The Economics of Ecosystems & Biodiversity

Palm Oil

TEEB FOR AGRICULTURE AND FOOD

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

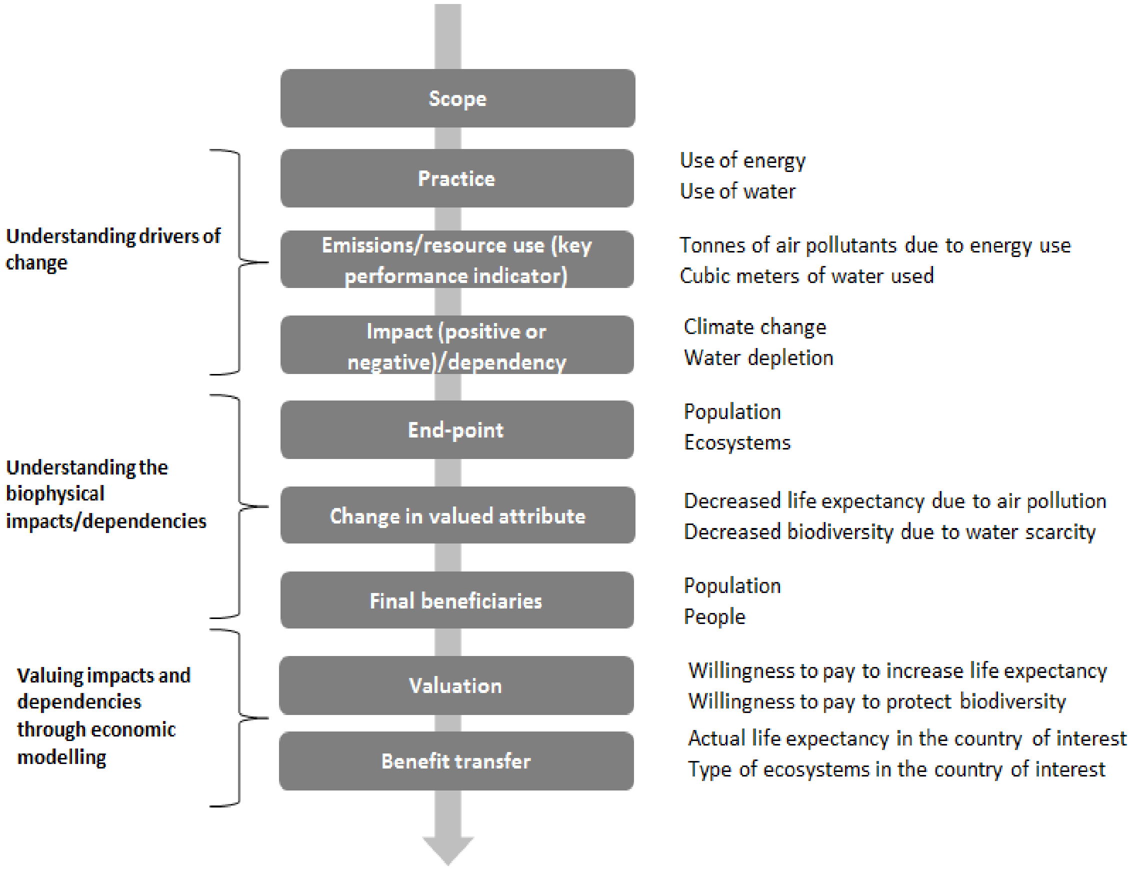
Valuation year: 2014

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

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 agri-businesses

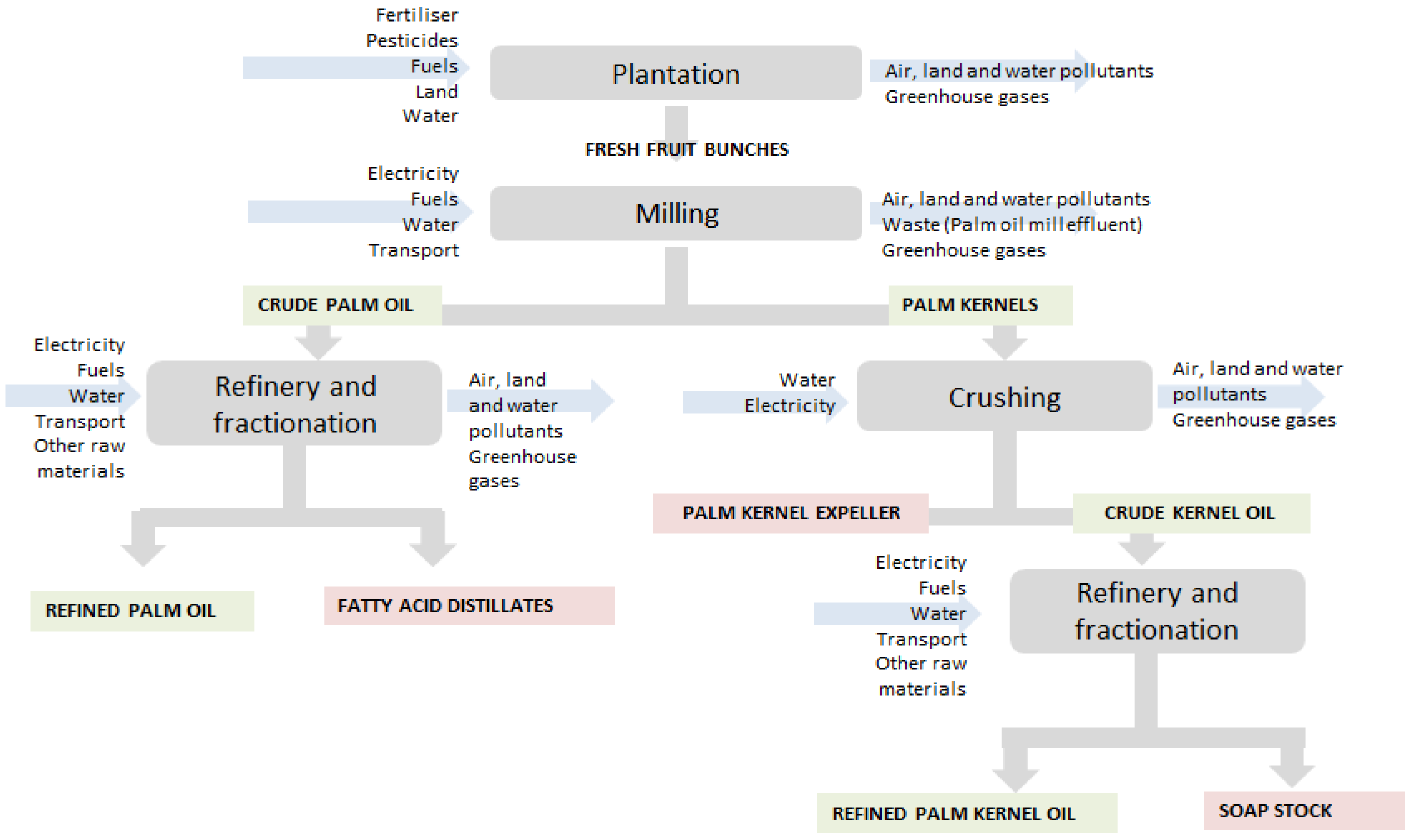
Life cycle stages included

