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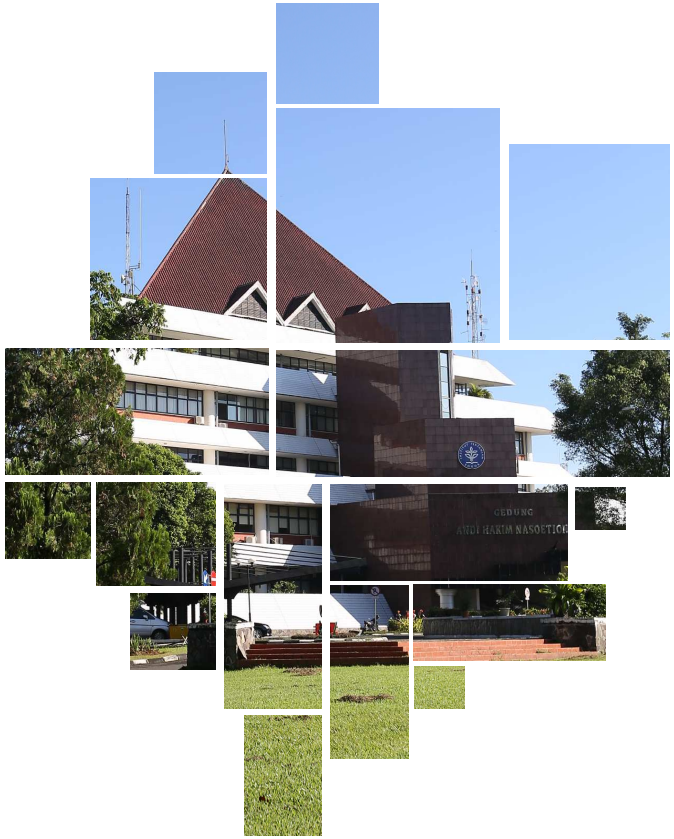


The Economics of Ecosystems and Biodiversity:

Promoting Biodiversity and Sustainability in The Agriculture and Food Sector Through Economic Valuation

Outline

- Analytical Assessment and Methods
- Scenario Development
- Land Use Model
- Biophysical Model
- Value Chain Analysis
- CGE Assessment

TEEBAGRIFOOD Indonesia: Analytical Assessment

Focusing on **the cocoa agroforestry** related to aspects of natural, manufactured, social capital, & other related aspects e.g., value chain & external factors

