Framework for Valuing Degradation of Forests Due to Coal Mining

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2011: 1403.11 km² of dense forest cover would be diverted for coal mining
Delineation

Why was the decision taken?
- Existing Indian Energy Scenario
- Indian ‘Coal mining vs. Dense Forest’ policy Dilemma
- Delineating the objectives of current research

Is the decision good?
- Framework for the Benefit-Cost analysis of policy decision
- Estimations of Benefit
- Estimation of Costs
- Analyzing the Balance sheet

What can be alternative perspective for the situation?
- Global perspective

Conclusion
India needs to cater growing energy needs of approximately 1.2 billion sustainably.

Peak power deficit (2011-2012) stands at 12.9%. (Central Electricity Authority CEA, 2011)

Approximately 404.5 million people do not have access to power in India (International Energy Agency, 2010)

Indian energy policy aims to scale up its power generation capacity from 174 GW in 2010 to 778 GW by 2030 in order to maintain economic growth rate of 8% per annum (Indian Energy policy, Planning Commission of India, 2005)

Indigenous coal production for power generation would be scaled up three folds in next 20 years (560 Million MT/ annum to 2010 to 1659 Million MT in 2030) (India Energy Book 2012, World Energy Council)
Coal Mining vs. Dense Forest

Should 3206.8 km² of dense forest area be compromised to produce 660 million tons of coal/annum?
Benefit - Cost Analysis of policy decision to compromise dense forests for coal mining in India

Disassociating the value of forest degradation due to coal mining for national and global boundaries
Valuing Degradation of Forests Due to Coal Mining in India

Opening 3206.84 Km² Of Dense Forests for Coal Mining

Benefits: GDP Generation potential (USD) from 660 Million Ton of coal supply per annum

Costs: Forest loss, GHG Emissions

Direct Cost (USD)
- Cost of Timber lost
- Cost of Non Timber Forest Produce lost

Indirect Cost (USD)
- Cost of soil replenishing
- Cost of water recharge
- Cost of Flood prevention

Option Cost (USD)
- Value of carbon released as a result of deforestation
- Cost of fugitive emissions from the mining process

* Country level estimation factors
* Estimations in USD (2005 base price)
Benefit Estimation

Assumption: Entire coal production is utilized for power generation

There exists a unidirectional causality from coal to GDP in India (Wolde-Rufael, 2010; Li, 2011)

- **Coal Production**: 660 Million Tons/annum
- **Indian Energy Intensity 2011**: 0.117 kWh (INR, 2005 base price)
- **Coal factor-Indian Power Plants**: 0.7 Ton coal/MWh of power generated
  ([Central Electricity Authority, GOI, 2011](#))
- **182,672.74 million USD/annum**
  ([Research estimate](#))
Cost Estimation

Diverting 3206.84 km$^2$ of Dense Forest Area for coal mining

Direct Value

Timber Value
Average volume of standing timber 7400 m$^3$/ km$^2$ of forest (Gundimeda 2002, 2000, GAISP Monograph 1, 2005)
Prevailing price of timber adjusted to 2005 constant prices (Timber commodity market average rates, 2012)

NTFP Value
134,800 USD / km$^2$/annum of dense forest cover (Mahapatra, 2005)

Direct Value of forest
1500.152 Million USD/annum (research Estimate)
Cost Estimation

Diverting 3206.84 km² of Dense Forest Area for coal mining

Indirect Value

Cost of Soil Replenishing
Resource value of soil loss estimated in terms of NPK and OC

<table>
<thead>
<tr>
<th>Element</th>
<th>Replacement Cost (USD)</th>
<th>Million USD</th>
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<tbody>
<tr>
<td>N (Urea)</td>
<td>8,464,419.34</td>
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<tr>
<td>P (DAP)</td>
<td>209,328.21</td>
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<tr>
<td>K (Muriate)</td>
<td>25,222,877.40</td>
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<tr>
<td>Organic Carbon</td>
<td>1,642,837.00</td>
<td>35.54</td>
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</tbody>
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Cost of Water Recharge
Differential recharge capacity of forest 10900.0 m³/km²
Opportunity Cost of water = 0.12398 USD/ m³