- 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

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

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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:

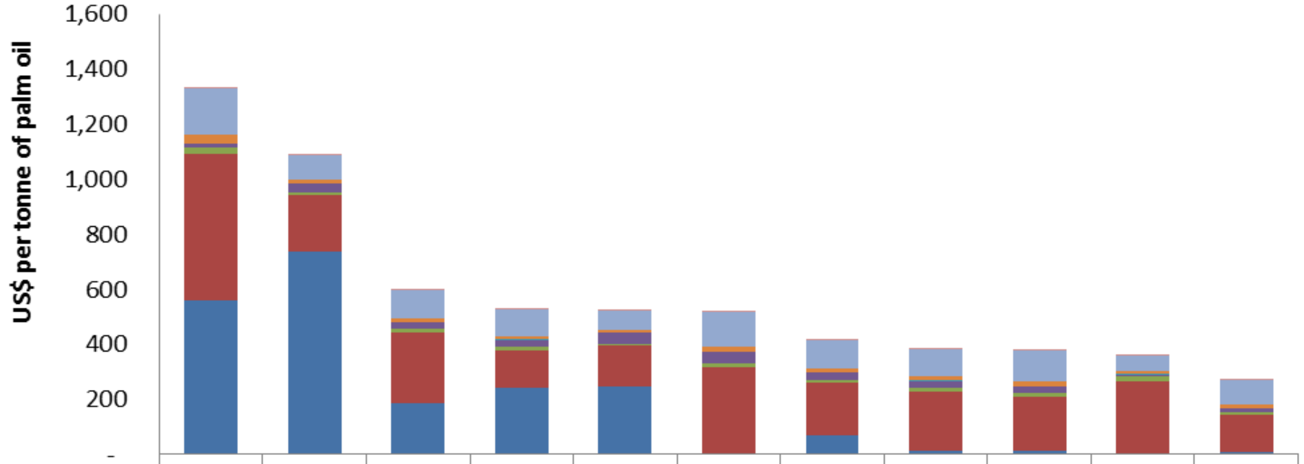
- Yield (tonnes of FFB per ha) and conversion rate (tonnes of FFB per tonne of finished product)
- Quantity and type of inputs
- Monetary valuation per unit quantity of emissions