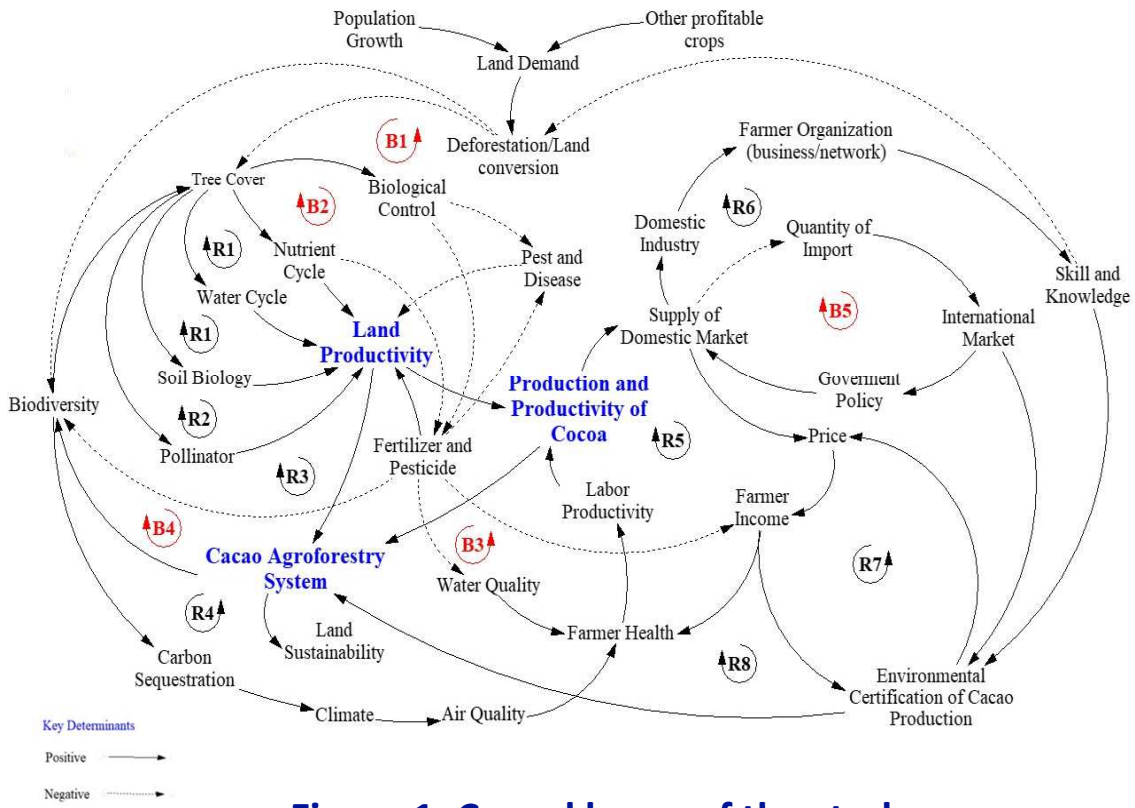
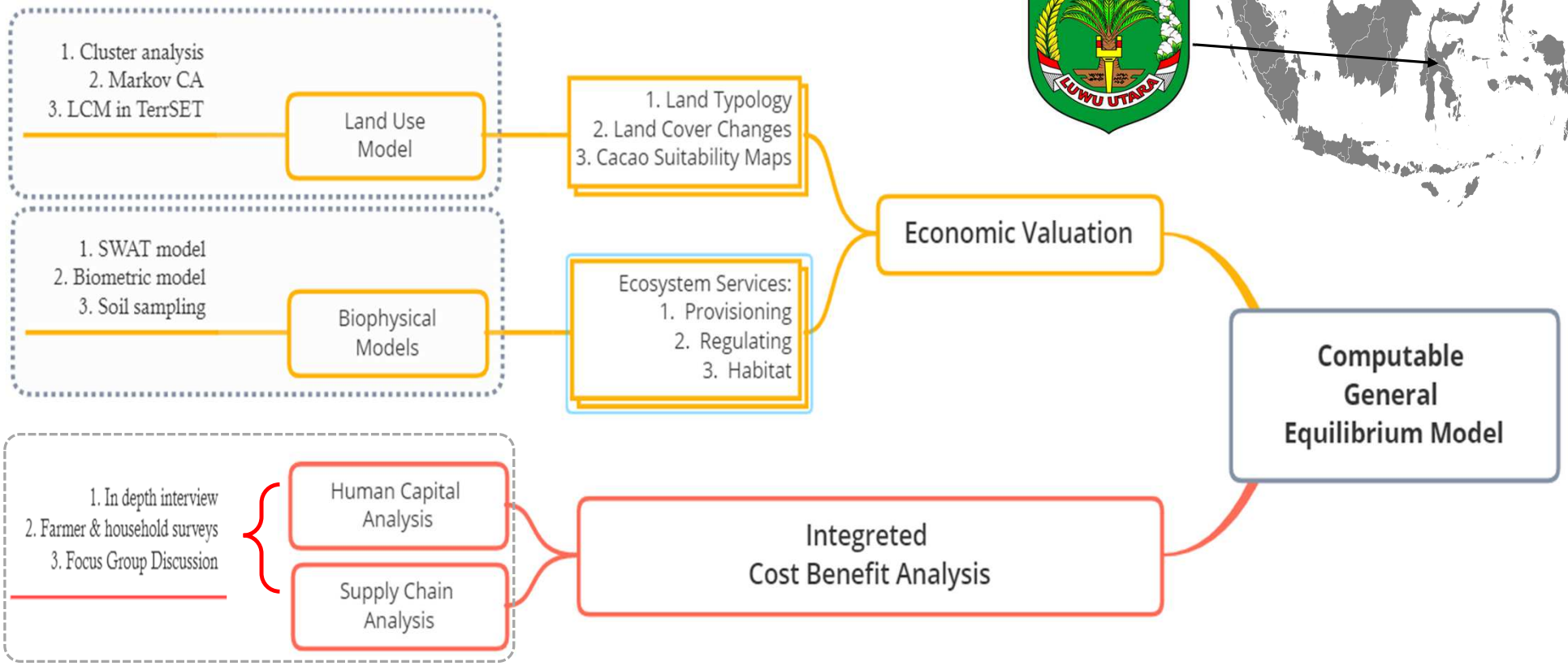


Figure 1. Causal loops of the study

TEEBAGRIFOOD Indonesia: Methods



TEEBAGRIFOOD Indonesia: Scenario Development

- **Mid-Term Development Plan:** Promoting Agroforestry through the inclusion of agroforestry and agri food systems in Indonesia's Mid-Term Development Plan (2020-2024), and within the 2020 Presidential Decree #18
- **Long-Term Development Plan**

Scenarios	Policy interventions	Material impact driver or dependency	Indicators
BAU (Monoculture & agroforestry, AF)	No intervention	1. Household income 2. Soil use 3. Water flow 4. Fertilizer and pesticide use 5. GHG 6. Water quality 7. Wildlife habitat	1. Resilient income 2. Nutrient loss through erosion 3. Discharge fluctuation in rainy and dry seasons 4. N and P load 5. Carbon sequestration 6. Health 7. Wildlife habitat
Agroforestry	Providing seedlings for agroforestry system and GAP training & extension		
	Certification and Eco-labelling		
	International export limited to deforestation free cacao		
	Expansion to the designated area (social forestry)		

