Palm Oil

TEEB FOR AGRICULTURE AND FOOD
Overview

- Palm oil consumption set to double in 40-years

- Aim
  - Support the development of natural and social capital accounting.
  - Showing how businesses can identify more sustainable practices that yield financial and societal returns

- Materiality Assessment
  - Palm oil production in the top 11 countries analysed

- Indonesia Case Study
  - Land conversion
  - Fertiliser application
  - Methane capture from palm oil mill effluent (POME) ponds
  - Wage, salary, occupational health, and safety practices

Palm Oil
Countries in this study are responsible for 96% of global palm oil production

- Africa
  Cote d'Ivoire and Nigeria

- Asia
  China, Indonesia, Malaysia, and Thailand

- Oceania
  Papua New Guinea

- South America
  Brazil, Colombia, Guatemala, and Honduras

Biophysical data: 2011
Valuation year: 2014
Framework

1. Understand drivers of change
   - Devise KPIs that measure impact or dependency

2. Understand the consequence
   - Identify the endpoint (primary receptor) of the impact or dependency

3. Quantify in biophysical terms
   - Changes in life expectancy, quality of life, ecosystem service provision

4. Quantify in monetary terms
   - Valuation is always human-centric and reflect the value to the endpoint
Palm Oil

Indonesia and Malaysia are responsible for 49% and 35% of global palm oil production.

Three cultivation systems
- Smallholders; Estate plantations and; Large agribusinesses

Life cycle stages included
- Planting and growing
- Milling
- Refining (palm oil and palm oil kernels)

Materiality Assessment

- Biophysical Quantification
  - Input-output modelling
  - Secondary life-cycle assessment (LCA) data – Agri-Footprint
  - Agri-footprint was externally reviewed
  - The data corresponds to a typical farm and milling operation in Indonesia and Malaysia

- Planting and growing
  - Inputs: Fertilizers, fuel, land, pesticides, and water

- Milling
  - Inputs: Electricity, fuel, transportation, and water

- Refining - Crude palm oil & palm kernels
  - Inputs: Electricity, fuel, other raw materials, transportation, and water
Materiality Assessment - Processes
## Materiality Assessment - Practices

<table>
<thead>
<tr>
<th>Practice or input</th>
<th>Measured output</th>
<th>Operational</th>
<th>Supply chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use change</td>
<td>Loss in carbon stored (above-ground and soil)</td>
<td></td>
<td>n/a</td>
</tr>
<tr>
<td>Fertilizer application</td>
<td>Air, land and water pollution from application</td>
<td></td>
<td>Air, land and water pollution from manufacture</td>
</tr>
<tr>
<td>Pesticide application</td>
<td>Land pollution from application</td>
<td></td>
<td>Air, land and water pollution from manufacture</td>
</tr>
<tr>
<td>Water use</td>
<td>Water use</td>
<td></td>
<td>n/a</td>
</tr>
<tr>
<td>Use of other inputs: energy, raw materials and transportation</td>
<td>Air, land and water pollution from use</td>
<td></td>
<td>Air, land and water pollution from manufacture</td>
</tr>
<tr>
<td>POME management</td>
<td>Methane (greenhouse gas) emissions</td>
<td></td>
<td>n/a</td>
</tr>
</tbody>
</table>
Palm Oil

Indonesia and Malaysia are responsible for 49% and 35% of global palm oil production

Three cultivation systems
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Life cycle stages included
- Planting and growing
- Milling
- Refining (palm oil and palm oil kernels)

Natural capital costs
- Air, land, and water pollutants
- Greenhouse gas emissions
- Waste production
- Water consumption

Materiality Assessment

- Monetary Valuation
  - Impact on human health and ecosystems
  - Air, land, and water pollutants
  - GHG emissions
  - Waste production
  - Water consumption

- Limitations
  - Natural capital costs excluded:
    - Impact resulting loss of biodiversity
    - Displacement of local communities
  - Partially excluded:
    - Air pollution from biomass burning – not all health impacts included
  - Natural capital dependencies excluded:
    - Ecosystem services
Palm oil

Palm oil production has a total cost of $38.5bn and palm kernel oil $5bn

Main drivers of valuation results:
- Yield (tonnes of FFB per ha) and conversion rate (tonnes of FFB per tonne of finished product)
- Quantity and type of inputs
- Monetary valuation per unit quantity of emissions

Materiality Assessment [results]

- Indonesia and Malaysia contribute **66% and 26%** to the total impact of palm oil production