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]



	Nigeria	Indonesia	Honduras	Malaysia	Papua New Guinea	Thailand	Guatemala	Brazil	Colombia	China	Côte d'Ivoire
Other raw materials, milling and refining	4	3	2	3	2	3	3	2	3	2	2
Emissions from POME	170	90	99	99	71	129	100	95	113	58	87
Other raw materials, planting phase	30	13	15	10	10	16	17	17	17	10	13
Pesticide manufacturing	4	2	2	1	1	3	2	2	2	2	1
Pesticide application	13	30	24	26	38	39	25	26	25	8	14
Fertiliser manufacturing	22	13	11	13	6	15	12	13	12	16	8
Fertiliser application	533	206	259	136	151	315	190	214	197	263	137
Land use change	560	735	186	241	246	2	70	14	13	4	8

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 *[land conversion]*

- 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]*

	Prevailing ecosystem	Soil type	Land conversion method
1	Primary forest	Peat soil	Mechanical clearing
2	Primary forest	Mineral soil	Mechanical clearing
3	Grassland	Mineral soil	Mechanical clearing
4	Disturbed forest	Mineral soil	Mechanical clearing
5	Primary forest	Peat soil	Use of fire
6	Primary forest	Mineral soil	Use of fire
7	Disturbed forest	Mineral soil	Use of fire

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Indonesia Case Study *[land conversion]*

- **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

Indonesia Case Study

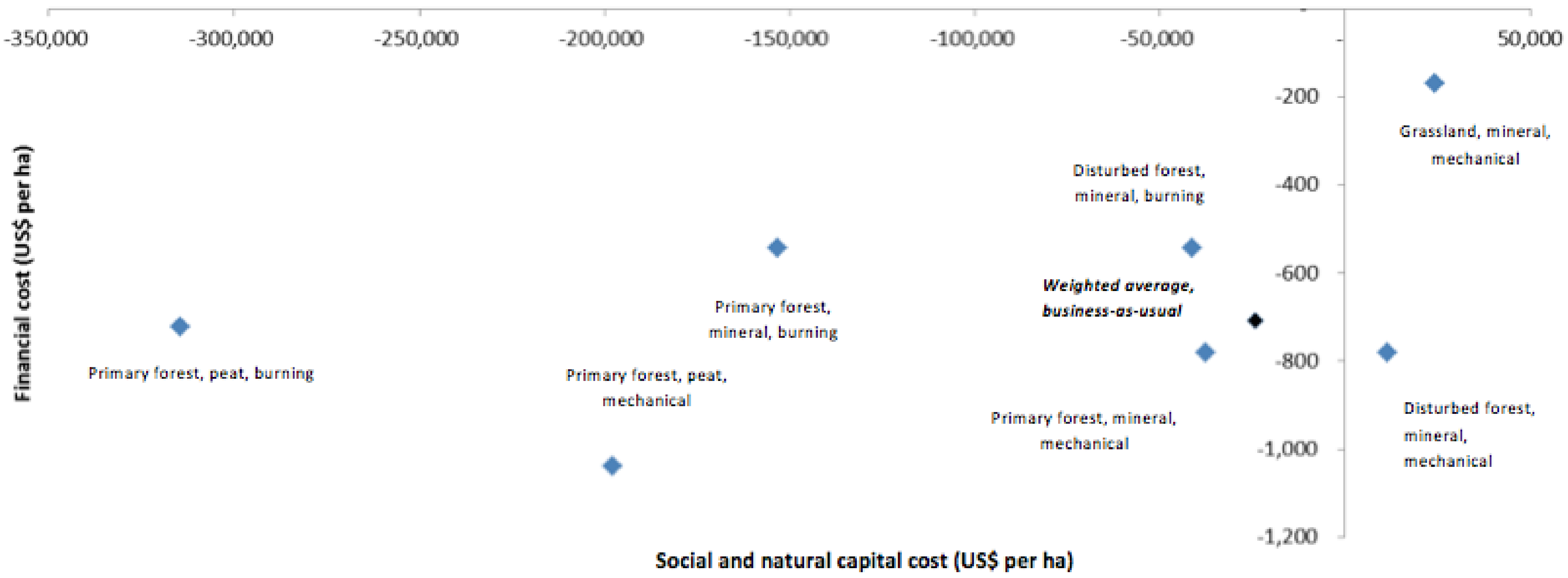
[land conversion results]