Land use models (1)

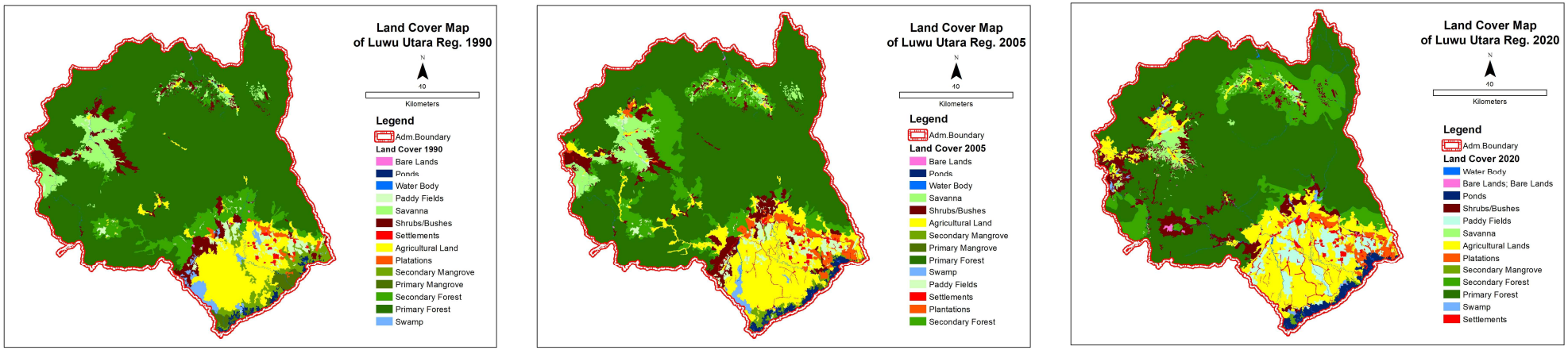
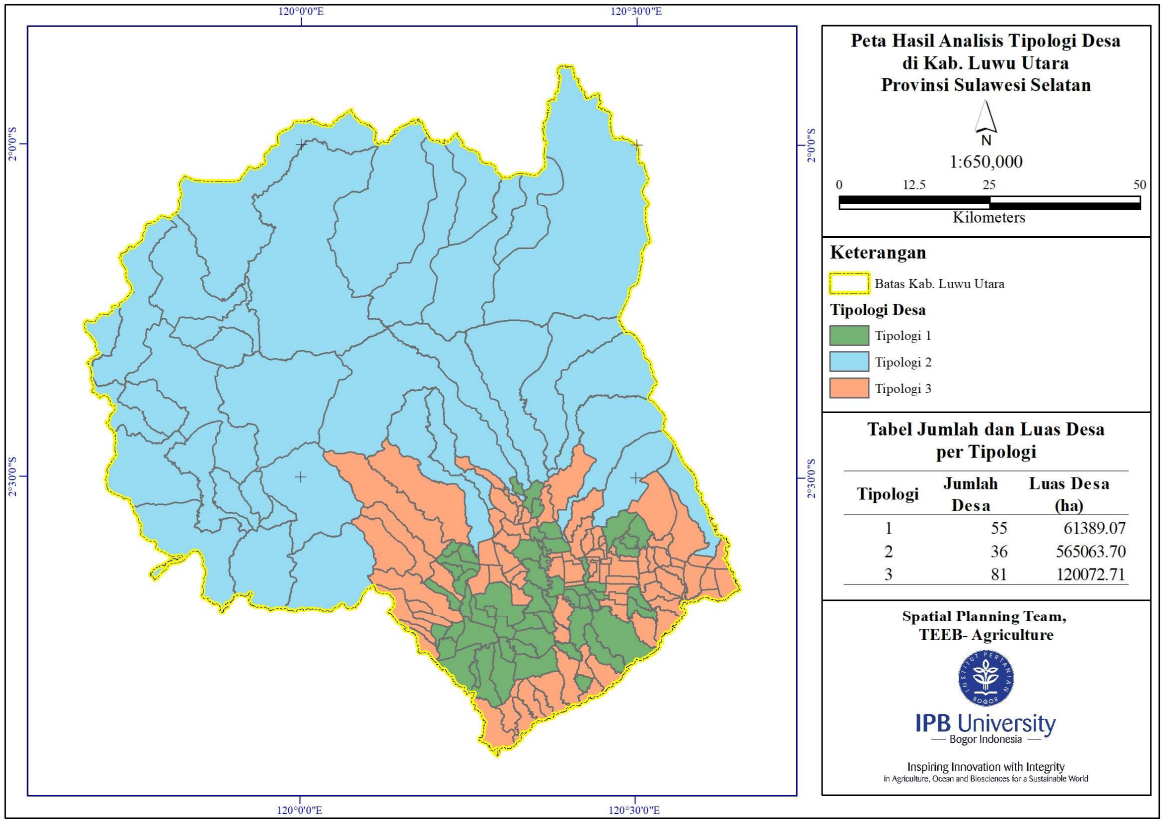


