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ECONOMIC TOOLS TO EVALUATE LINEAR INFRASTRUCTURE IN ASIA

22 September, 2021

3:00 – 5:00 a.m. GMT

Module 2 of Building a Foundation for LINEAR INFRASTRUCTURE IN ASIA WEBINAR SERIES

Photo credit: Rob Ament

AGENDA

- Why do we need economic analysis of linear infrastructure and safeguards?
  - Some key considerations
- What economic tools can we use?
  - Valuation
  - Cost-benefit analysis and Cost-effectiveness analysis
  - Economic impact analysis and other tools
- Q&A Session
- Case studies of economic analysis of LI safeguards
  - Transmission line in Indonesia
  - Highway in Malaysia
- Regional and national road development planning in Latin America and Africa
- Q&A Session

ECONOMIC ANALYSIS OF LINEAR INFRASTRUCTURE

How do we include the environment in development decisions?

Some key considerations…

Dr. Morley Read / Shutterstock

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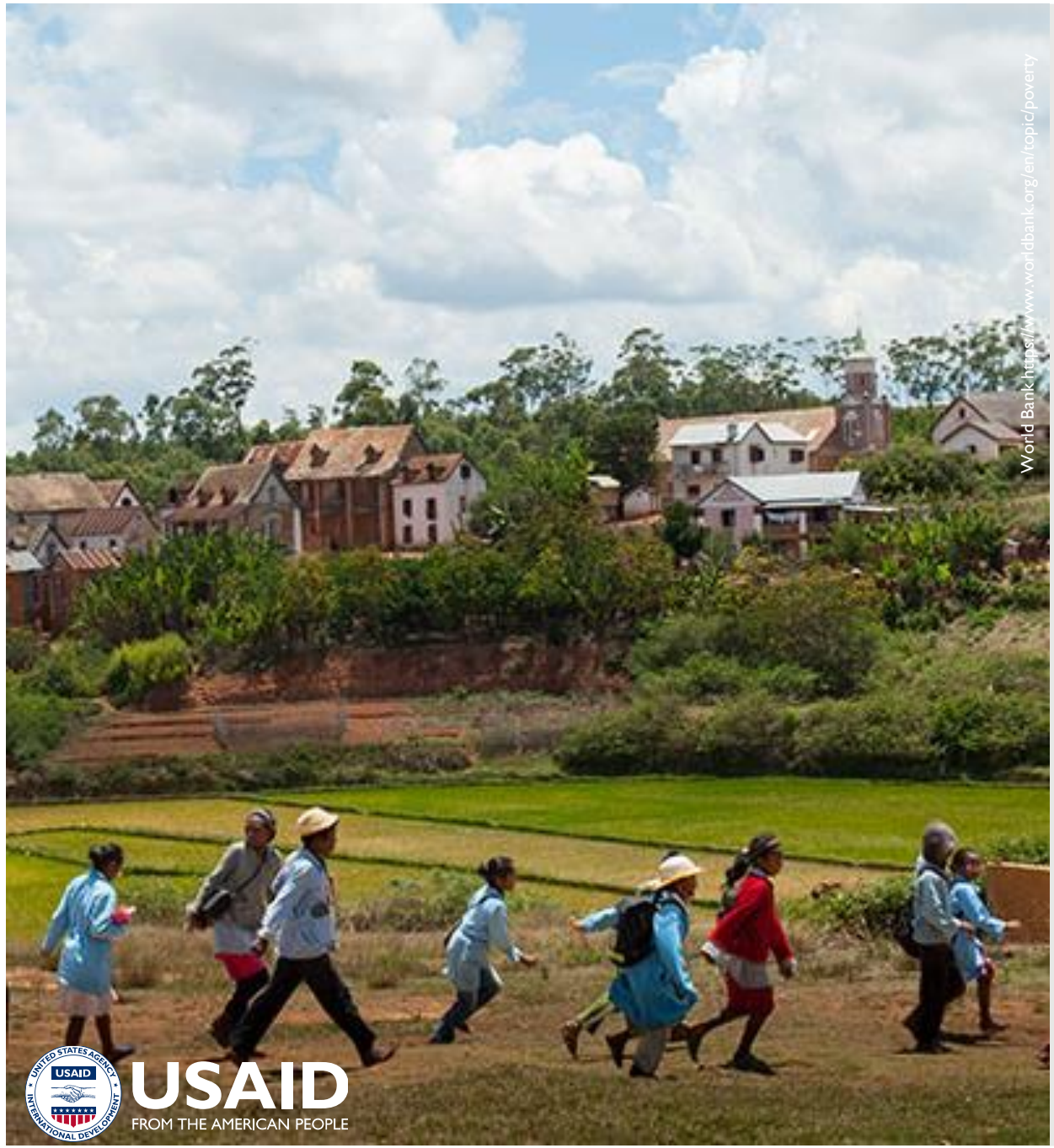
Tradeoffs and indirect impacts



Net economic benefits

The Conversation April 2020 / David Tipling/Universal Images Group/Getty Images

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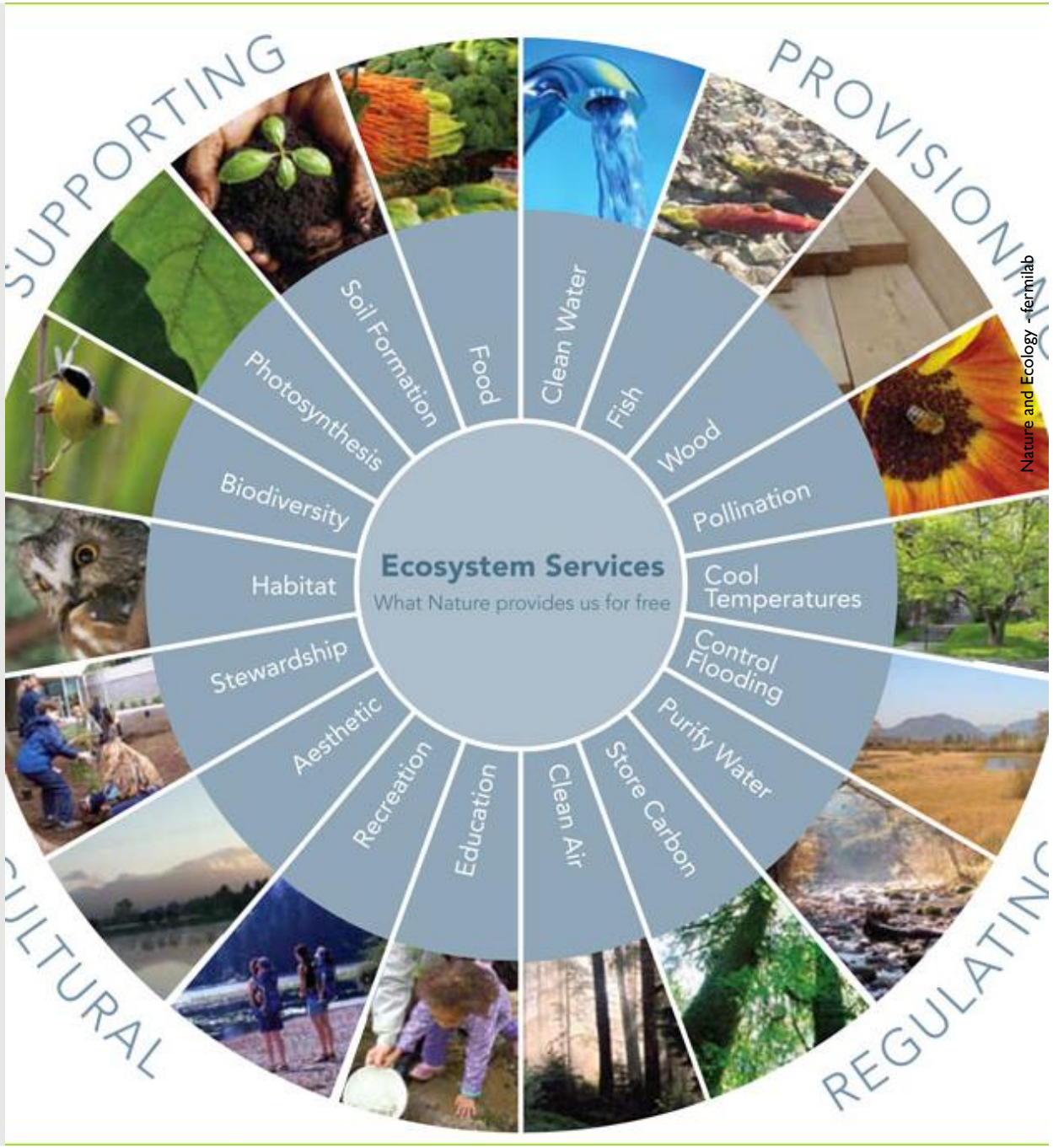
Avoidance before mitigation

ECONOMIC VALUATION OF ECOSYSTEM SERVICES

- What is environmental valuation?
  - Placing a value or price on environmental goods and services that are left out of market transactions



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What is environmental valuation?

Placing a value or price on environmental goods and services that are left out of market transactions

Why do we need it?

- Valuation is needed because price does not equal value for most environmental goods and services

Price ≠ Value

No price ≠ no value

Missing information and markets

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Public /shared resources (common pool)


Image by Bjorn


Image by USDA

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Externalities

Image by Erik de Castro

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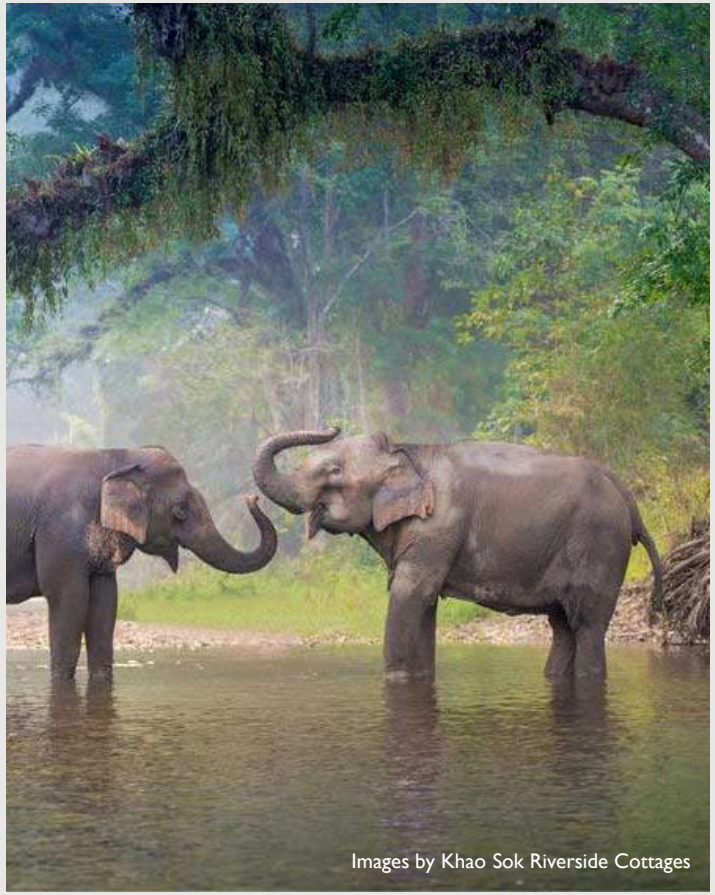
Lack of property / tenure rights and restrictions