- 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]



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- Land conversion
- **Fertilizer application**
- POME management
- Social impact

Indonesia Case Study *[fertilizer use]*

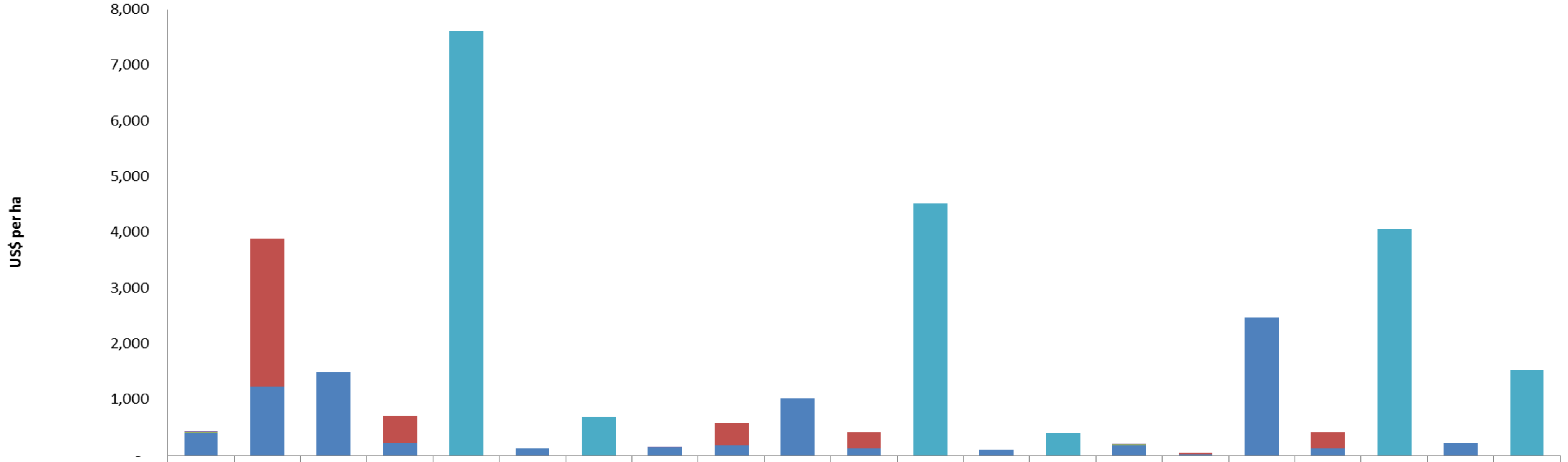
- 3 scenarios
- **Biophysical Quantification**
  - Calculated nitrogen and phosphorus balance over 25 years
  - Yield maintained in all scenarios
- **Monetary Valuation**
  - The same coefficients are applied as in the Materiality Assessment
  - Average fertilizer cost per type of fertilizer is derived 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

[fertilizer use]

	Inputs	Optimisation?
Baseline	EFB, POME, crop cover, use of pruned fronds, chemical fertilizers	No - Surplus of nutrients
1	EFB, POME, crop cover, use of pruned fronds, chemical fertilizers	Yes - Quantity of each input adjusted to provide the adequate quantity of nutrients
2	Chemical fertilizer only	Yes - Quantity adjusted to provide adequate quantity of nutrient