Figure 3. Land cover maps of North Luwu Regency 1990-2020

- Cacao plantations are located within “agricultural lands” class
- Higher elevations area (>200 masl) are dominated by state forest area
- **Cacao plantations are steadily moving upwards to higher elevations-- MoEF Social Forestry are suggested**

Land use models (2)



Tipologi	Jumlah Desa	Luas Desa (ha)
1	55	61389.07
2	36	565063.70
3	81	120072.71

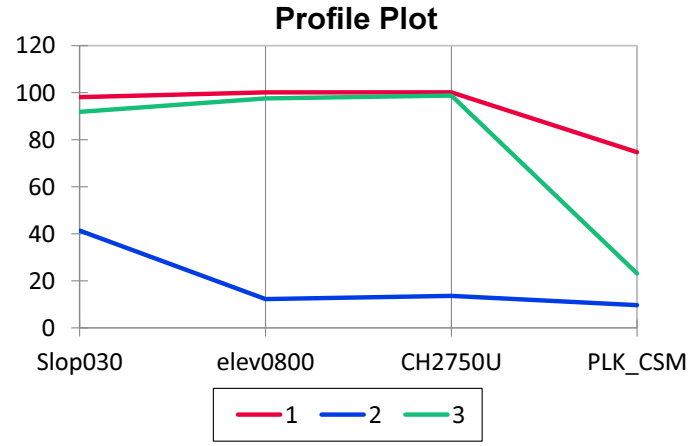


Figure 4. Cacao villages typology distribution within North Luwu

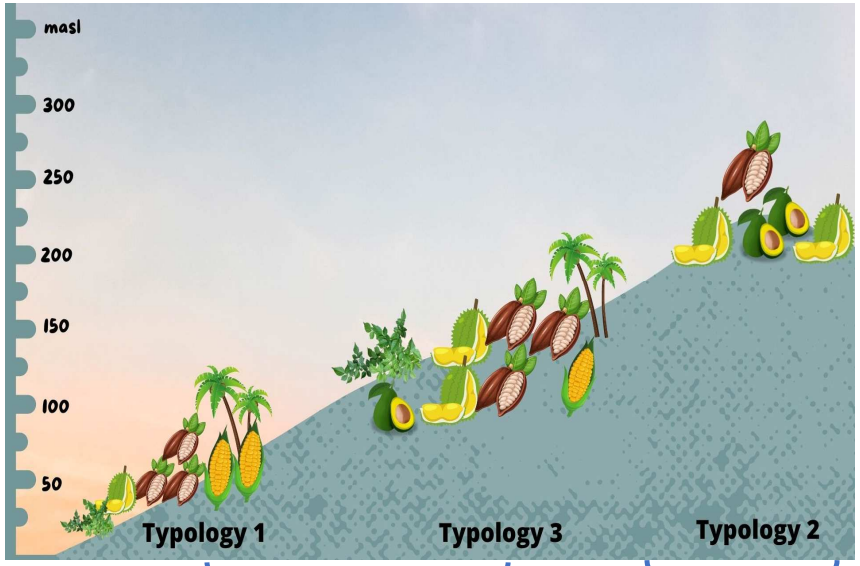
Biophysical Models: Ecosystem Services (1)

Local ecosystem services quantifying through models and field observations

TEEB classification	Types of Ecosystem Services	Variable	Unit
Provisioning Services	On farm output	Cacao Production	kg/ha/year
		Other Crops Production	kg/ha/year
Regulating Services	Water Regulation	Groundwater Recharge	mm/year
		Surface Runoff	mm/year
	Carbon Regulation	Carbon Stock	kg/ha/year
		Carbon Sequestration	kg/ha/year
	Nutrient Retention	Leached Phosphorus	kg/m3/year
		Leached Nitrogen	Kg/m3/year
	Erosion Prevention	Erosion Rate	kg/ha/year
		Sediment Yield	kg/ha/year
Habitat and Biodiversity	Soil Biodiversity	Total Invertebrates	individual/ha
		Total Microbes	colony/ha
		Total Fungi	colony/ha

