Ecosystem services assessment in Southeast Cameroon tropical forests

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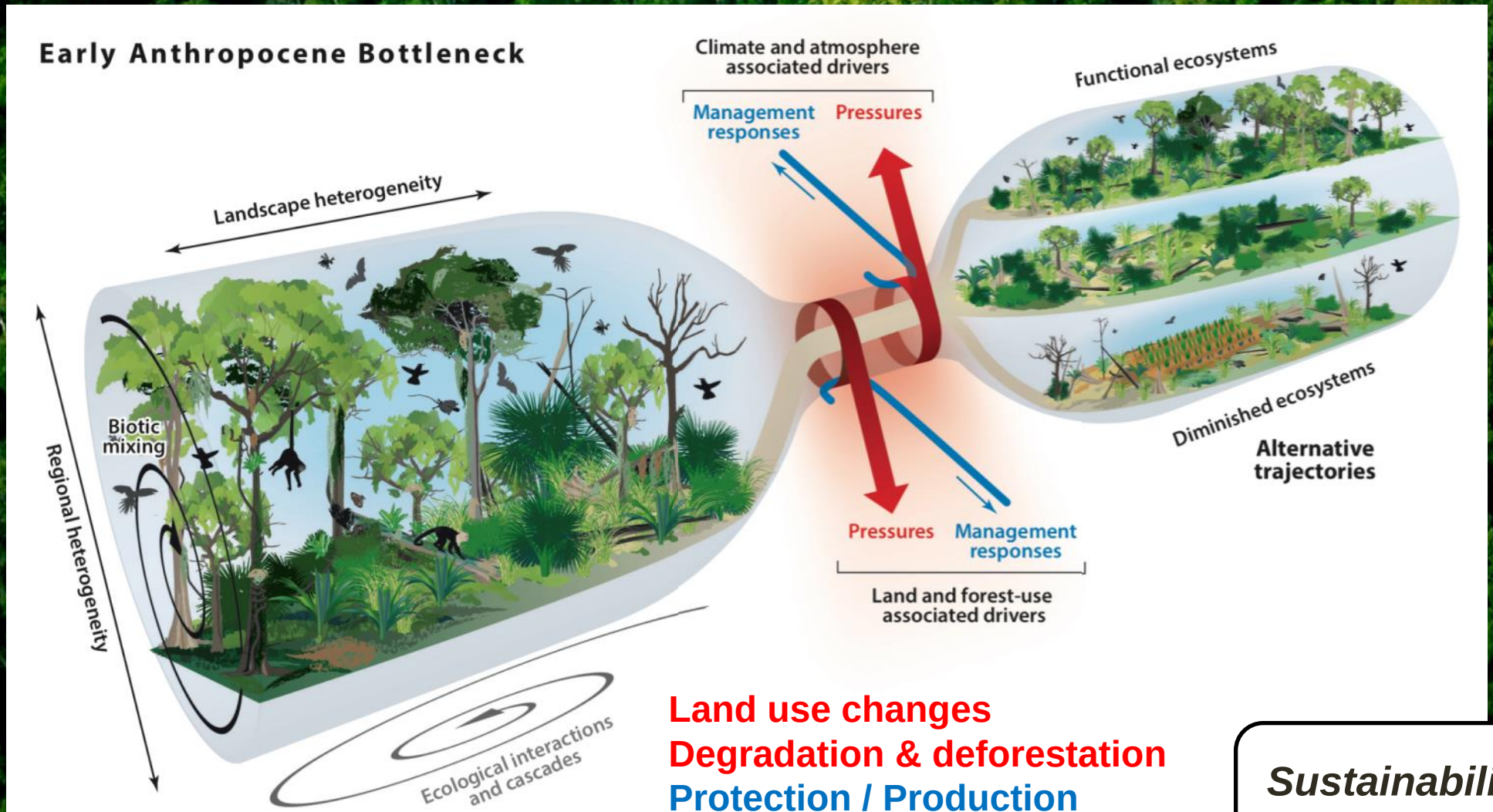
Tropical forests in the Anthropocene