Images by K9 Counselor


Image by Ethan Daniels Shutterstock


Images by Khao Sok Riverside Cottages

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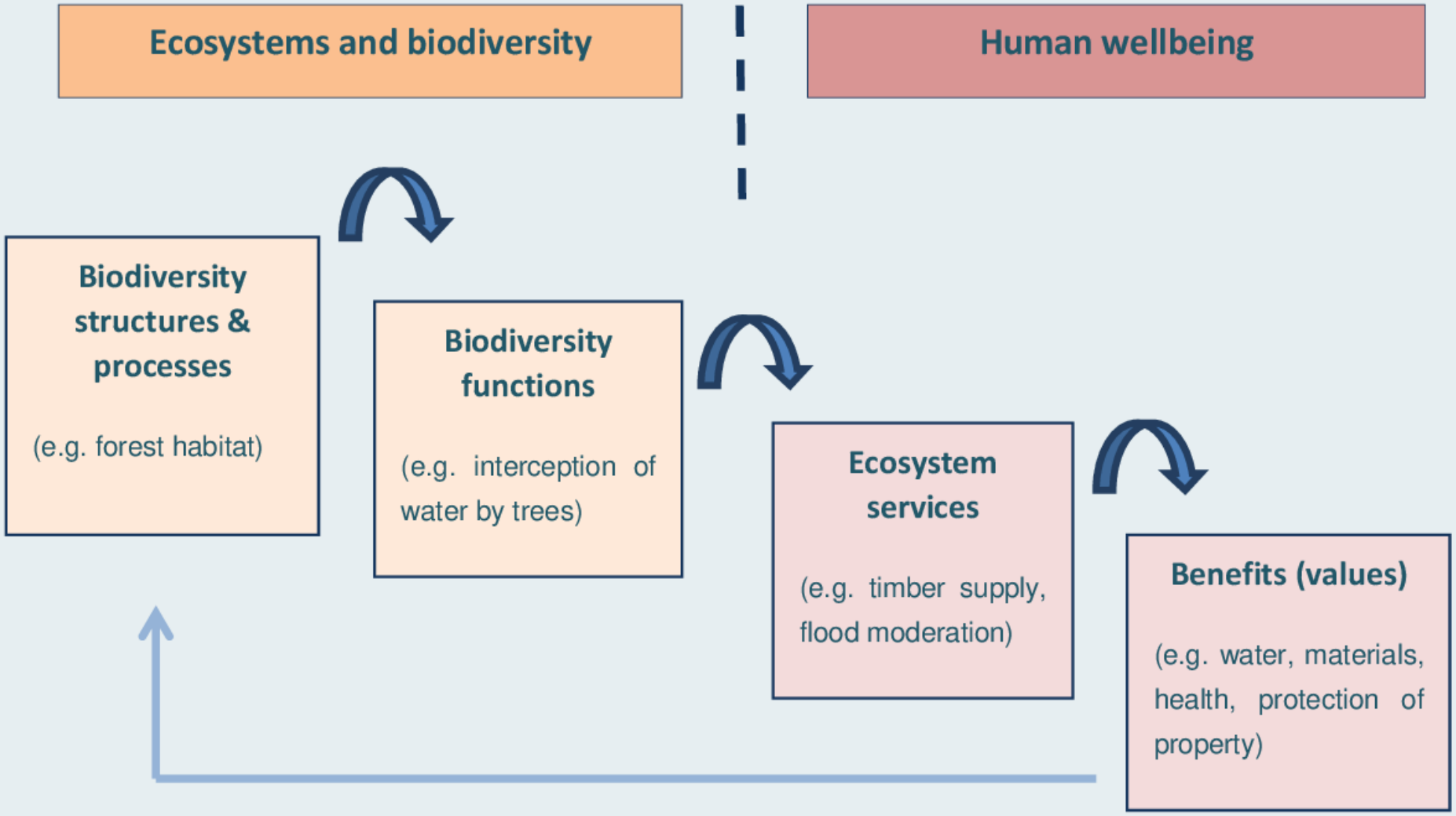
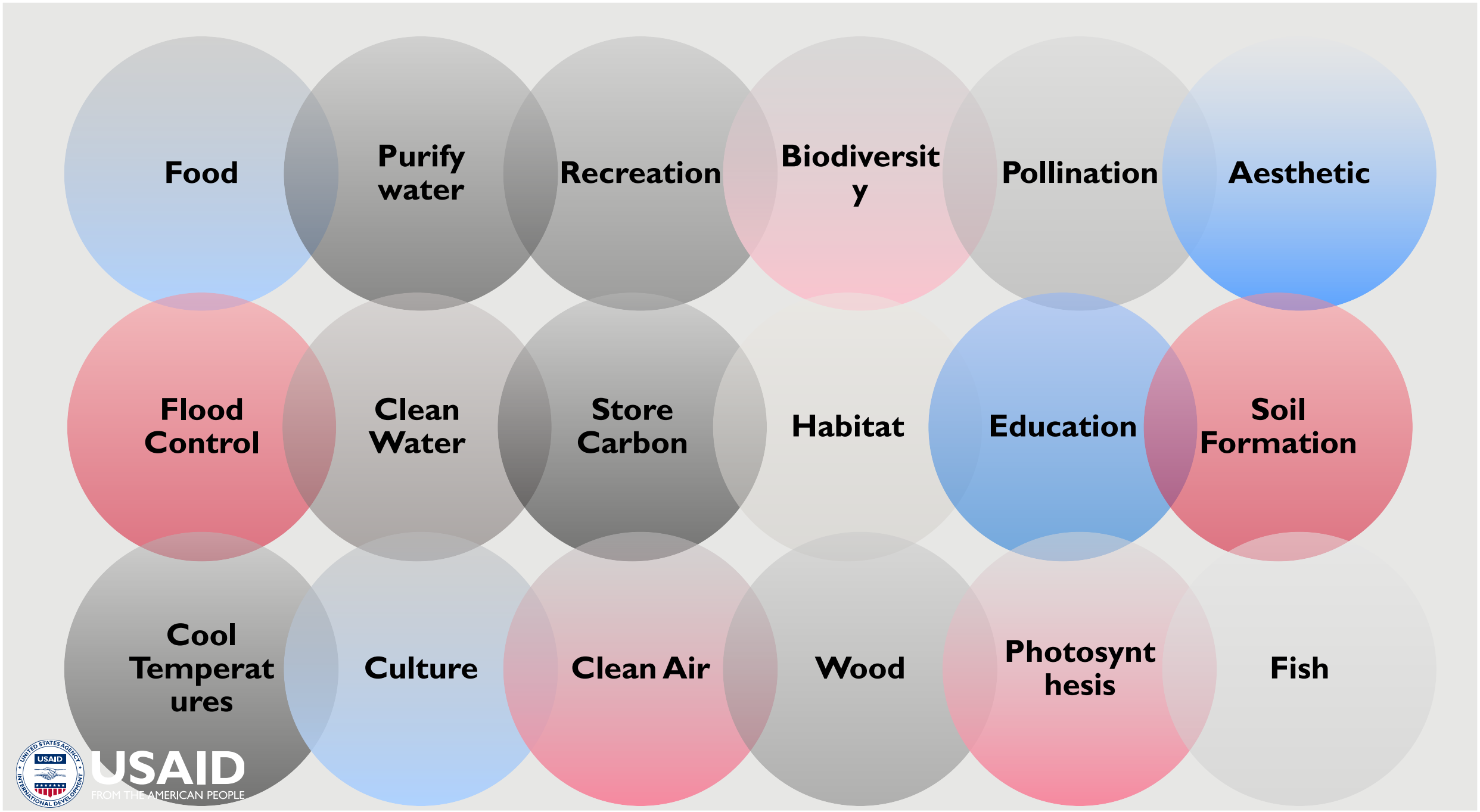
What are we "valuing"?

Figure 2: The Cascade Model (Haines-Young & Potschin, 2010)



Source: Bullock, C. (2017). Nature's Values: From Intrinsic to Instrumental. A review of values and valuation methodologies in the context of ecosystem services and natural capital.



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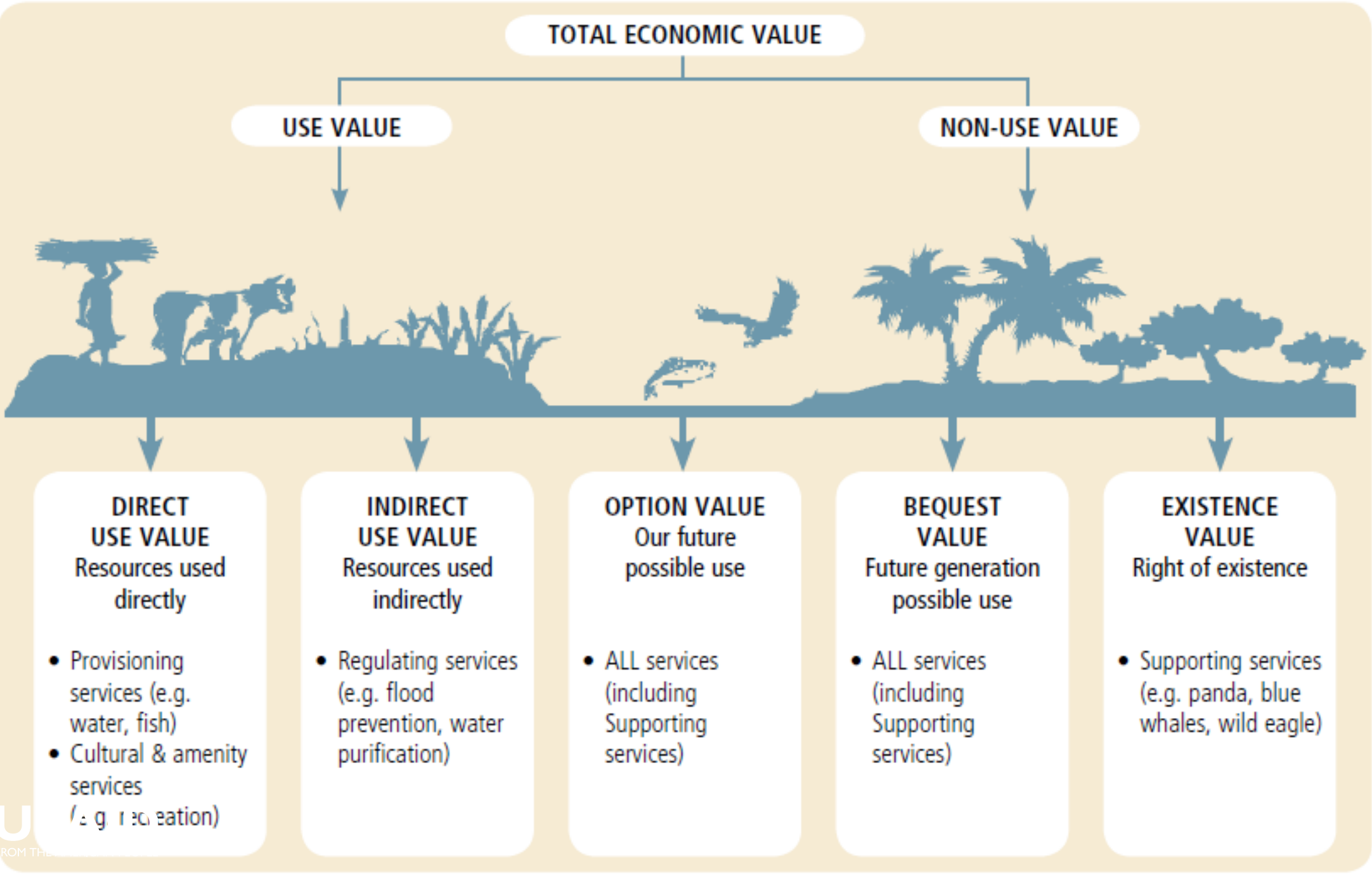

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Myanmar

Forestry sector:

- Official statistics: forests contribute <0.5% (US$ 160M) to the economy
- Almost all from commercial timber

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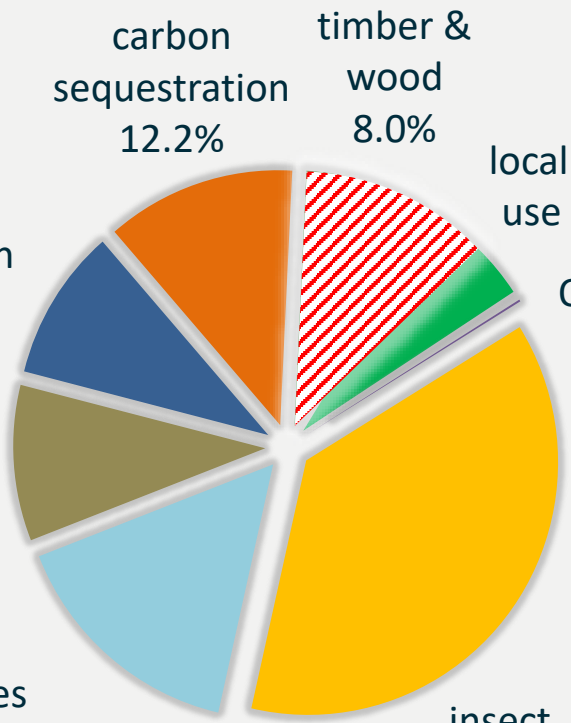
Emerton, L. and Yan Min Aung (2013) The Economic Value of Forest Ecosystem Services in Myanmar and Options for Sustainable Financing. IMG, Yangon and Ministry of Environmental Conservation and Forests, Nay Pyi Daw.

Real total value: US$ 7.3 billion



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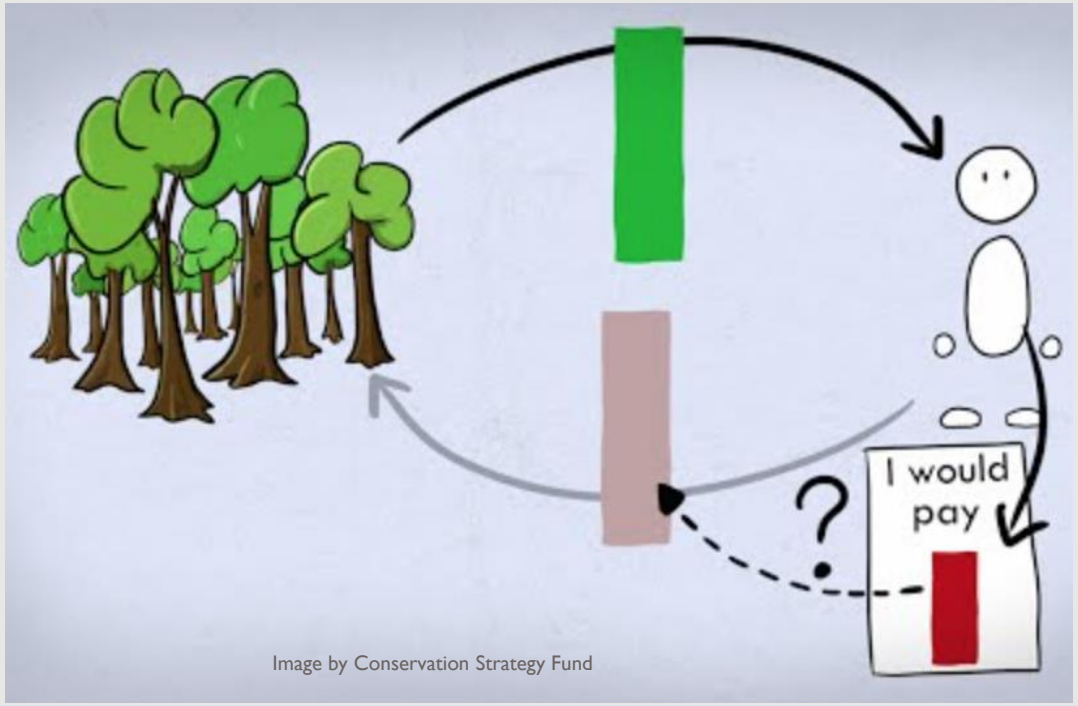
Emerton, L. and Yan Min Aung (2013) The Economic Value of Forest Ecosystem Services in Myanmar and Options for Sustainable Financing. IMG, Yangon and Ministry of Environmental Conservation and Forests, Nay Pyi Daw.