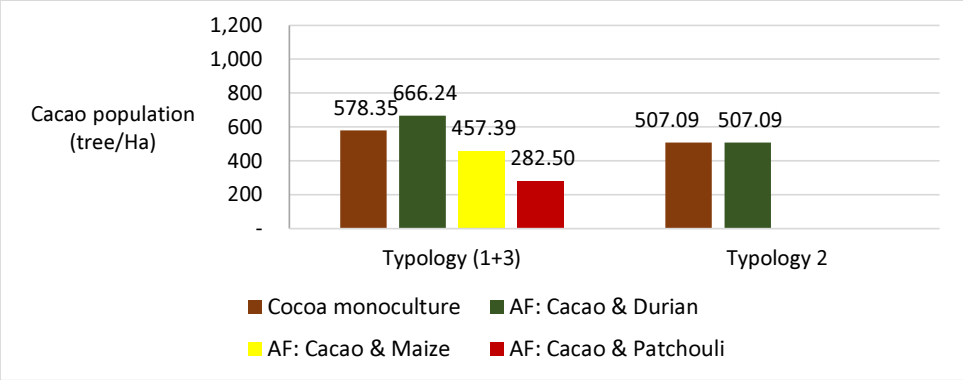
Biophysical Models: Ecosystem Services (2)

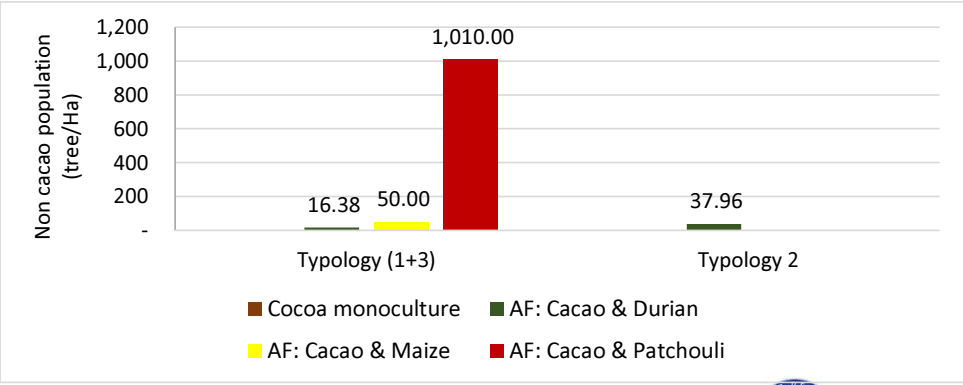
Provisioning services: monoculture vs cocoa agroforestry:



Cacao & Durian
Cacao & avocado
Cacao & Patchouli
Cacao & Maize

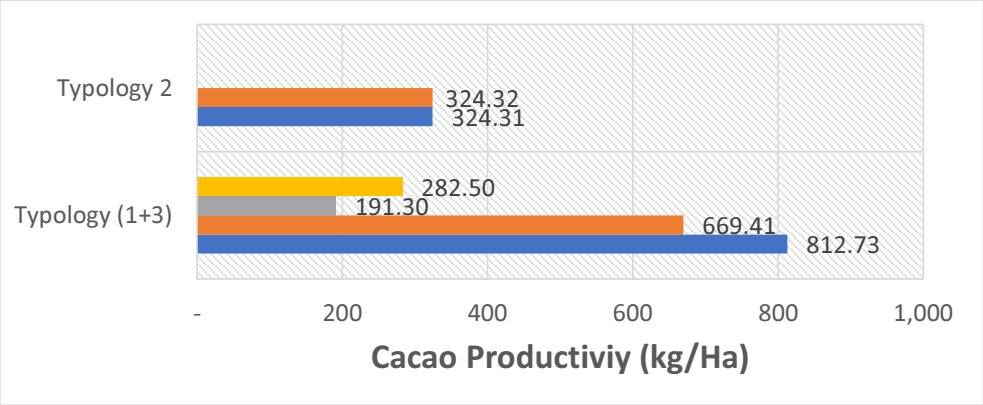
Cacao & Durian
Cacao & avocado



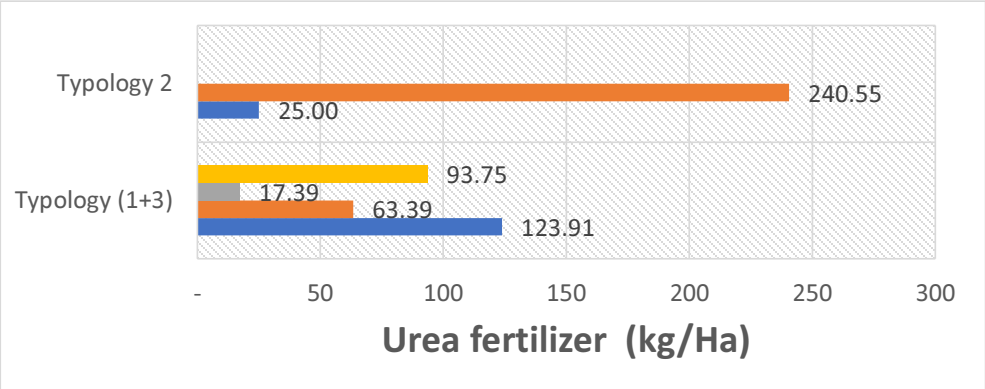


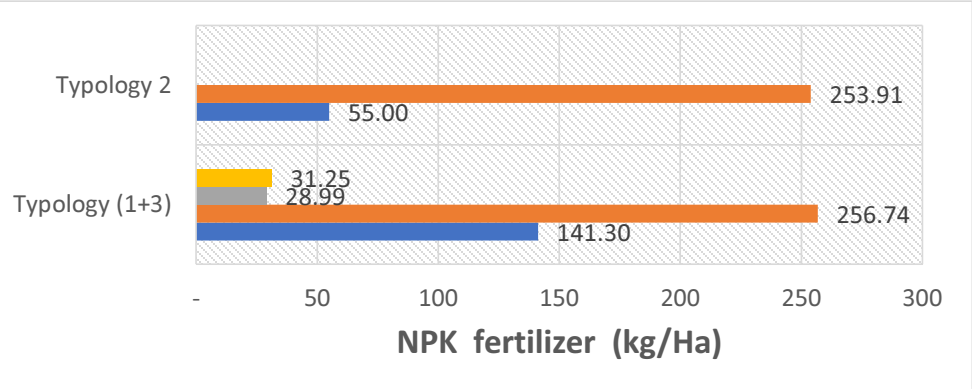
Biophysical Models: Ecosystem Services (2)

Cacao Productivity vs Fertilizer use: Monoculture vs Cocoa Agroforestry



- AF: Cacao & Patchouli
- AF: Cacao & Maize
- AF: Cacao & Durian
- Cocoa monoculture





Biophysical Models: Ecosystem Services (4)

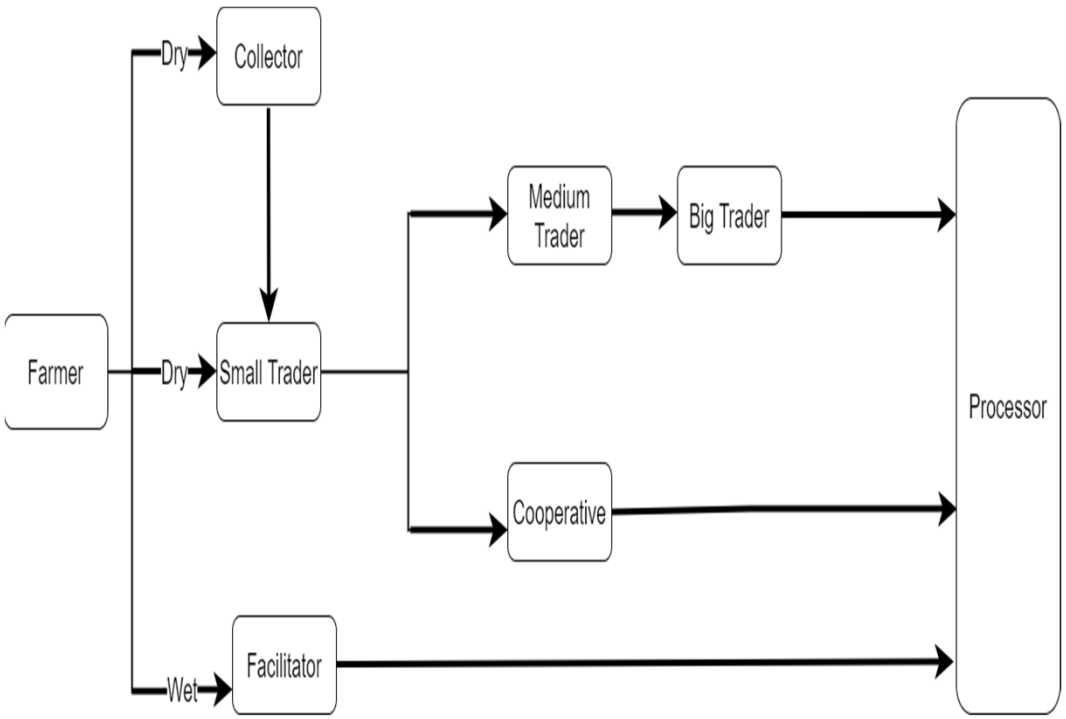
Cacao agroforestry increases various local ecosystem services