Indonesia Case Study *[fertilizer use]*



	Heavy metals S1	Nitrate to water S1	Ammonia to air S1	P to water (rest in soil) S1	N20 to air S1	N0 to air S1	Fertilizer manufacturing S1	Heavy metals S2	Nitrate to water S2	Ammonia to air S2	P to water (rest in soil) S2	N20 to air S2	N0 to air S2	Fertilizer manufacturing S2	Heavy metals S3	Nitrate to water S3	Ammonia to air S3	P to water (rest in soil) S3	N20 to air S3	N0 to air S3	Fertilizer manufacturing S3
Other (GHGs)		-	-	-	7,618	-	694	-	-	-	-	4,520	-	408	-	-	-	-	4,063	-	1,536
Marine toxicity	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-
Terrestrial toxicity	19	-	-	-	-	-	-	7	-	-	-	-	-	-	12	-	-	-	-	-	-
Freshwater toxicity	0	2,659	-	483	-	-		0	399	-	284	-	-	-	0	31	-	284	-	-	-
Health toxicity	399	1,230	1,491	224	-	121	-	135	185	1,022	131	-	93	-	179	14	2,472	131	-	221	-

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Significant natural and social capital costs in Indonesia:

- Land conversion
- Fertilizer application
- **POME management**
- Social impact

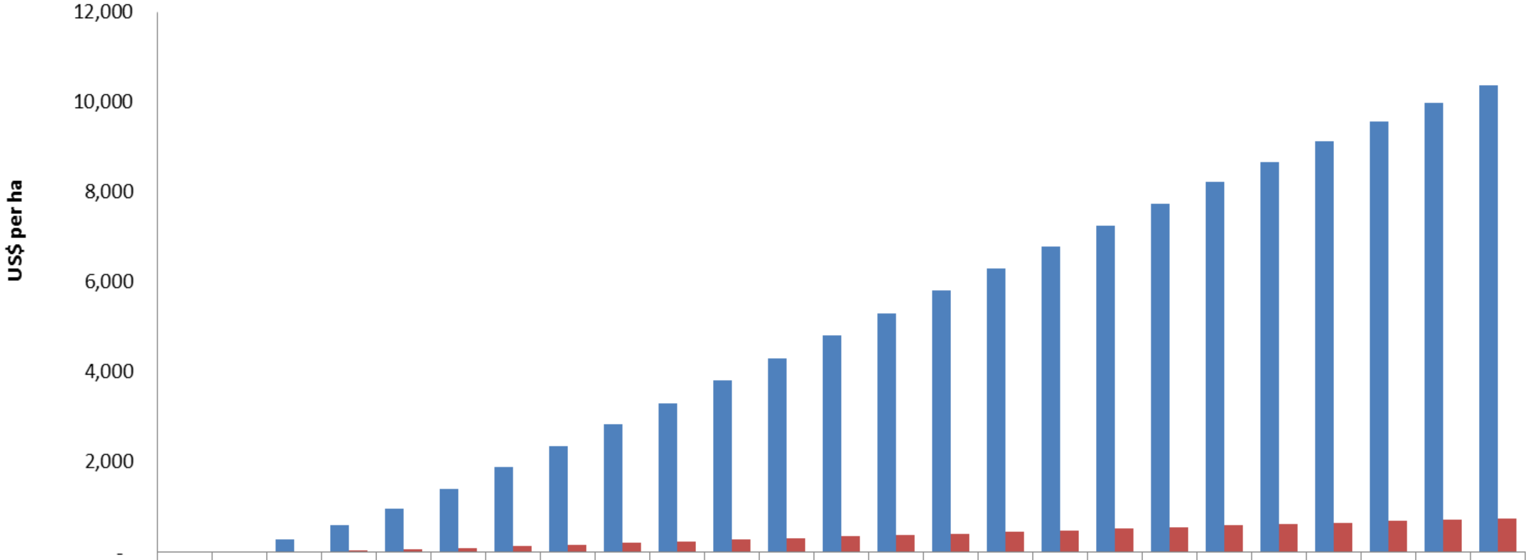
Indonesia Case Study *[POME]*

- 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



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ponds - no methane capture (US) - cumulative	-	-	282	607	976	1,409	1,886	2,363	2,840	3,317	3,816	4,314	4,813	5,311	5,810	6,309	6,786	7,263	7,739	8,216	8,672	9,127	9,560	9,972	10,363
Anaerobic digester system (gas to electricity) - impacts (US) - cumulative	-	-	20	44	70	101	136	170	204	239	275	310	346	382	418	454	488	523	557	591	624	657	688	718	746

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Significant natural and social capital costs in Indonesia:

- Land conversion
- Fertilizer application
- POME management
- **Social impact**

Indonesia Case Study *[social]*

- 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

Indonesia case study *[social]*

- 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...