How do we do it?

Market proxies using complementary or substitute goods, activities and preferences



Direct Market	Uses data from existing markets
Production Function	Values a change in productivity or production
Revealed Preferences	Economic values are revealed through individual's behaviour/choices
Stated Preferences	Simulated/hypothetical markets elicit individual's value for a change

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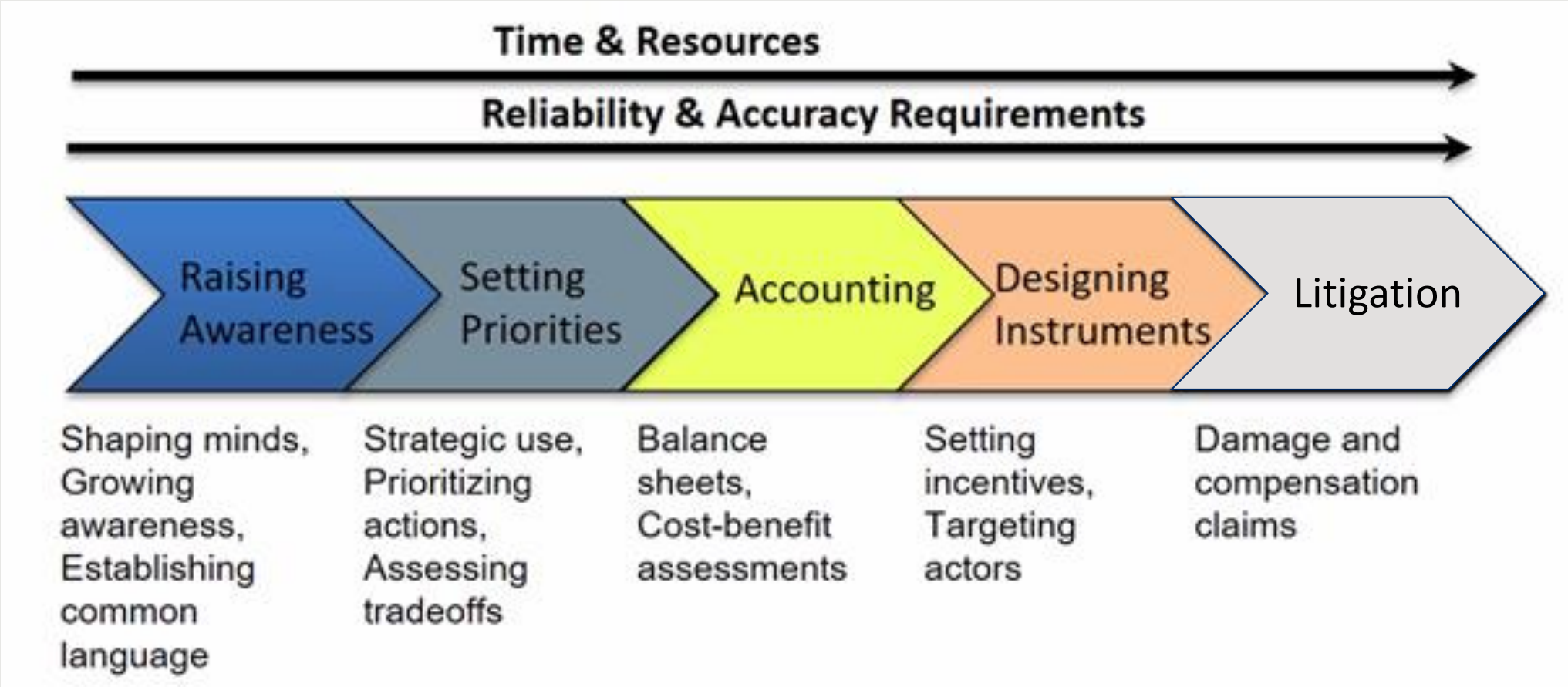
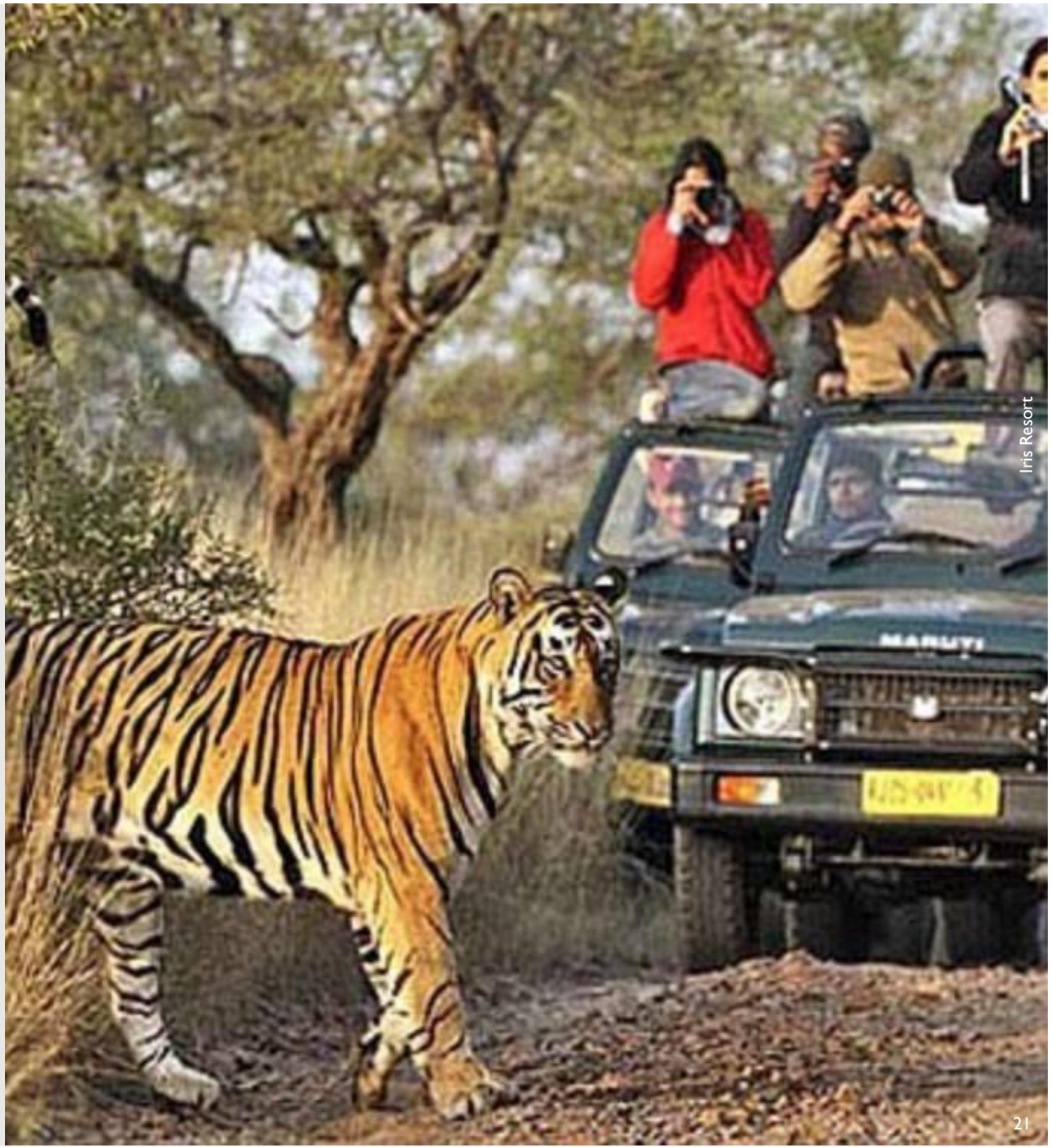
Why do a valuation study?



Economic valuation of tiger reserves in India

- More than half of global wild tiger population
- Provide a wide range of economic, social and cultural benefits via various ecosystem services – almost all non-market benefits
- Employment, carbon, water, soils, waste assimilation, pollination, storm protection, habitat/nurseries, recreation, agriculture, fishing, fuelwood, grazing, timber, research
- Benefits = US$130 million - $270 million per year ($800-$3000 per ha/year)
- Benefits 200X - 500X management costs
- But often local costs > local benefits



Iris Resort

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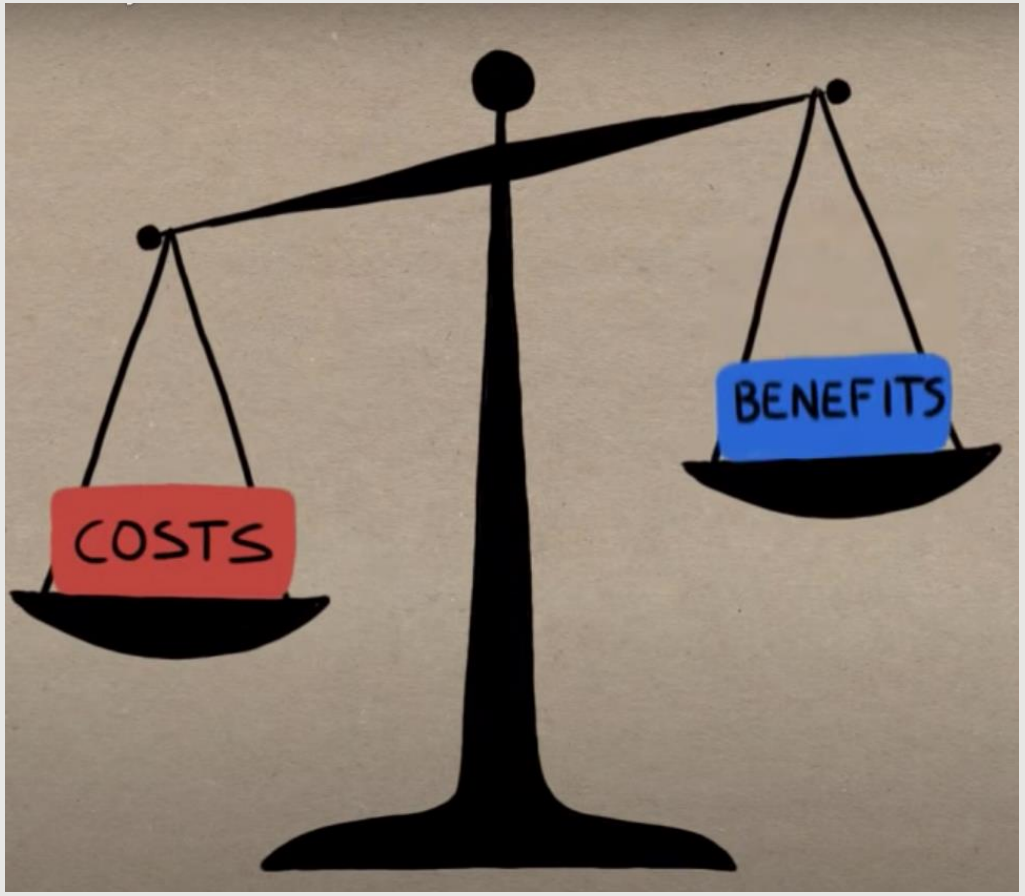
Elephant conservation in Sri Lanka

- Stated willingness to pay for elephant conservation
- Benefits - elephant-based tourism and recreational activities, ecological role, cultural and religious values
- WTP based on ethical or existence values decreases once population is stable
- Use values increase with population size
- WTP a guide to demand for conservation action to preserve a species, but does not capture other values

COST-BENEFIT ANALYSIS

- *Framework* to assess the merits of a project, policy or investment versus its cost
- A process of identifying, measuring, and comparing the benefits and costs of a project or program
- Determines if a project/investment is worthwhile
- It is a decision *support* tool



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What questions can CBA answer?

Is this project worthwhile?

Is it feasible for the private entrepreneur?

Is it beneficial to society at large?

What is the distribution of costs and benefits among different stakeholders?

What are the main constraints?