Regulation Services	Unit	Typology 1 & 3		Typology 2	
		Monoculture	Agroforestry	Monoculture	Agroforestry
Water Regulation					
Groundwater Recharge	m3/ha/year	14570	16343	9315	10599
Deep Aquifer Recharge	m3/ha/year	728	817	465	530
Surface Runoff	m3/ha/year	16487	15708	18428	17216
Erosion Prevention					
Soil Erosion	ton/ha/year	51.20	1.18	180.89	5.07
Sediment Yield	ton/ha/year	47.98	1.13	206.56	6.40
Nutrient Retention					
Leached Organic Nitrogen	kg/ha/year	44.24	6.86	47.41	21.80
Leached Org. Phosphorus	kg/ha/year	5.37	0.86	5.75	2.76
Leached Min. Phosphorus	kg/ha/year	4.50	0.66	4.97	2.23
Leached Mineral Nitrogen	kg/ha/year	0.36	0.16	0.42	0.19

Habitat services	Unit	Typology 1 & 3		Typology 2	
		Monoculture	Agroforestry	Monoculture	Agroforestry
Soil Biodiversity					
Topsoil Fungi	colony/ha	3.705E+13	9.135E+13	2.145E+13	3.99E+13
Topsoil Microbes	colony/ha	1.04E+17	1.0935E+17	1.053E+17	1.461E+17
Topsoil Microfauna	individual/ha	8.55E+09	21.5E+09	2.01E+09	2.64E+09

- **Provisioning**: **Increasing land production and productivity** by **providing crops other than cocoa** such as fruits, seasonal cash crops, and woods even though, in some cases, it reduces cocoa production.
- **Regulating**: **Increasing and preserving ecosystem functions** so that ecosystem processes can run in the long term by **increasing groundwater recharge**, **decreasing surface runoff, decreasing erosion and sedimentation, and decreasing nutrient leaching from soil to water bodies.**
- **Habitat**: **Increasing habitat suitability** as indicated by an **increase in soil quality** as indicated by a **more significant amount of soil biodiversity.**

Value Chain Mapping



Channel.1
Farmers – Pacatok /Collectors – Small Retailers/Traders– Cooperative- Processor

Channel. 2
Farmers – Pacatok /Collectors – Small Retailers/Traders- Medium Retailers/Traders– Cooperative- Processor

Channel. 3
Farmers – Pacatok /Collectors – Small Retailers/Traders- Medium Retailers/Traders– Large Retailers/Traders- Processor

Channel. 4
Farmers – Small Retailers/Traders- Medium Retailers/Traders– Large Retailers/Traders- Processor

Channel. 5
Farmers – Small Retailers/Traders- Cooperative- Processor

Channel. 6
Farmers –Facilitator– Processor

Ch	Description	Channel 4		Channel 5		Channel 6	
		IDR/kg	%	IDR/kg	%	IDR/kg	%
1	**Farmers**						
	Selling price	19,000.00		21,000.00		12,000.00	
2	**Pacatok/collector**						
	Purchasing price	19,000.00					
	Cost	4,285.71	41.23%				
	Profit (margin-cost)	2,714.29	58.92%				
	Total Margin (selling-purchasing price)	7,000.00	46.67%				
	Selling Price	26,000.00					
3	**Facilitator**						
	Purchasing price					12,000.00	
	Cost					0.00	0.00%
	Profit (margin-cost)					150.00	100.00%
	Total Margin (selling-purchasing price)					150.00	100.00%
	Selling Price					12,150.00	
4	**Small Retailers**						
	Purchasing price	26,000.00		21,000.00			
	Cost	4,347.83	41.83%	4,764.49	67.28%		
	Profit (margin-cost)	652.17	14.16%	4,735.51	87.39%		
	Total Margin (selling-purchasing price)	5,000.00	33.33%	9,500.00	76.00%		
	Selling Price	31,000.00		30,500.00			
5	**Medium Retailer**						
	Purchasing price	31,000.00					
	Cost	1,190.00	11.45%				
	Profit (margin-cost)	310.00	6.73%				
	Total Margin (selling-purchasing price)	1,500.00	10.00%				
	Selling Price	32,500.00					
6	**Cooperative**						
	Purchasing price			30,500.00			
	Cost			2,316.67	32.72%		
	Profit (margin-cost)			683.33	12.61%		
	Total Margin (selling-purchasing price)			3,000.00	24.00%		
	Selling Price			33,500.00			
7	**Large Retailer**						
	Purchasing price	32,500.00					
	Cost	570.00	5.48%				
	Profit (margin-cost)	930.00	20.19%				
	Total Margin (selling-purchasing price)	1,500.00	10.00%				
	Selling Price	34,000.00					
	Total Cost	10,393.54		7,081.16		0.00	
	Total Profit	4,606.46		5,418.84		150.00	
	Total Margin	15,000.00		12,500.00		150.00	
	Farmer's Share (%)	55.88%		62.69%		98.77%	