- On average, producing one tonne of palm oil and palm kernel oil has a natural capital cost of $813 and $924 respectively

- Producing palm oil in **Nigeria** has the highest cost per tonne, due to lower yield per ha and conversion rate

- **Cote d’Ivoire** has the lowest cost per tonne due to lower social and natural capital costs of emissions associated with fertiliser application and pesticide application
Materiality Assessment

[results]

<table>
<thead>
<tr>
<th>Country</th>
<th>Other raw materials, milling and refining</th>
<th>Emissions from POME</th>
<th>Other raw materials, planting phase</th>
<th>Pesticide manufacturing</th>
<th>Pesticide application</th>
<th>Fertiliser manufacturing</th>
<th>Fertiliser application</th>
<th>Land use change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nigeria</td>
<td>4</td>
<td>170</td>
<td>30</td>
<td>4</td>
<td>13</td>
<td>22</td>
<td>533</td>
<td>560</td>
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<tr>
<td>Indonesia</td>
<td>3</td>
<td>90</td>
<td>13</td>
<td>2</td>
<td>30</td>
<td>13</td>
<td>206</td>
<td>735</td>
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<tr>
<td>Honduras</td>
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<td>15</td>
<td>2</td>
<td>24</td>
<td>11</td>
<td>259</td>
<td>186</td>
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<tr>
<td>Malaysia</td>
<td>3</td>
<td>99</td>
<td>10</td>
<td>1</td>
<td>26</td>
<td>13</td>
<td>136</td>
<td>241</td>
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<tr>
<td>Papua New Guinea</td>
<td>2</td>
<td>71</td>
<td>10</td>
<td>1</td>
<td>38</td>
<td>6</td>
<td>151</td>
<td>246</td>
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<tr>
<td>Thailand</td>
<td>3</td>
<td>129</td>
<td>16</td>
<td>1</td>
<td>39</td>
<td>15</td>
<td>315</td>
<td>70</td>
</tr>
<tr>
<td>Guatemala</td>
<td>3</td>
<td>100</td>
<td>17</td>
<td>2</td>
<td>25</td>
<td>12</td>
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<td>Brazil</td>
<td>2</td>
<td>95</td>
<td>17</td>
<td>2</td>
<td>26</td>
<td>12</td>
<td>214</td>
<td>13</td>
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<tr>
<td>Colombia</td>
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<td>113</td>
<td>17</td>
<td>2</td>
<td>25</td>
<td>12</td>
<td>197</td>
<td>4</td>
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<tr>
<td>China</td>
<td>2</td>
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<td>10</td>
<td>2</td>
<td>8</td>
<td>16</td>
<td>263</td>
<td>8</td>
</tr>
<tr>
<td>Côte d’Ivoire</td>
<td>2</td>
<td>87</td>
<td>13</td>
<td>1</td>
<td>14</td>
<td>8</td>
<td>137</td>
<td>4</td>
</tr>
</tbody>
</table>
Indonesia Case Study
Palm Oil

Production in Indonesia causes $25bn worth of damages annually, and over $1,000 per tonne of palm oil.

Significant natural and social capital costs in Indonesia:
- Land conversion
- Fertilizer application
- POME management
- Social impact

Indonesia Case Study

- 7 scenarios

Biophysical Quantification

- Change in above and belowground carbon stock
  - Primary data used where possible from RSPO and FAO, IPCC, EC, Blonk Consultants
  - Same method as in the Materiality Assessment

Air pollution from biomass and peatland burning

- 24 air pollutants taken into account

Monetary Valuation

- GHG cost of $126
- Indonesia specific air pollutant costs
- Financial costs of fire and mechanical clearing
  - Includes labour and input costs
### Indonesia Case Study

#### Land Conversion Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Prevailing ecosystem</th>
<th>Soil type</th>
<th>Land conversion method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Primary forest</td>
<td>Peat soil</td>
<td>Mechanical clearing</td>
</tr>
<tr>
<td>2</td>
<td>Primary forest</td>
<td>Mineral soil</td>
<td>Mechanical clearing</td>
</tr>
<tr>
<td>3</td>
<td>Grassland</td>
<td>Mineral soil</td>
<td>Mechanical clearing</td>
</tr>
<tr>
<td>4</td>
<td>Disturbed forest</td>
<td>Mineral soil</td>
<td>Mechanical clearing</td>
</tr>
<tr>
<td>5</td>
<td>Primary forest</td>
<td>Peat soil</td>
<td>Use of fire</td>
</tr>
<tr>
<td>6</td>
<td>Primary forest</td>
<td>Mineral soil</td>
<td>Use of fire</td>
</tr>
<tr>
<td>7</td>
<td>Disturbed forest</td>
<td>Mineral soil</td>
<td>Use of fire</td>
</tr>
</tbody>
</table>
Palm Oil