CBA Process

1. Define project and identify alternatives
2. Identify perspectives of analysis and estimate costs and benefits
3. Calculate indicators of project feasibility
4. Sensitivity and risk analysis, scenarios
5. Equity considerations

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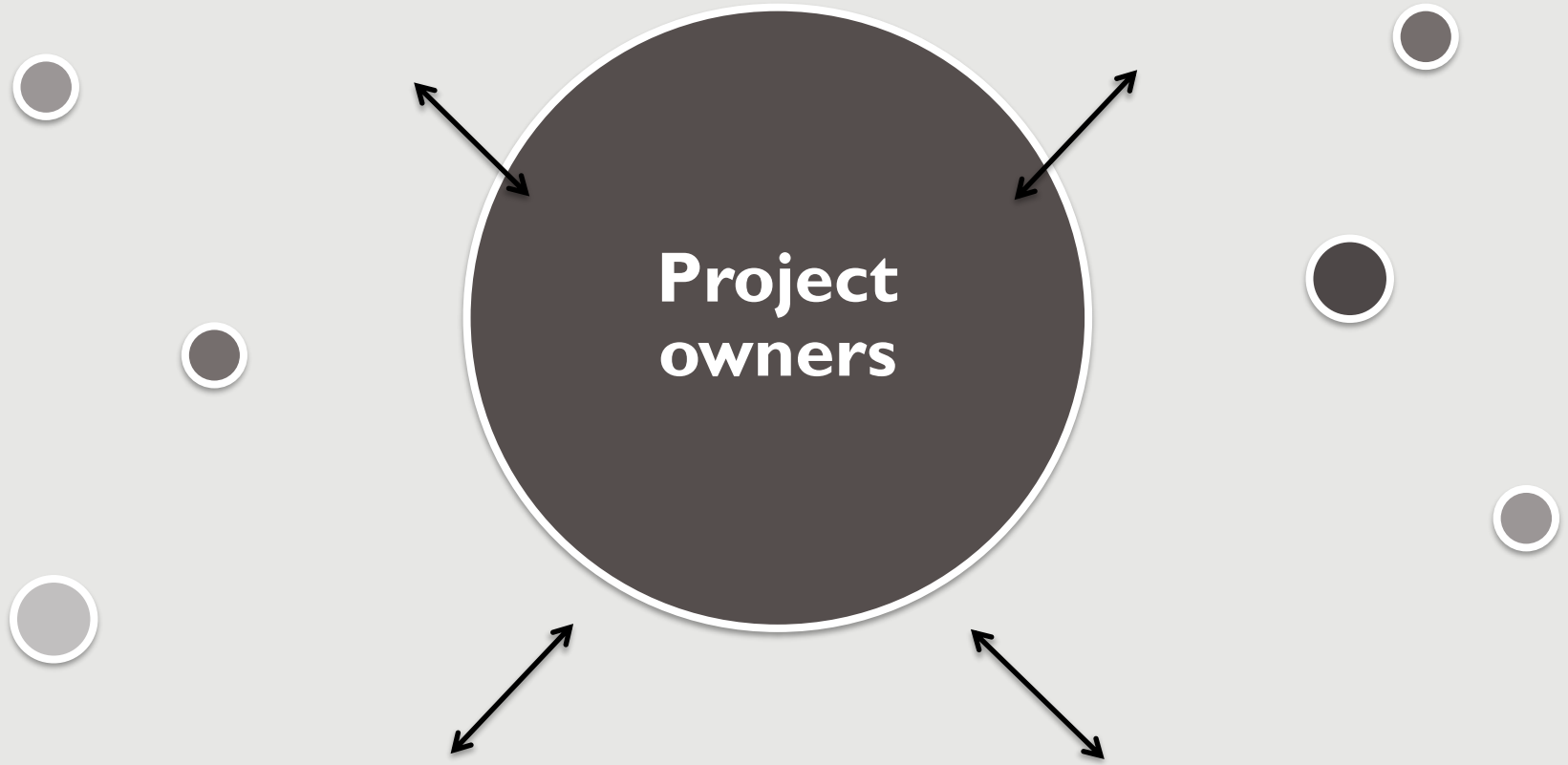
Define perspectives

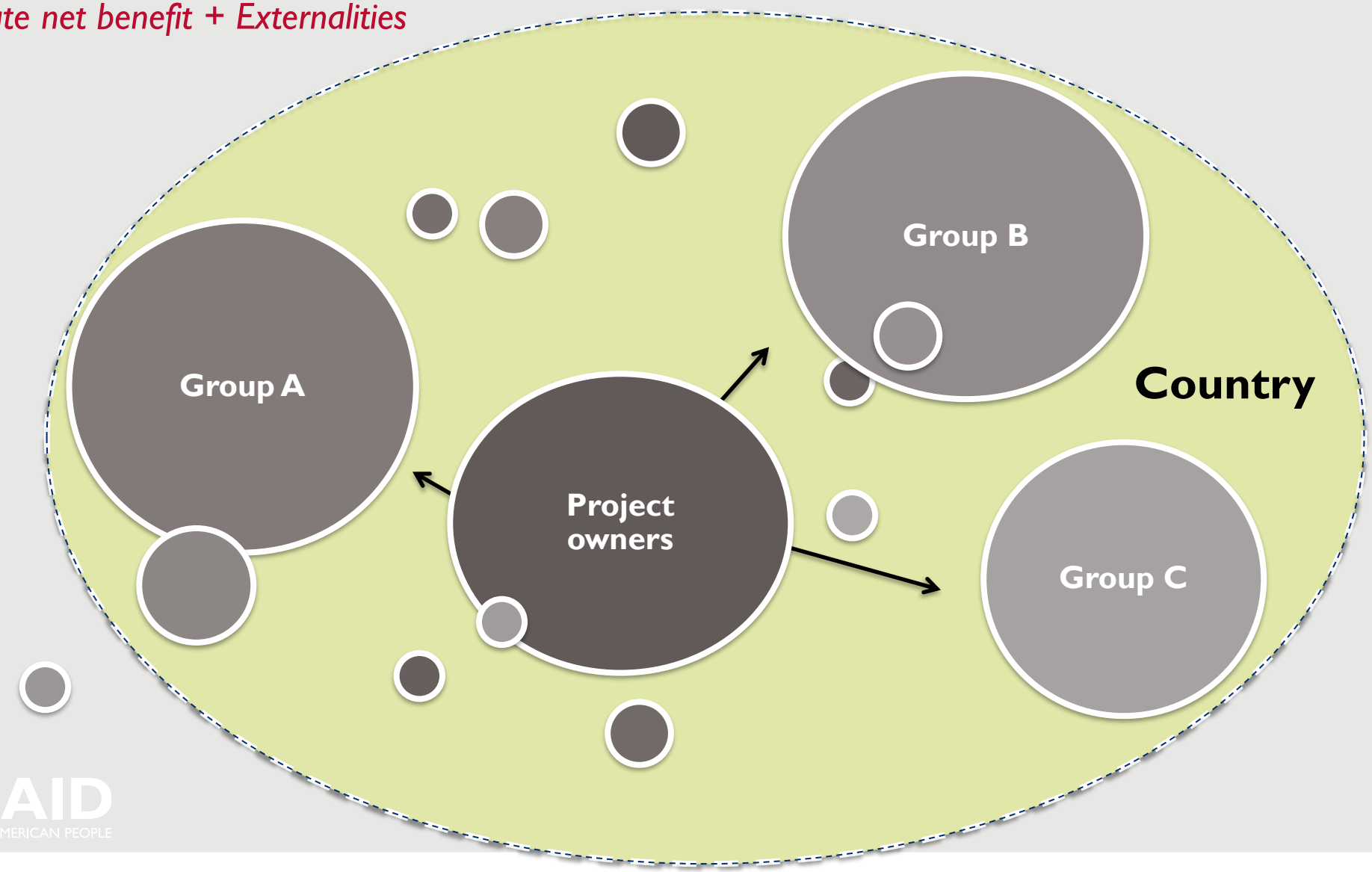
1. Government (Fiscal)
2. Private (Financial)
3. Social/Environmental (Economic)

Financial Analysis ("private perspective")



Economic analysis ("social perspective")

Private net benefit + Externalities



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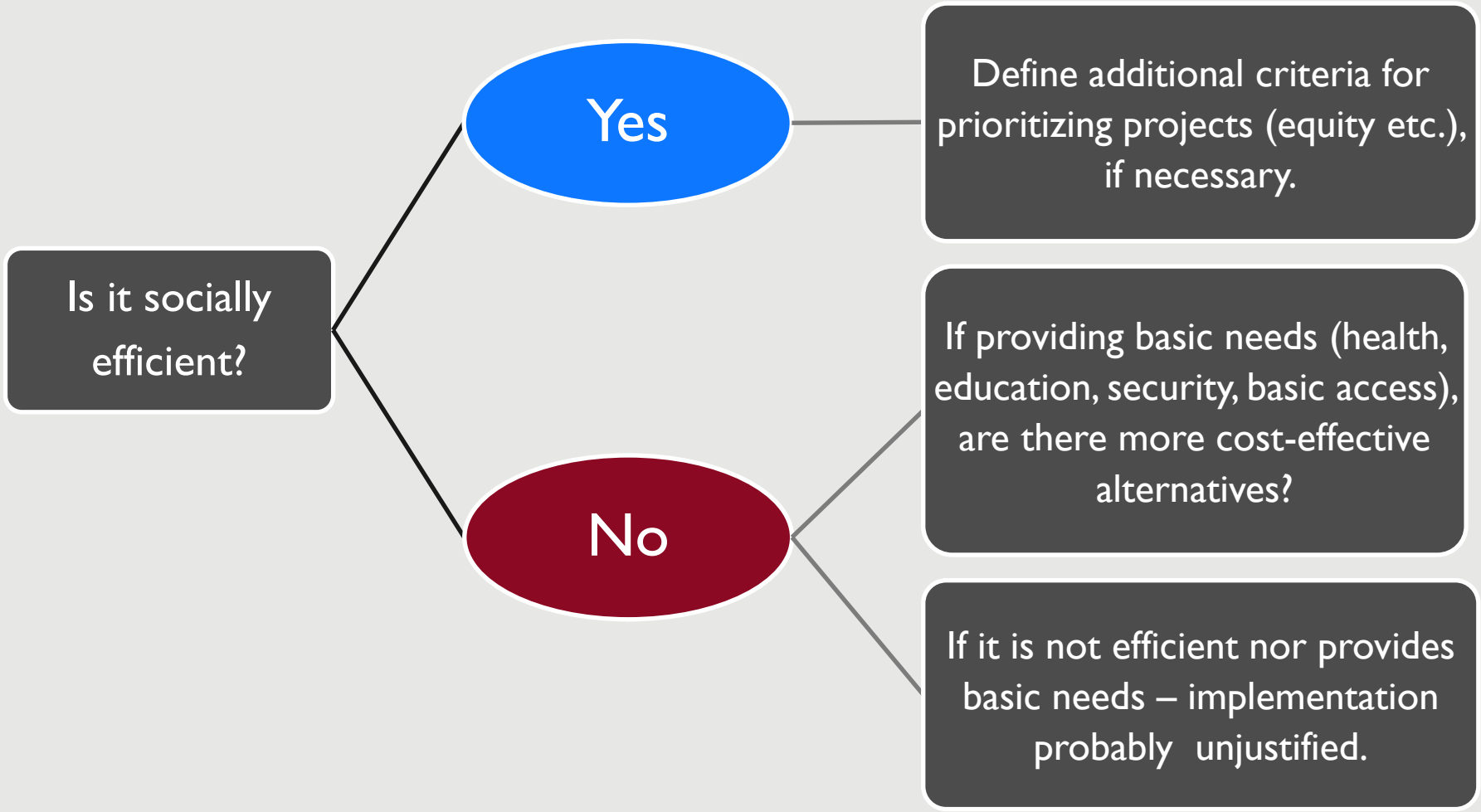
CBA strategy

- Are there better alternatives?
- Is project technically feasible?
- Is project financially feasible?
- Is project economically feasible?
  - Can external or intangible costs/benefits be quantified?
- Is project equitable?
  - What is the distribution of costs and benefits?