Margin analysis of the cacao value chains

- Dry cacao value chains (channel 4 and 5) show less farmers share in comparison to the channel 6 which is classified as wet cacao value chains. This is mainly because both wet cacao value chains are relatively longer and involve more actors within the chains

- At the channel 4 and 5, it can be inferred that *pacatok* (collectors) and small traders earn the highest margin and profit in comparison to other actors eg medium retailer, large retailer, and cooperative. The highest additional costs are paid by the small collectors. They are responsible for the cost of packing and distribution in the value chains

CGE Assessment : Agroforestry (1)

Simulation 1

- Increasing annual yield growth of cacao by 3.09 %

Simulation 2

- Increasing annual yield growth of cacao by 3.09 % and annual growth of clean water availability by 2.74 % due to Agroforestry
- Agroforestry environmental services effect is represented by improvement in ground water availability

Macroeconomic Impacts

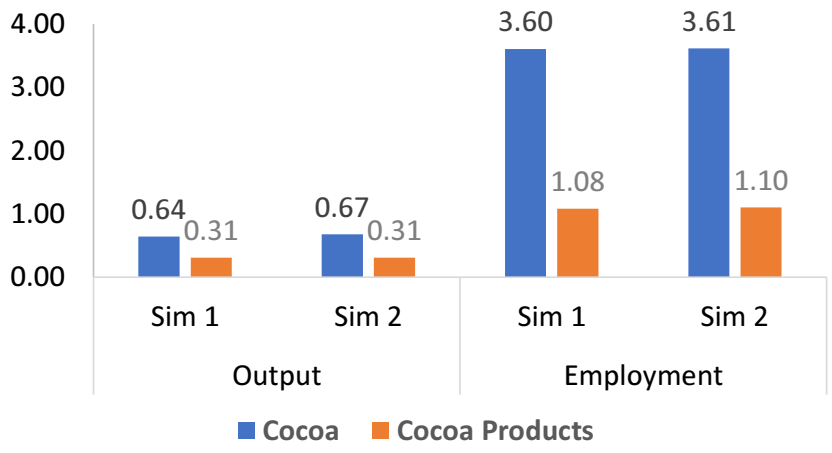
Description	Sim 1	Sim 2
Average real wage	0.0191	0.0716
Nominal GDP from expenditure side	0.0076	0.0149
Aggregate government expenditure	0.0937	0.2067
Nominal total household consumption	0.0013	0.0163
Import volume index, C.I.F. weights	-0.0054	-0.0004
Real GDP from expenditure side	0.0076	0.0149
Import volume index, duty-paid weights	-0.0054	-0.0004
Export volume index	0.0002	0.0020

Agroforestry potentially improves macroeconomic condition in the long run by 2040. It is also expected to contribute to economic expansion and generating exchange reserves

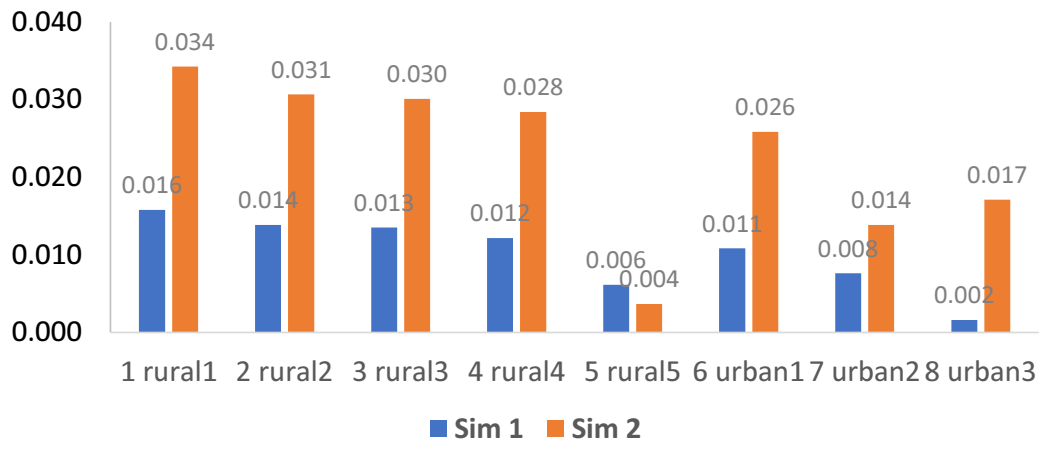
- ***Next Steps: incorporating social forestry related to Agroforestry as policy intervention***

CGE Assessment : Agroforestry (2)

Output and Employment



Household Income



- ***Agroforestry potentially improves sectoral performance both in upstream and downstream sectors***
- ***Agroforestry is developmental as it generates more employment***

- ***Agroforestry improves household resilience as income rises***

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