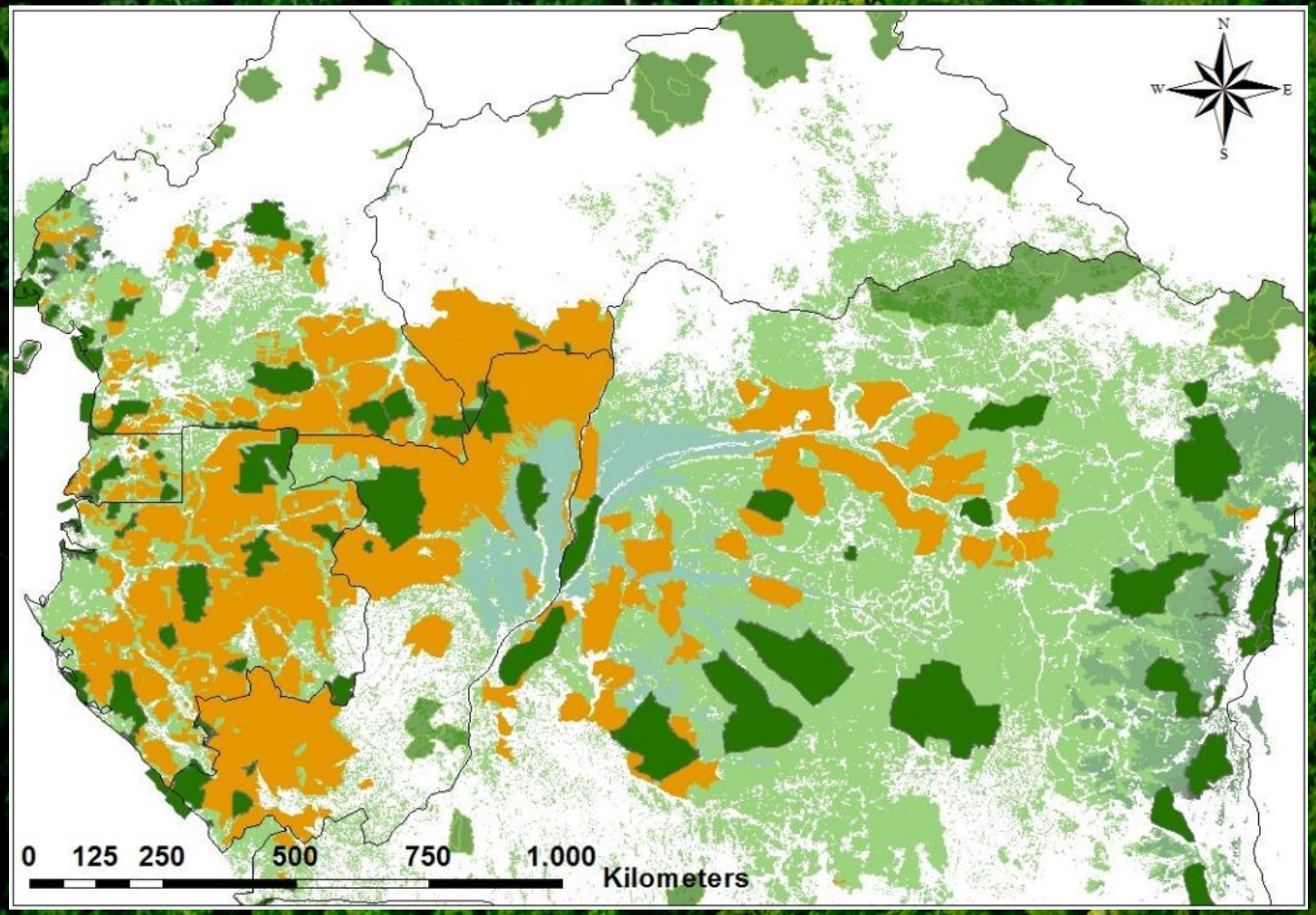
Malhi *et al.* (2014)

Land use changes
Degradation & deforestation
Protection / Production

Sustainability & impacts?

+ Other important changes in central Africa:
Population growth, climate change, political instabilities, etc.