CBA limitations

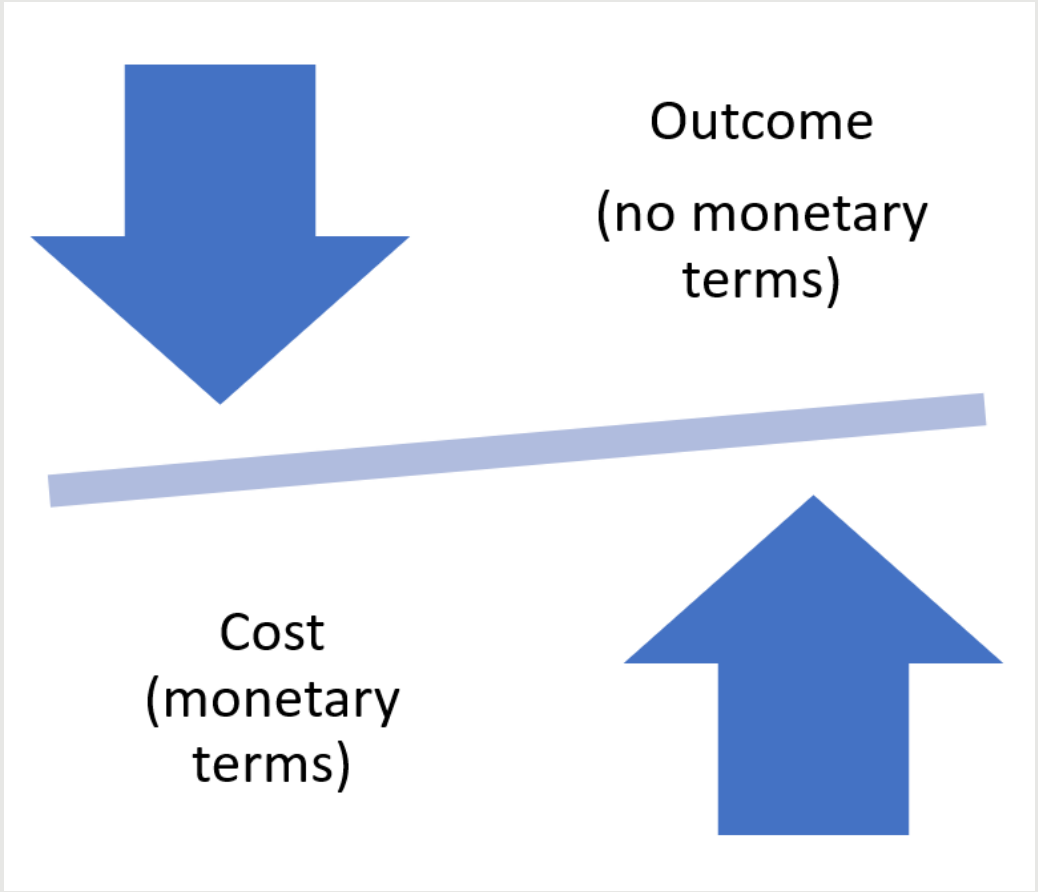
- Environmental benefits and costs are difficult to measure
- Forecasting might be inaccurate
- Future values preclude sustainability
  - Discounting

Decision tree for CBA



Cost-effectiveness analysis

CEA = cost per unit of outcome



Economic Impact Analysis

- Flow of gross benefits of an economic investment/project through an economy
- Job creation, labor income, and tax benefits
- Multiplier impacts, leakage
- Does not consider costs or feasibility – i.e. important to ask if benefits (e.g. jobs) could be gained at lower cost
- It is not the same as impact *evaluation* – i.e. whether a policy or intervention achieved its intended effect

DIRECT IMPACT
- Initial investment
- Tourism spending

INDIRECT IMPACT
- Inter-industry spending

INDUCED IMPACT
- Spending of employee's wages

https://www.boyette-sa.com/services/impact-analysis/

Other analysis tools

- Multi-criteria analysis
- Least-cost path analysis

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Thank you

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Questions?

COST-BENEFIT ANALYSIS CASE STUDIES

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Economics Module 2 Presentation 2
CASE STUDIES

Transmission Line (Indonesia)

Java-Bali 500 Kilovolt Project

Road (Malaysia)

FR 4 East-West Highway

CASE STUDY

- Transmission line (Indonesia)
  - Java-Bali 500 Kilovolt Project

Bali Starling by rumpelstiltskin1 (https://www.flickr.com/photos/rumpelstiltskin1/4891802721)

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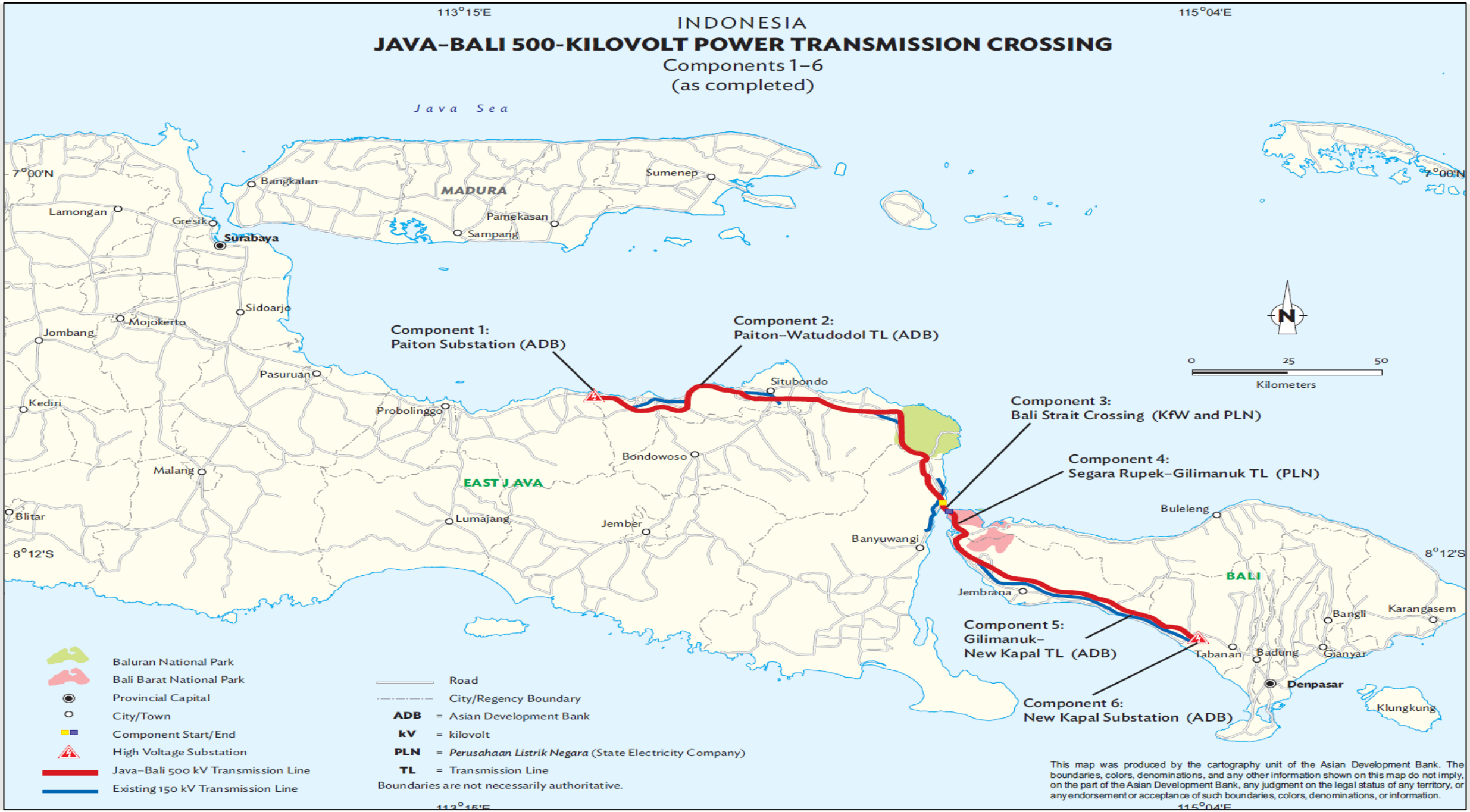
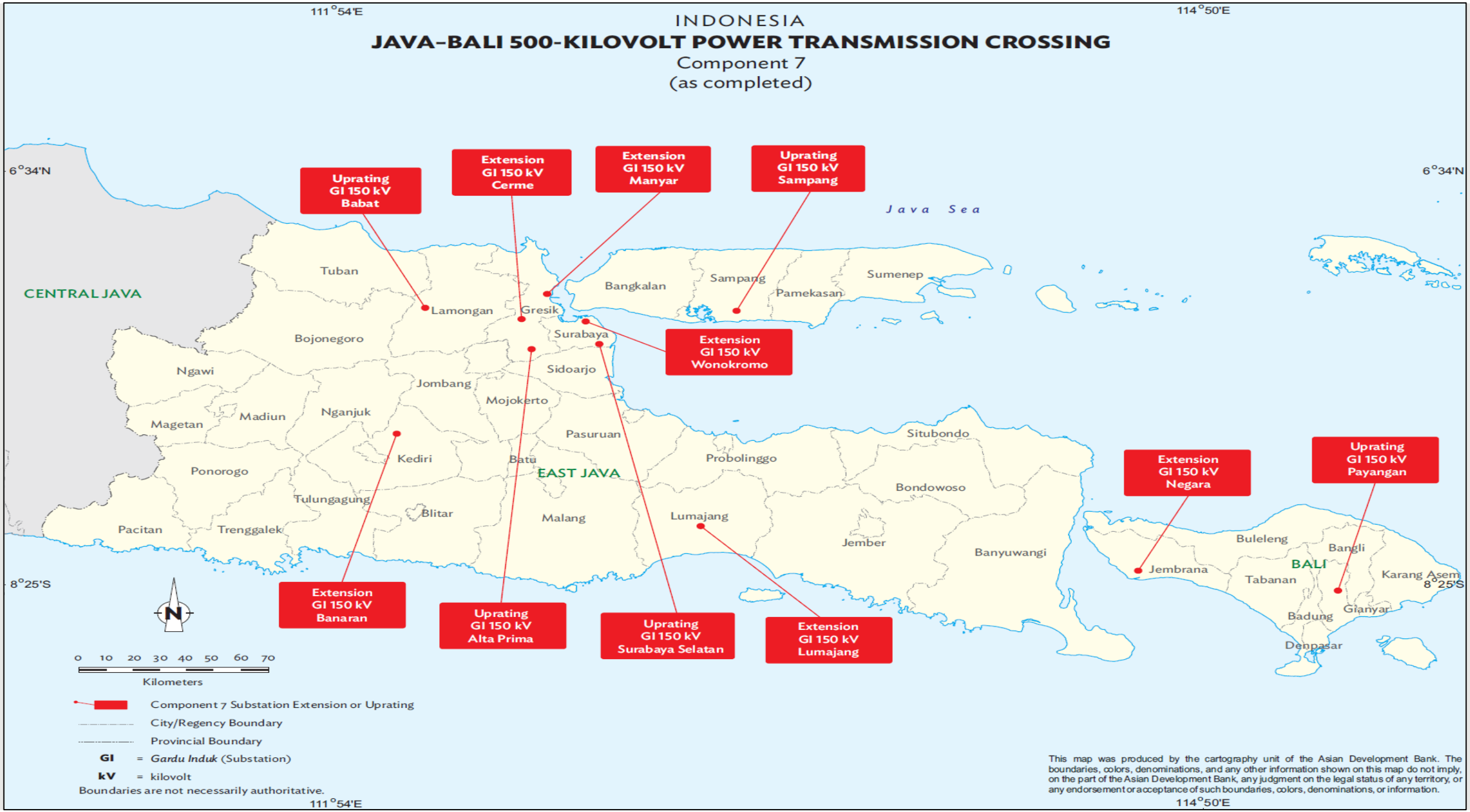
TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

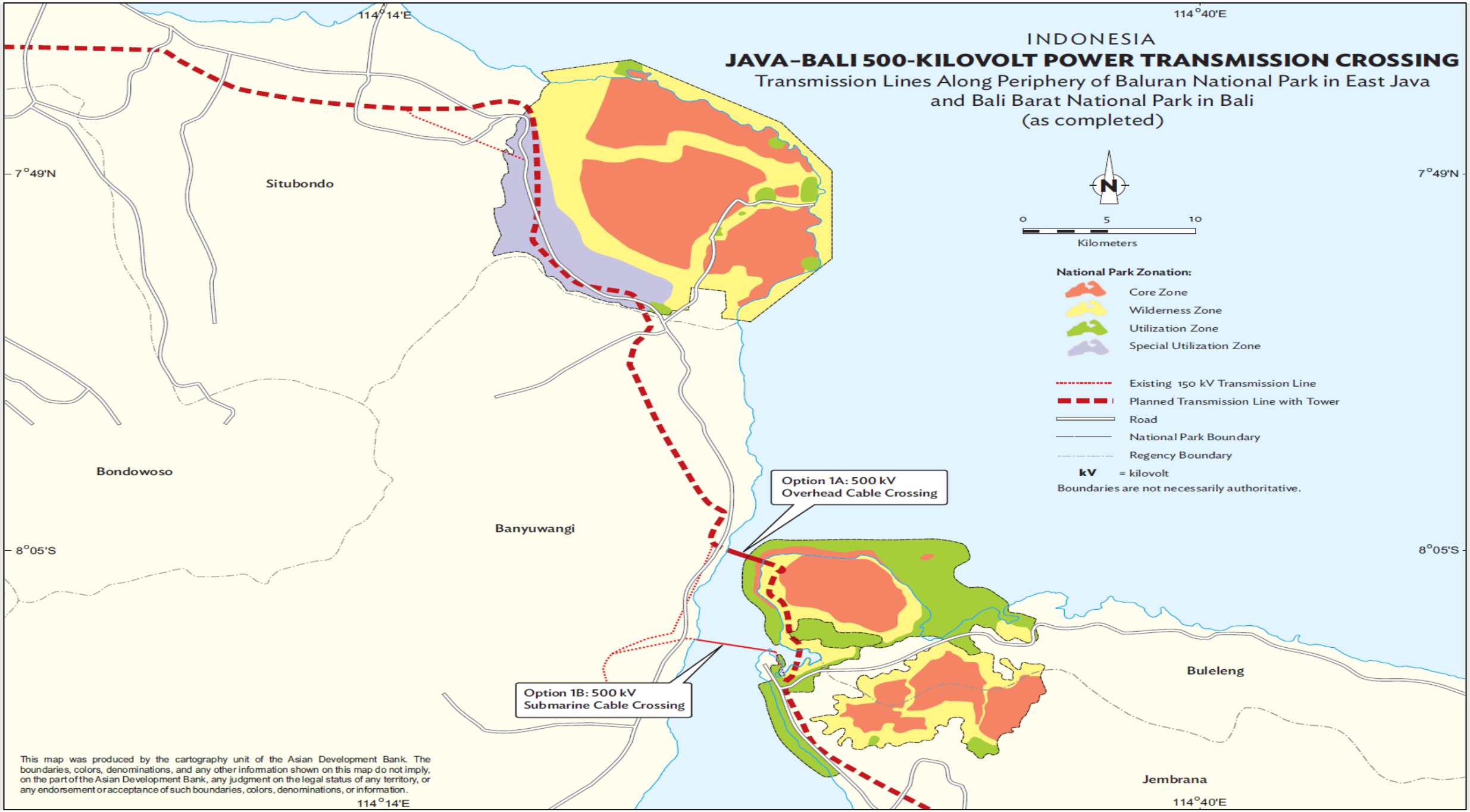
- Proponents
  - National government and ADB
- Project description


