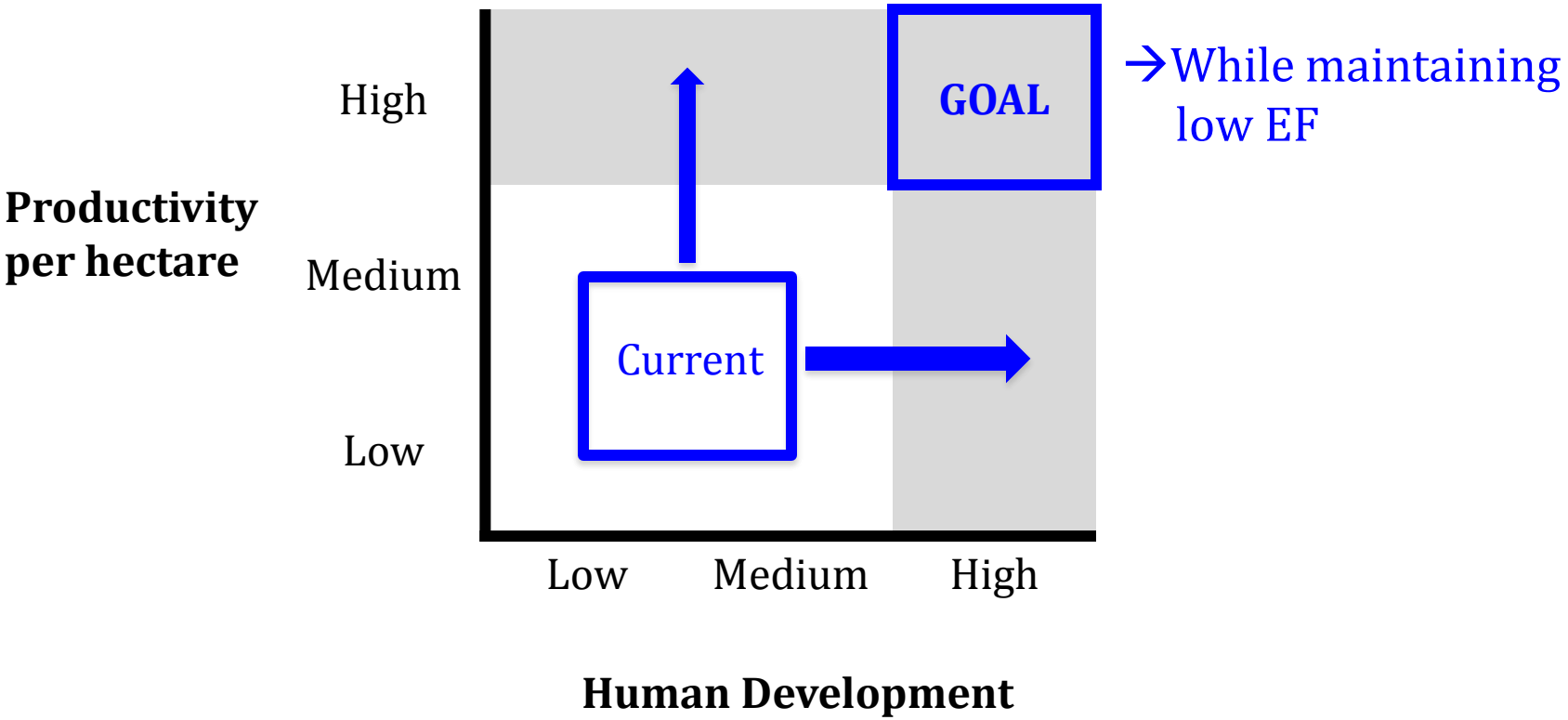
Tracking the Improved Resource Management



Need to track ΔHDI and Δ Productivity/Ha in constant measures for constant area over a period of time.

Thank you!

Tata Power

Dr. Saxena, Col. Tewari, Mr. Puranik,

Mr. Pradhan, and

LSE