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Indonesia Case Study

- Limitations and Assumptions
  - Assumptions on the amount of carbon held in primary ecosystems can influence results significantly
  - Mechanical land clearing
    - Linear decay of forest matter
  - Use of fire in land clearing
    - 50% of forest biomass is burnt; 50% decays linearly over 25 years
    - 7% of land is burnt – approximately 3 tonnes of soil per hectare
Over 25 years, converting primary forest on:
- Peat soil emits the most carbon per ha, or 429 tonnes of carbon per ha
- Mineral soil leads to emissions of 82 tonnes of carbon per ha

Converting disturbed forest and grassland on mineral soil leads to a **positive change** in carbon stocks, meaning that oil palm plantation sequesters more carbon than the net loss due to land use change.

**Headline results (no discounting vs. discounted)**

1. Converting primary forest on peat soil using burning techniques
   - $314,000 per ha or $270,000 per ha

2. Converting primary forest on peat soil using mechanical clearing
   - $198,000 per ha or $146,000 per ha
Indonesia Case Study
[land conversion]
Palm Oil

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Significant natural and social capital costs in Indonesia:
- Land conversion
- Fertilizer application
- POME management
- Social impact

Indonesia Case Study

- 3 scenarios
- Biophysical Quantification
  - Calculated nitrogen and phosphorus balance over 25 years
  - Yield maintained in all scenarios
- Monetary Valuation
  - The same coefficients are applied as in the Materiality Assessment
  - Average fertilizer cost per type of fertilizer is derived from the UN Comtrade database (Indonesia-specific 2013)
  - $1,453 to $2,107 per hectare per year
- Limitations and Assumptions
  - Full effect of soil erosion on not taken into account
  - Assumptions in USLE calculation
  - Cost of improved management practice, such as fertigation, require a large initial investment
### Indonesia Case Study

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Optimisation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>EFB, POME, crop cover, use of pruned fronds, chemical fertilizers No - Surplus of nutrients</td>
</tr>
<tr>
<td>1</td>
<td>EFB, POME, crop cover, use of pruned fronds, chemical fertilizers Yes - Quantity of each input adjusted to provide the adequate quantity of nutrients</td>
</tr>
<tr>
<td>2</td>
<td>Chemical fertilizer only Yes - Quantity adjusted to provide adequate quantity of nutrient</td>
</tr>
</tbody>
</table>
Indonesia Case Study

[fertilizer use]
Palm Oil
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Significant natural and social capital costs in Indonesia:
- Land conversion
- Fertilizer application
- POME management
- Social impact

Indonesia Case Study

2 scenarios

Biophysical Quantification
- Literature review of methane capture and conversion rates (UNFCCC CDM)
- Use of energy
- Treatment of wastewater
- Fugitive emissions and flaring

Monetary Valuation
- GHG cost $126 per tonne
- Marginal capital and operating expenditure costs

Limitations and Assumptions
- Limited range of studies providing an evidence base
- CAPEX costs means the scenario is only applicable to large businesses
Indonesia Case Study

[POME]

- The social and natural capital cost of POME with and without methane capture is $29 and $409 per ha per year respectively.
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Indonesia Case Study

- Income and Occupational Health & Safety
- Quantification
  - National and regional data (research studies, certification reports...)
  - Financial and in-kind wage data, labour productivity and occupational accident rates based on larger palm oil estates in Riau, North Sumatra and Kalimantan
- Monetary Valuation
  - Income
    - Living wage gap: difference between living wage and average wage of underpaid workers
    - In-kind wage (financial value of in-kind benefits) taken into account
  - Occupational health & safety
    - Disability Adjusted Life Years (DALY) approach
    - Cost of PPE to prevent impacts
  - Social return on investment (SROI) of possible interventions calculated based on cash flow analysis of average plantation
- Limitations and Assumptions
  - Lack of quantitative research on social issues in general (land use rights) and relation between better working conditions and profit/productivity/incident rates
  - Uncertainty on value of DALY
The social cost of underpayment of hired workers equals $390 per FTE whereas the social cost of health impacts, caused by occupational incidents, is valued at $185 per FTE.

Social return on investment (SROI) for:
- Paying living wages = 89%
- Increasing use of PPE = 83%
Questions...