INDONESIA
JAVA–BALI 500-KILOVOLT POWER TRANSMISSION CROSSING
Components 1–6
(as completed)
Java Sea
113°15'E
115°04'E
7°00'N
8°12'S
Bangkalan
MADURA
Sumenep
Pamekasan
Sampang
Lamongan
Gresik
Surabaya
Sidoarjo
Mojokerto
Jombang
Pasuruan
Kediri
Probolinggo
Situbondo
Bondowoso
Malang
EAST JAVA
Blitar
Lumajang
Jember
Banyuwangi
Buleleng
BALI
Jembrana
Bangli
Karangasem
Tabanan
Badung
Gianyar
Denpasar
Klungkung
Component 1:
Paiton Substation (ADB)
Component 2:
Paiton–Watudodol TL (ADB)
Component 3:
Bali Strait Crossing (KfW and PLN)
Component 4:
Segara Rupek–Gilimanuk TL (PLN)
Component 5:
Gilimanuk–
New Kapal TL (ADB)
Component 6:
New Kapal Substation (ADB)
N
0
25
50
Kilometers
Baluran National Park
Bali Barat National Park
Provincial Capital
City/Town
Component Start/End
High Voltage Substation
Java–Bali 500 kV Transmission Line
Existing 150 kV Transmission Line
Road
City/Regency Boundary
ADB = Asian Development Bank
kV = kilovolt
PLN = Perusahaan Listrik Negara (State Electricity Company)
TL = Transmission Line
Boundaries are not necessarily authoritative.
This map was produced by the cartography unit of the Asian Development Bank. The boundaries, colors, denominations, and any other information shown on this map do not imply, on the part of the Asian Development Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information.



TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

- TL crosses to national parks
  - Baluran National Park
  - Bali Barat National Park
- ADB (lending institution) requires safeguards


INDONESIA
JAVA–BALI 500-KILOVOLT POWER TRANSMISSION CROSSING
Transmission Lines Along Periphery of Baluran National Park in East Java and Bali Barat National Park in Bali
(as completed)
114°14'E
114°40'E
7°49'N
8°05'S
Situbondo
Bondowoso
Banyuwangi
Buleleng
Jembrana
N
0
5
10
Kilometers
National Park Zonation:
Core Zone
Wilderness Zone
Utilization Zone
Special Utilization Zone
Existing 150 kV Transmission Line
Planned Transmission Line with Tower
Road
National Park Boundary
Regency Boundary
kV = kilovolt
Boundaries are not necessarily authoritative.
Option 1A: 500 kV Overhead Cable Crossing
Option 1B: 500 kV Submarine Cable Crossing
This map was produced by the cartography unit of the Asian Development Bank. The boundaries, colors, denominations, and any other information shown on this map do not imply, on the part of the Asian Development Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information.

TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

- Cost-benefit analysis of the Java-Bali 500 kV Project

	Value (US$ million, over 10 years)
Step 1 - Financial analysis	
Costs (including mitigation measures)	2,282
Benefits	2,470
Net Present Value	188
Step 2 – Other externalities	
Costs	26
Step 3 - Environmental mitigation measures	
Benefits	3.9
Step 4 - Adjusted Net Present Value	
Adjusted Net Present Value	166

TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

- Lessons learned
  - Safeguard costs were included in the project, but
  - Not the benefits
    - Protect the environment and wildlife
    - Add to the project's overall net value

CASE STUDY

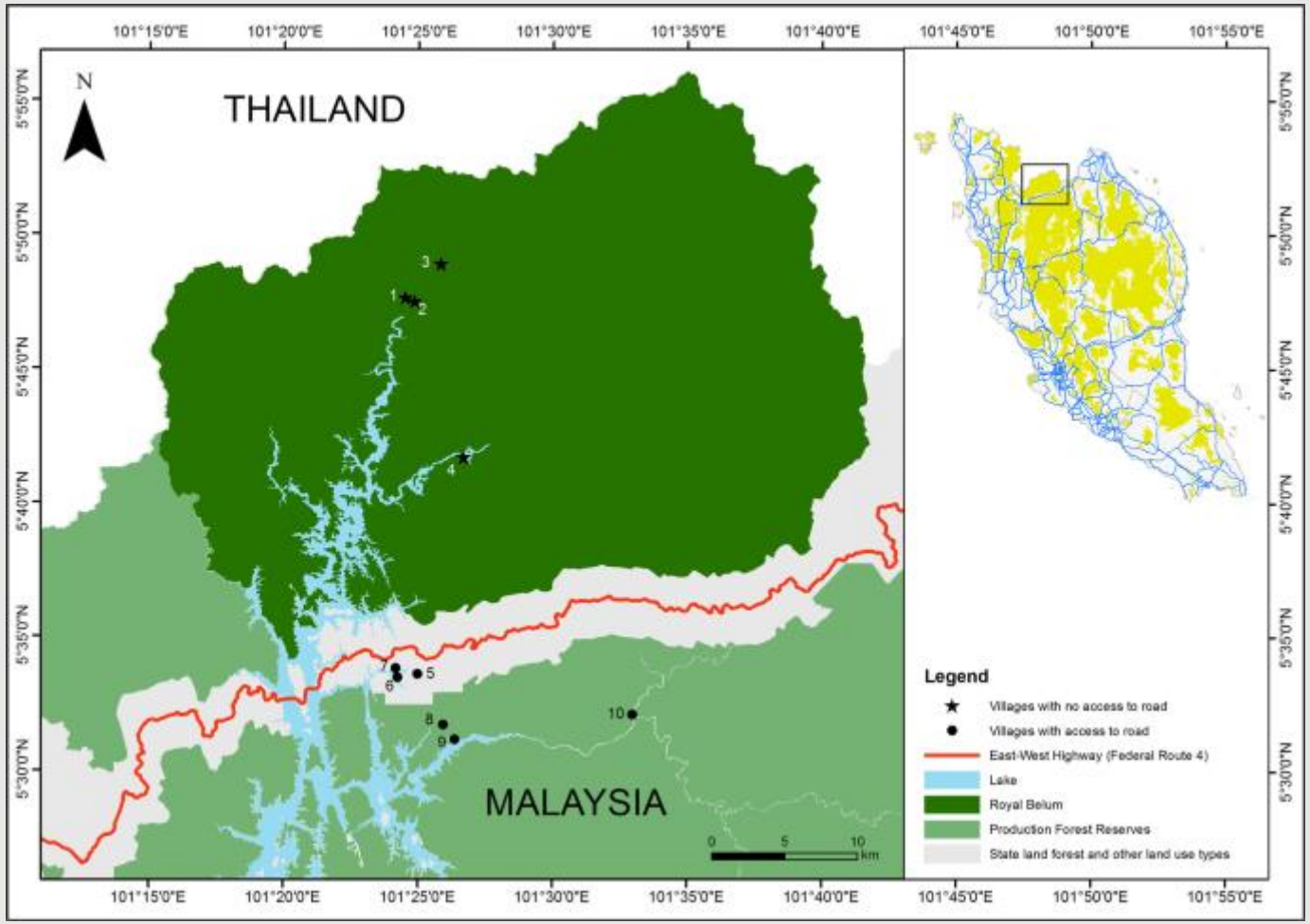
- Road (Malaysia)
  - FR 4 East-West Highway

Wadey et al (2018). Why did the elephant cross the road? The complex response of wild elephants to a major road in Peninsular Malaysia, Biological Conservation, 218, 91-98

ROAD: FR 4 East-West Highway (MALAYSIA)

- Proponent
  - National government
- Project description

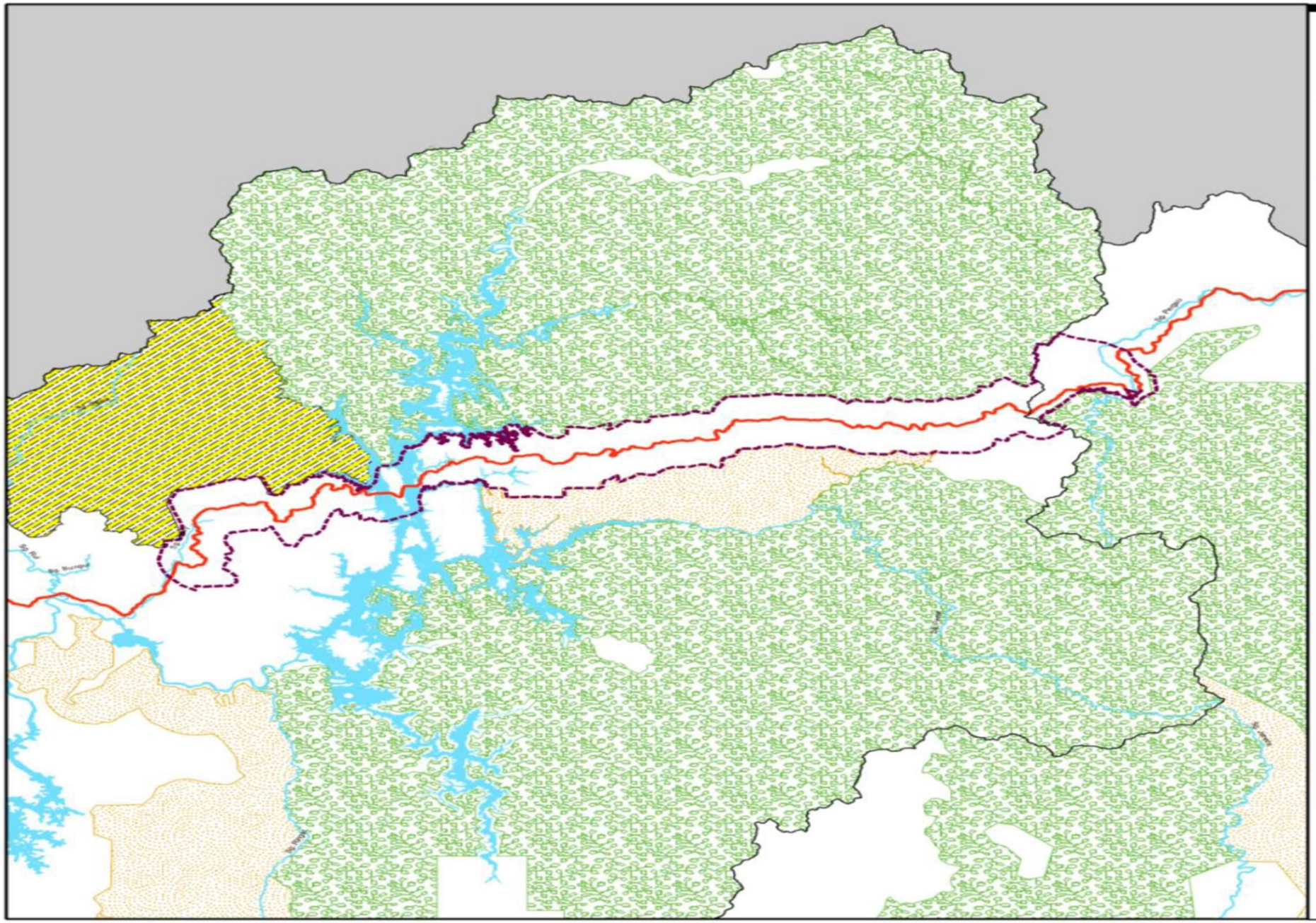
ROAD: FR 4 East-West Highway (MALAYSIA)