Central Africa



Production forests
55 millions hectares
(<10 % certified for sustainable management)

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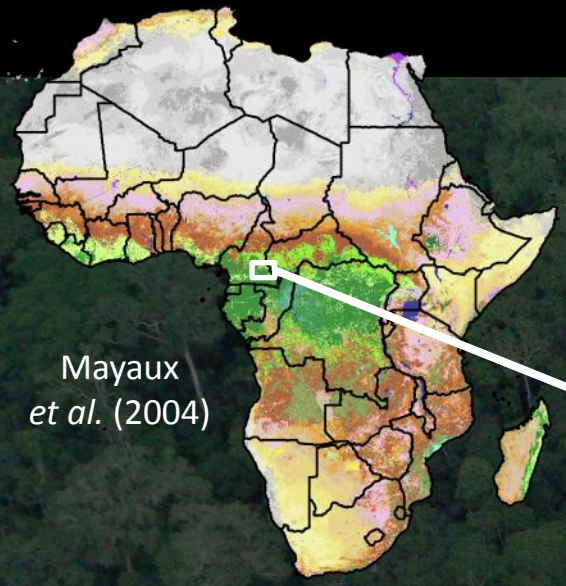
Protected forests
27 millions hectares

FSC

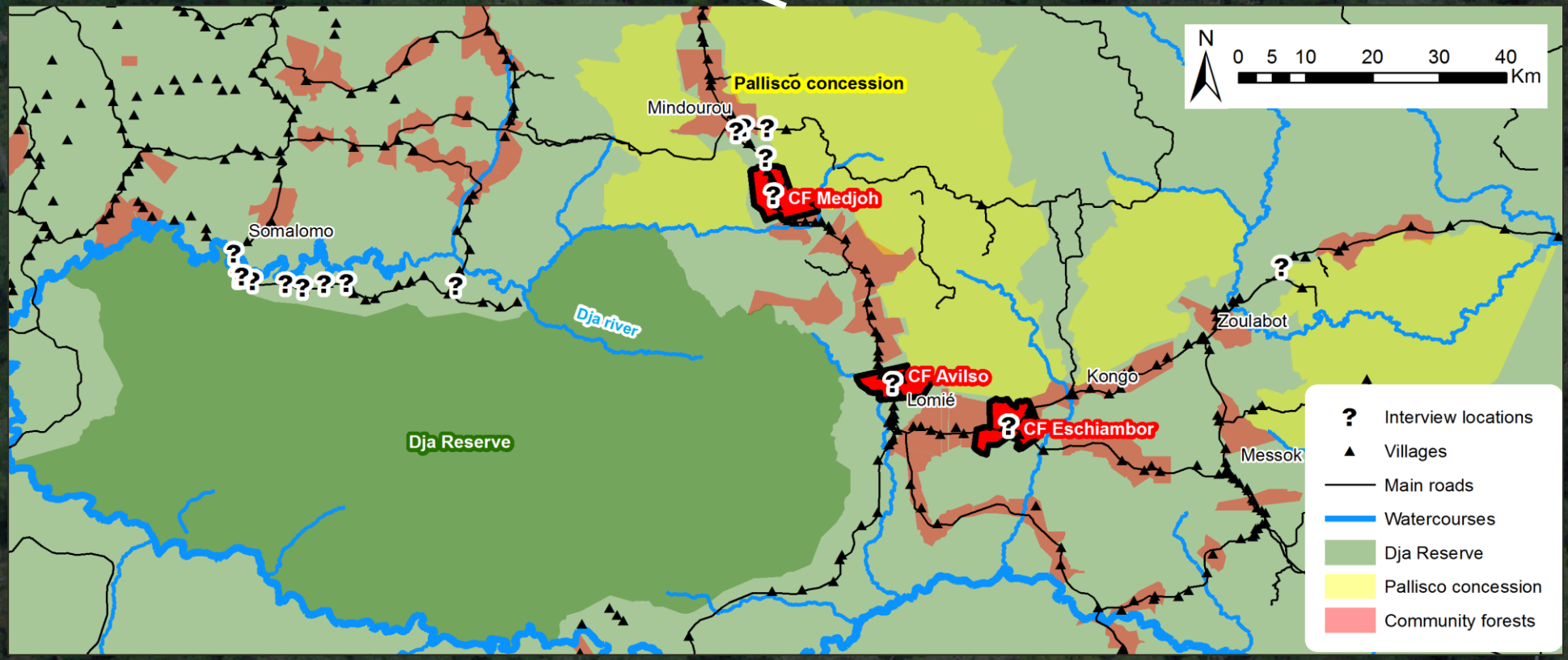
Study area: Southeast Cameroon



Mayaux *et al.* (2004)

Local populations:
Bantu and Baka Pygmies
Widely dependent on the forest for their daily activities (hunting, fishing, gathering of forest products, extensive agriculture)

Different land allocation types with different customary rights for rural populations



Conceptual framework of the thesis

2 Biodiversity

Trees
41 x 1-ha plots
DBH > 10 cm
Height (min. 50 trees/plot)
Species identification