4.33

98.93 Million USD /annum

Research Estimate

Cost of Flood Prevention
Flood damage losses per square km of forest loss 18419.47 USD /Km²

59.07

1 GAISP monograph 7, 2006
2 GAISP monograph 7, 2006
3 Bhatia, Kumar, Misra and Robins, 2000
4 GAISP monograph 7, 2006
Estimating GHG Emissions due to Land Use Change

Diverting 3206.84 km² of dense forest area for coal

GHG Emissions from land use change (MTCO₂Eq/Km²)

Carbon released due to Deforestation
MT of carbon/ Km²

Fugitive emissions from coal mining
MT of CH₄/Km²

Value of carbon released due to deforestation

Biomass density of Indian Forest: 9200T/km²
Carbon content: 0.5 times the biomass estimate
Carbon released from deforestation (3206.84 km²) 14.75 Million MT of Carbon
Value of carbon released due to deforestation 767 million USD

1 GAISP monograph1, Gundimeda (2002, 2000)

2 US Environmental Protection Agency-National Centre of Environmental Economics (US EPA-NCEE) 2011
2010 Social Cost of CO₂; Discount rate 2.5%, $ 52.0 (2007$/ton of CO₂)
Estimating Fugitive Emissions due to Mining

Coal Production: 660 million MT/annum

Surface Mining: 80%
- Emission Factor (CH₄): 2.15 m³/ton of coal

Underground Mining: 20%
- Emission Factor (CH₄): 13.08 m³/ton of coal

Methane emission from the process: 1.91 million MT/annum

Social Cost of Methane: **2103.04 million USD/annum**
- Research Estimate

1. Coal India Limited, 2011
2. INCCA, 2007
3. Density of CH₄ (0.668 kg/m³)
4. US EPA-NCEE 2011

2010 Social Cost of Methane; Discount rate 2.5%, $1,100 (2007$/ton)
The Balance Sheet
Benefit Cost Analysis

Benefits
182672.74 million USD

Costs
(2.44%)
4469.52 million USD

Cost Break Up: Diverting Dense Forest for Coal Mining

- 2.47% Indirect Cost
- 33.57% Direct Cost
- 71.54% Option Cost
- 19.12% Carbon released
- 52.43% Fugitive emissions

Benefits 182672.74 million USD

GHG Emissions
(7.71%)

Fugitive Emissions
(52.43%)

Option cost
GHG Emissions
(60.14%)

Direct Cost
(37.40%)

Indirect Cost
(2.47%)

Cost Break up : Diverting Dense Forest for Coal Mining

182672.74 million USD

4469.52 million USD
One unit of forest diverted to coal mining generates three times more GHG emissions year over year than forest degradation without the land use change.

**Indian context**

Coal ➡️ power generation ➡️ GDP

**Global Context**

Power ➡️ Production
Multi-perspective Evaluation

**Spatial**
- India needs to cater energy needs of 1.2 billion individuals sustainably
- Energy base is predominantly coal based
- Coal as fuel for power production has a huge negative environmental footprint
- Resources provisioned for basic human needs i.e. food, clean water, shelter & health may be compromised to provision resources for energy generation
**Temporal**

- Coal production peaks at 2032 when social cost of CH$_4$ emission almost doubles from $1100$/ Ton of CH$_4$ (2010) to $2000$/ Ton of CH$_4$ emitted
- The installed capacity of renewable energy is expected to reach 2.5TW by 2030, growth of over 800% (Bloomberg New Energy Finance 2011)

**Socio-technological**

- ‘Clean & affordable energy for all’
- Developing countries need access to appropriate and cost effective Environmentally Sound Technologies (EST)
- Absence of an active technology mechanisms for enhancing the development, adaption, diffusion and transfer of EST’s affordably to world at large
Inferences

- Existing socio-technical regime of energy generation in India is highly coal centric therefore it provides substantially high benefits to diverting dense forest for coal mining.

- Scaling up the existing coal regime may lead to long term, suboptimal lock-in of future resources and environmental performance of the society as whole.
“Whatever I dig from thee, O Earth, may that have a quick growth. O purifier, May we not injure thy vitals or thy heart.”

*Atharvaveda 12.1.35*