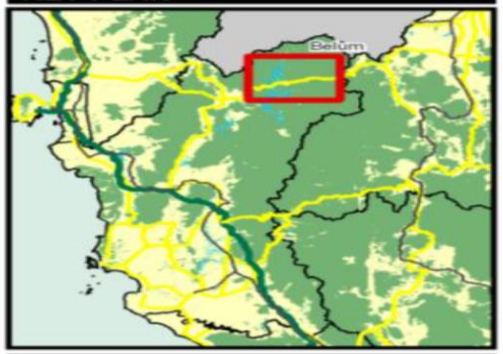
Source: Clements, G.R., Aziz, S.A., Bulan, R. et al. Not Everyone Wants Roads: Assessing Indigenous People's Support for Roads in a Globally Important Tiger Conservation Landscape. Hum Ecol 46, 909–915 (2018). https://doi.org/10.1007/s10745-018-0029-4

ROAD: FR 4 East-West Highway (MALAYSIA)

- Obstruction to wildlife movement
  - Between the Temenggor Forest Reserve and the Royal Belum State Park



KEY PLAN



LEGEND:

- Tiger, Seladang, Tapir & Elephant
- Tiger, Seladang, Tapir, Elephant & Rhino
- Elephant

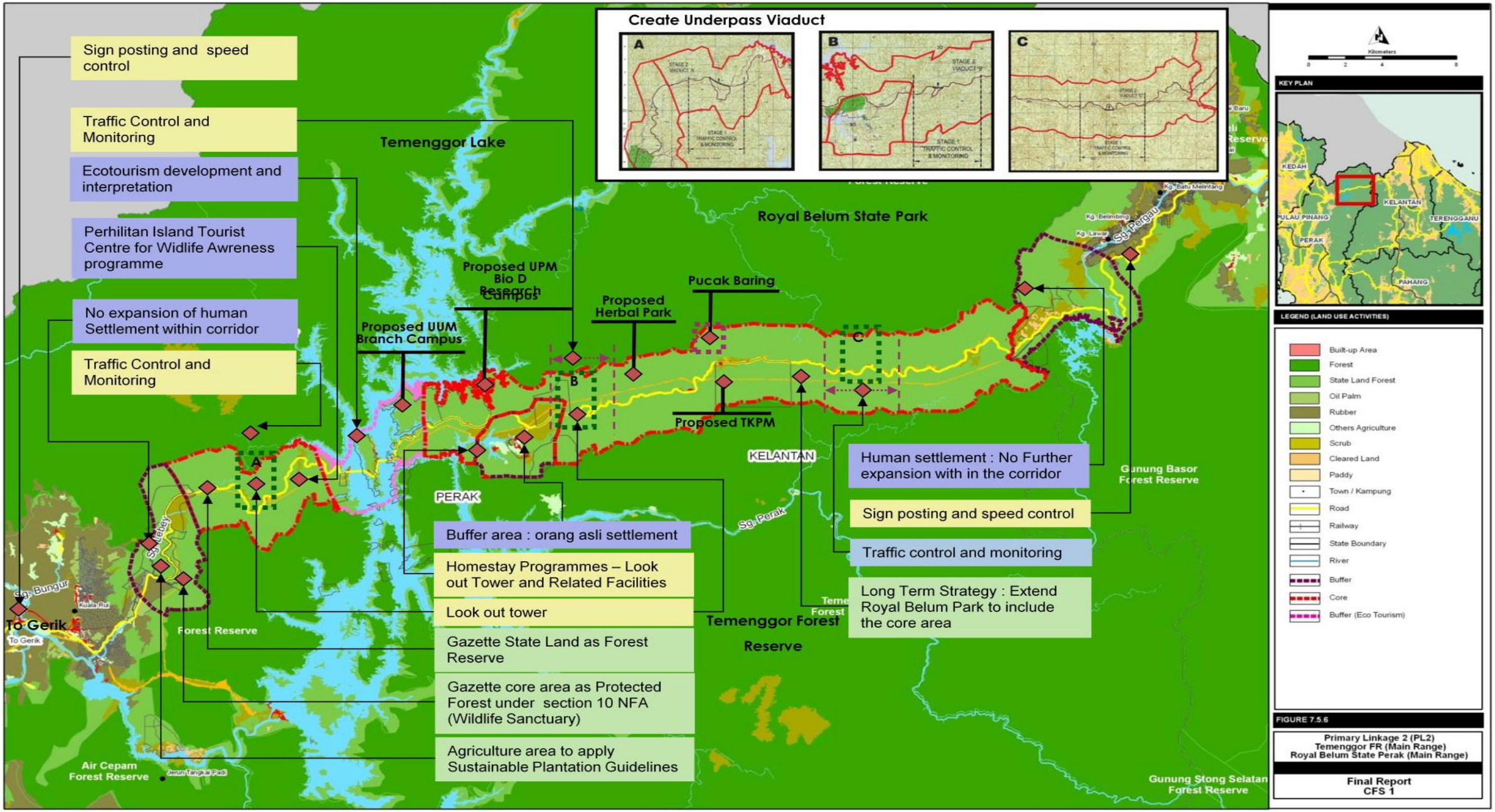
FIGURE 7.3.7

Wildlife Habitat PL2

Final Report
CFS 1

ROAD: FR 4 East-West Highway (MALAYSIA)

- **Environmental safeguards** to mitigate the negative impacts
  - Acquisition of lands surrounding both parks to expand connectivity between them and reduce the number of people living close to these parks to reduce human-wildlife conflicts.
  - Establishment of wildlife crossings and wildlife warning signs and speed limits in the forested corridors used by wildlife.
  - Establishment of guidelines for adopting sustainable agriculture management in the areas close to both parks.


Create Underpass Viaduct
A
B
C
Sign posting and speed control
Traffic Control and Monitoring
Ecotourism development and interpretation
Perhilitan Island Tourist Centre for Widlife Awreness programme
No expansion of human Settlement within corridor
Traffic Control and Monitoring
Temenggor Lake
Royal Belum State Park
Proposed UPM Bio D Research Campus
Proposed UUM Branch Campus
Proposed Herbal Park
Pucak Baring
Proposed TKPM
KELANTAN
PERAK
Human settlement : No Further expansion with in the corridor
Sign posting and speed control
Traffic control and monitoring
Long Term Strategy : Extend Royal Belum Park to include the core area
Buffer area : orang asli settlement
Homestay Programmes – Look out Tower and Related Facilities
Look out tower
Gazette State Land as Forest Reserve
Gazette core area as Protected Forest under section 10 NFA (Wildlife Sanctuary)
Agriculture area to apply Sustainable Plantation Guidelines
Temenggor Forest Reserve
Gunung Basor Forest Reserve
Gunung Stong Selatan Forest Reserve
Air Cepam Forest Reserve
Forest Reserve
To Gerik
Sg. Bungur
Sg. Perak
Sg. Pergau
KEY PLAN
KEDAH
KELANTAN
PULAU PINANG
PERAK
TERENGGANU
PAHANG
LEGEND (LAND USE ACTIVITIES)
Built-up Area
Forest
State Land Forest
Oil Palm
Rubber
Others Agriculture
Scrub
Cleared Land
Paddy
Town / Kampung
Road
Railway
State Boundary
River
Buffer
Core
Buffer (Eco Tourism)
FIGURE 7.5.6
Primary Linkage 2 (PL2)
Temenggor FR (Main Range)
Royal Belum State Perak (Main Range)
Final Report
CFS 1

ROAD: FR 4 East-West Highway (MALAYSIA)

- Safeguards cost: RM 465,127,865 (USD 131,280,797) in 2009
  - About 71% was the estimated cost related to land acquisition (25,227 hectares)

ROAD: FR 4 East-West Highway (MALAYSIA)

- Safeguards benefits:
  - Land acquisition: Market Price.
    - Assuming a market price of USD 30 per ton of carbon, the area (once reforested) could generate a revenue stream of RM 308 (or USD 87) million annually.
    - If this were the case, the payback for the proposed measures would be two years.

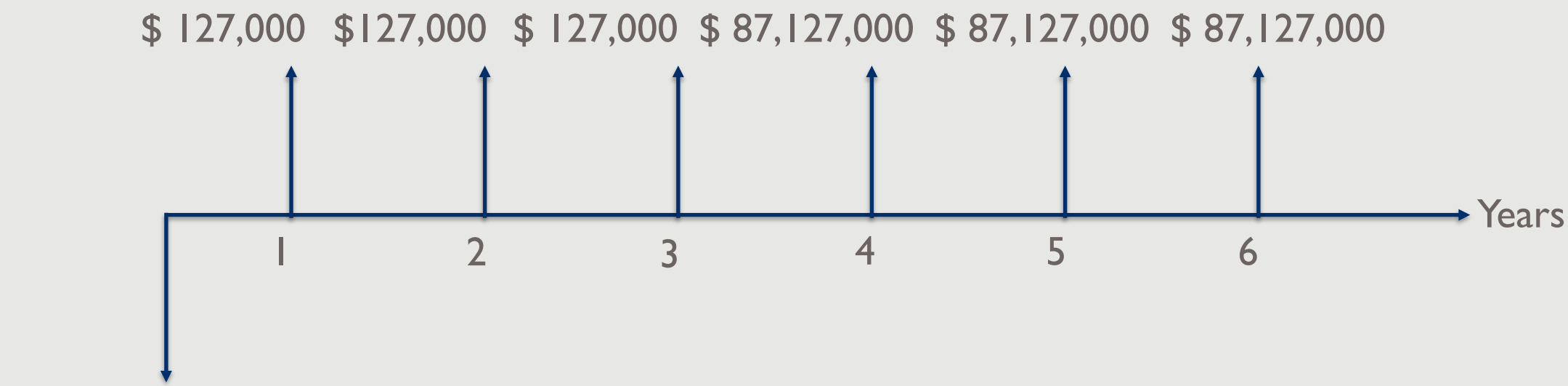
ROAD: FR 4 East-West Highway (MALAYSIA)

- Safeguards benefits:
  - Environmental safeguards: Avoided Cost method.
    - Hypothetical scenario: safeguards were not implemented
      - What would be the costs?
        - » Focus on human-elephant conflicts

ROAD: FR 4 East-West Highway (MALAYSIA)

- The benefit is RM 450,000 per year.
  - Which is the same as saying that the cost of not having environmental safeguards equals RM 450,000 per year (or about USD 127,000 per year)

ROAD: FR 4 East-West Highway (MALAYSIA)
Safeguards Costs and Benefits: Extrapolation from the case study



USD 131,280,797

ROAD: FR 4 East-West Highway (MALAYSIA)
Safeguards Costs and Benefits: Extrapolation from the case study

Benefit = USD
149,280,797

Cost = USD
131,280,797

NPV = $18 million (>0)

Assumption: discount rate = 12% per year

ROAD: FR 4 East-West Highway (MALAYSIA)

- Lessons learned
  - Safeguards benefits > safeguards costs, however
    - The road was built initially without a safeguard plan
    - The safeguards were only partially implemented by the government
      - Upfront financial costs of safeguards too high (despite the positive net benefits)

LESSONS LEARNED FROM THE CASE STUDIES

- The financial feasibility should be an economic feasibility. It should include:
  - Safeguards benefits and costs
  - (If possible) other positive and negative externalities
- Important to consider alternatives and avoid environmental impacts:
  - Investing in avoidance might be cheaper than investing in safeguards

Q&A

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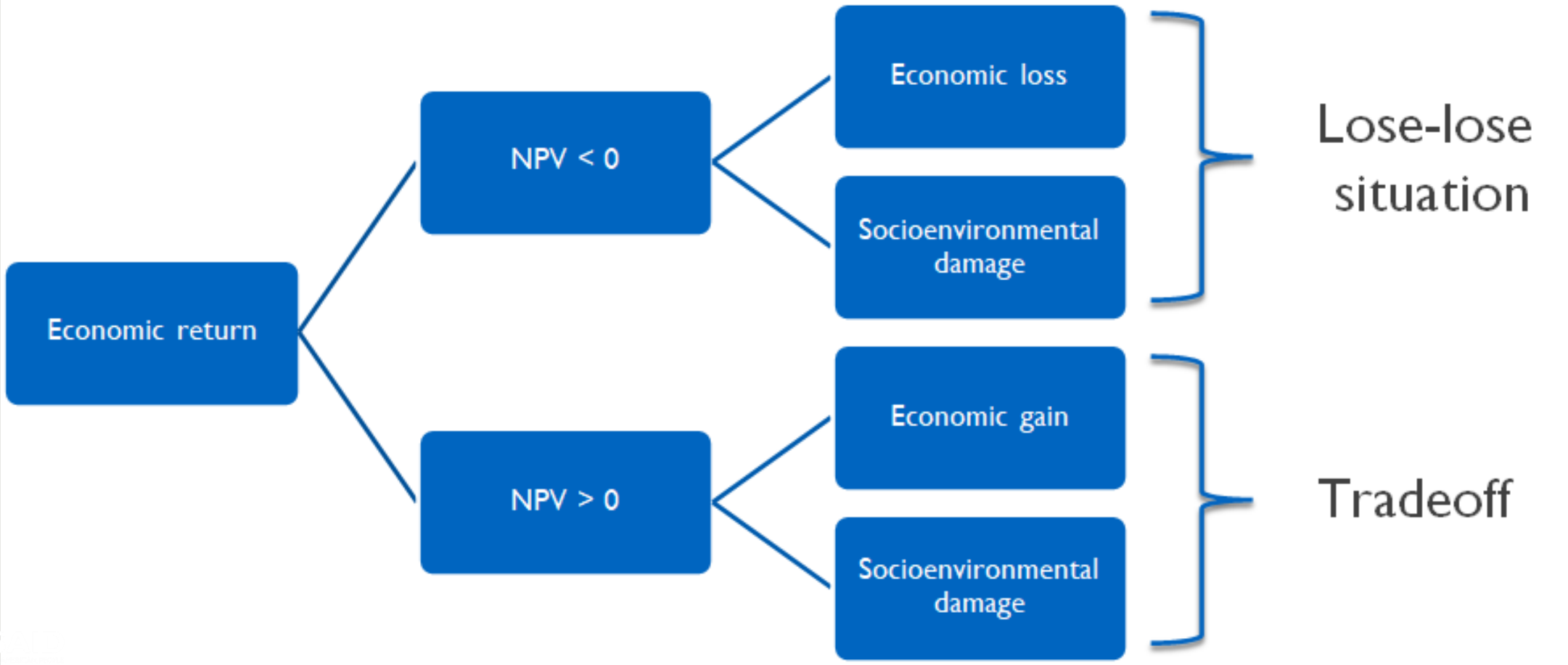
A Better Amazon Road Network for People and the Environment (2019)

A Better Amazon Road Network for People and the Environment

- Analytical framework



A Better Amazon Road Network for People and the Environment

- Set of road investments:
  - 75 projects
  - 12,263 km
  - US$ 27 billion
- Multicriteria approach:
  - Environmental
  - Social
  - Economic

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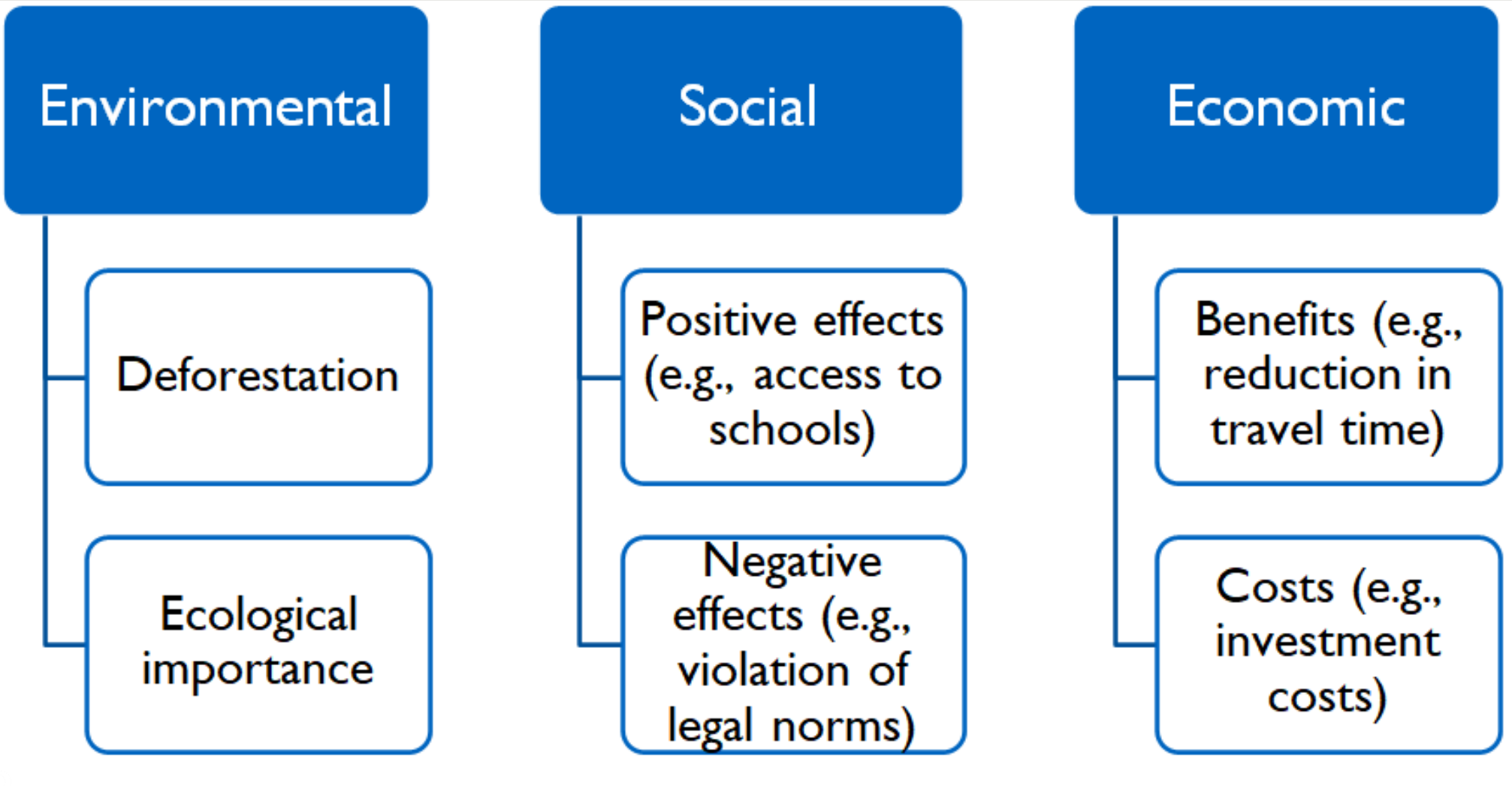

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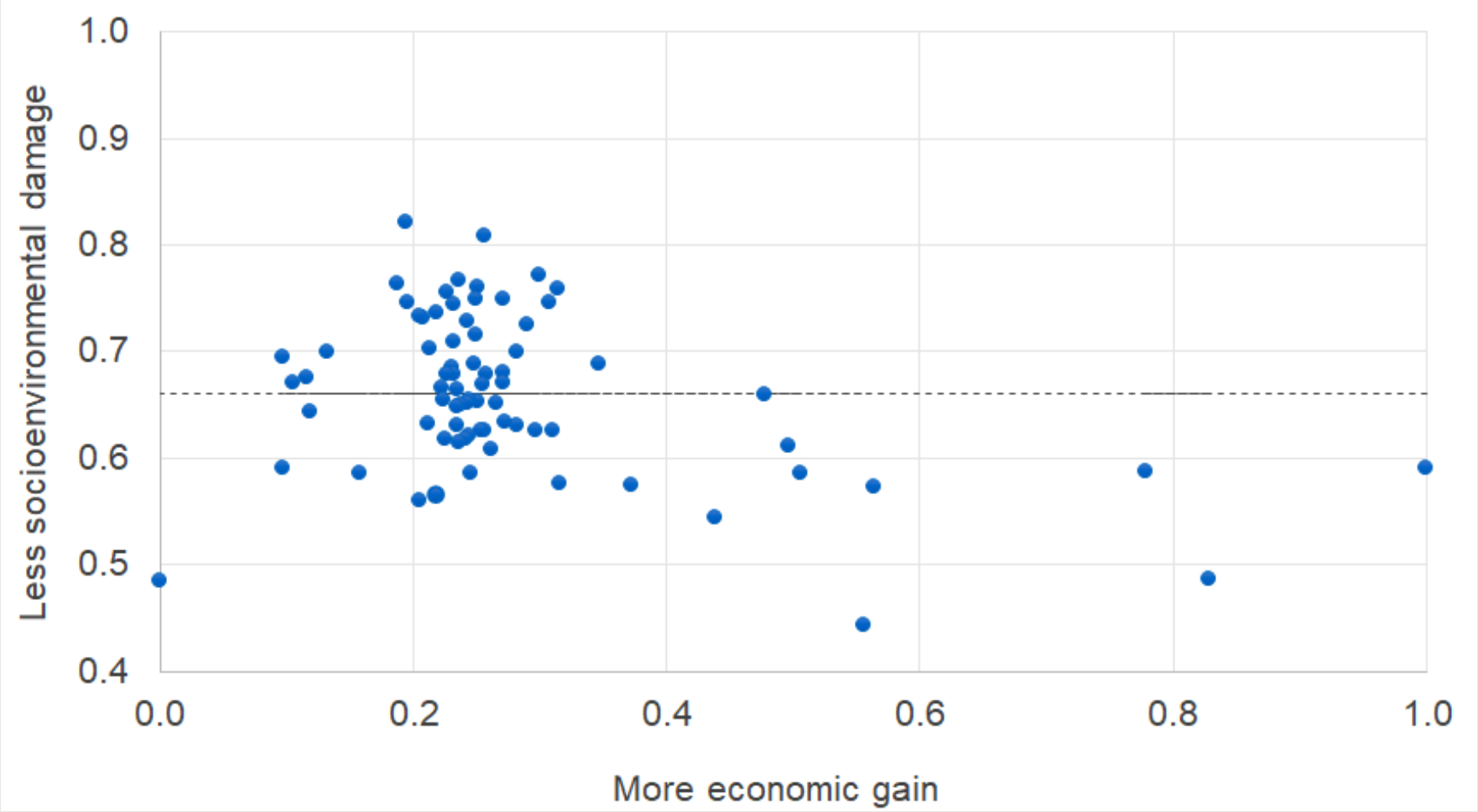

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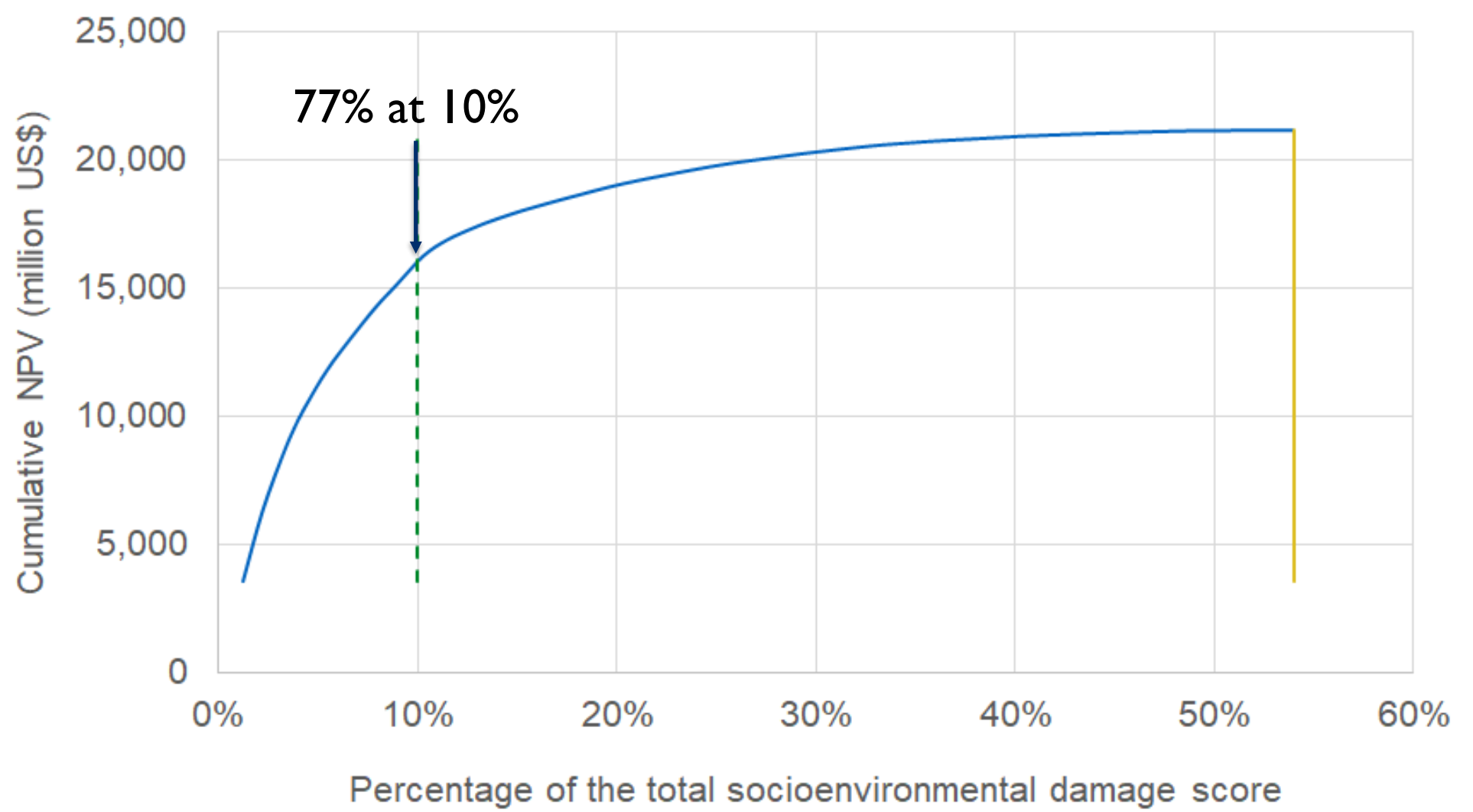

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- Recommendations

1. Don't build roads that don't make economic sense, i.e., NPV < 0.
2. For projects with NPV > 0, use this tool to consider the social and environmental costs too.
3. Be fully aware of the tradeoffs BEFORE making investment decisions.

CONCLUSIONS

- Ideal: AVOID
  - If avoidance not possible, mitigate impacts
    - Important to consider costs and benefits of mitigation measures/safeguards

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