Mammals
6 grids of 11-16 camera traps
2-3 months/grid
Species identification

Dung beetles
75 baited pitfall traps
48 hours/trap
Species identification

3 Ecosystem services

Provisioning


Timber


Firewood


Meat

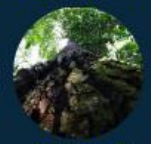

Fish


NTFP


Medicines

Regulating


Water quality


Climate & air quality regulation


Soil quality

Cultural


Heritage, rites & traditions


Education, science & tourism


Relaxation

Assessment with biophysical & social approaches

1 Forest stakeholders

Local populations

Forest managers

Administration

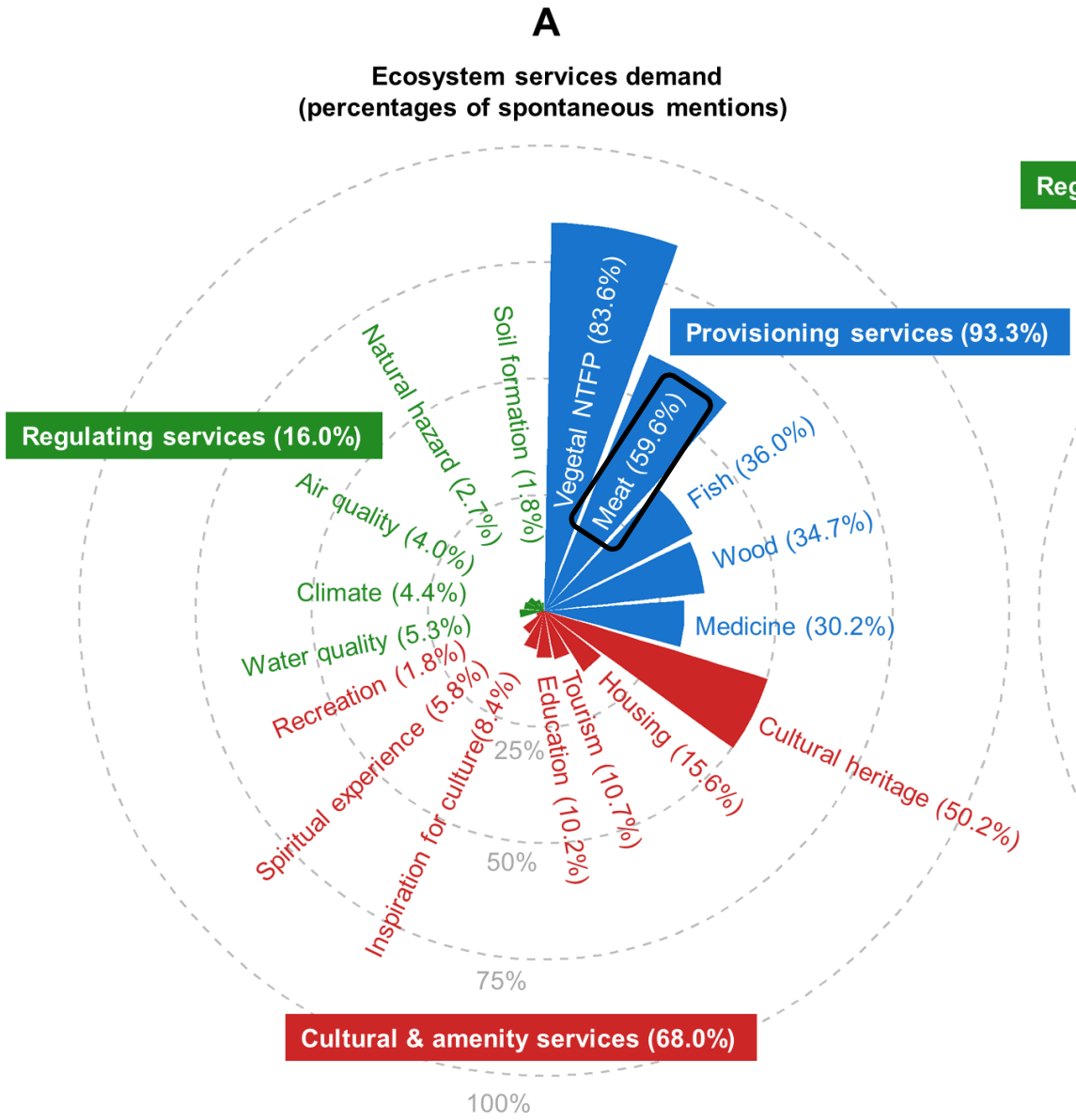
Forest land allocation

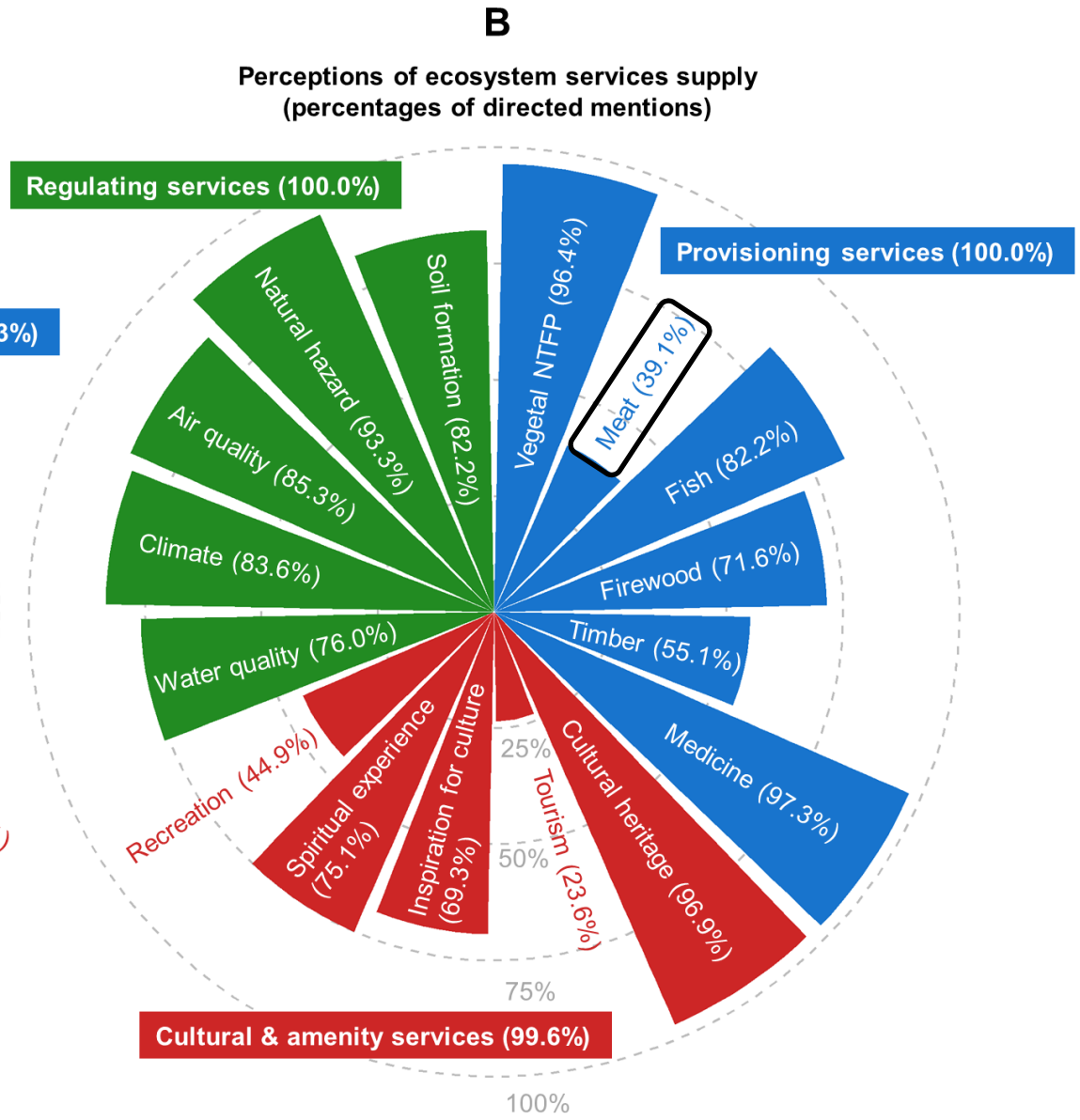
A protected area (Dja Biosphere Reserve)

A FSC-certified logging concession (Pallisco company)

Three community forests (Medjoh, Avilso, Eschiambor)

1 Perceptions of biodiversity and ecosystem services

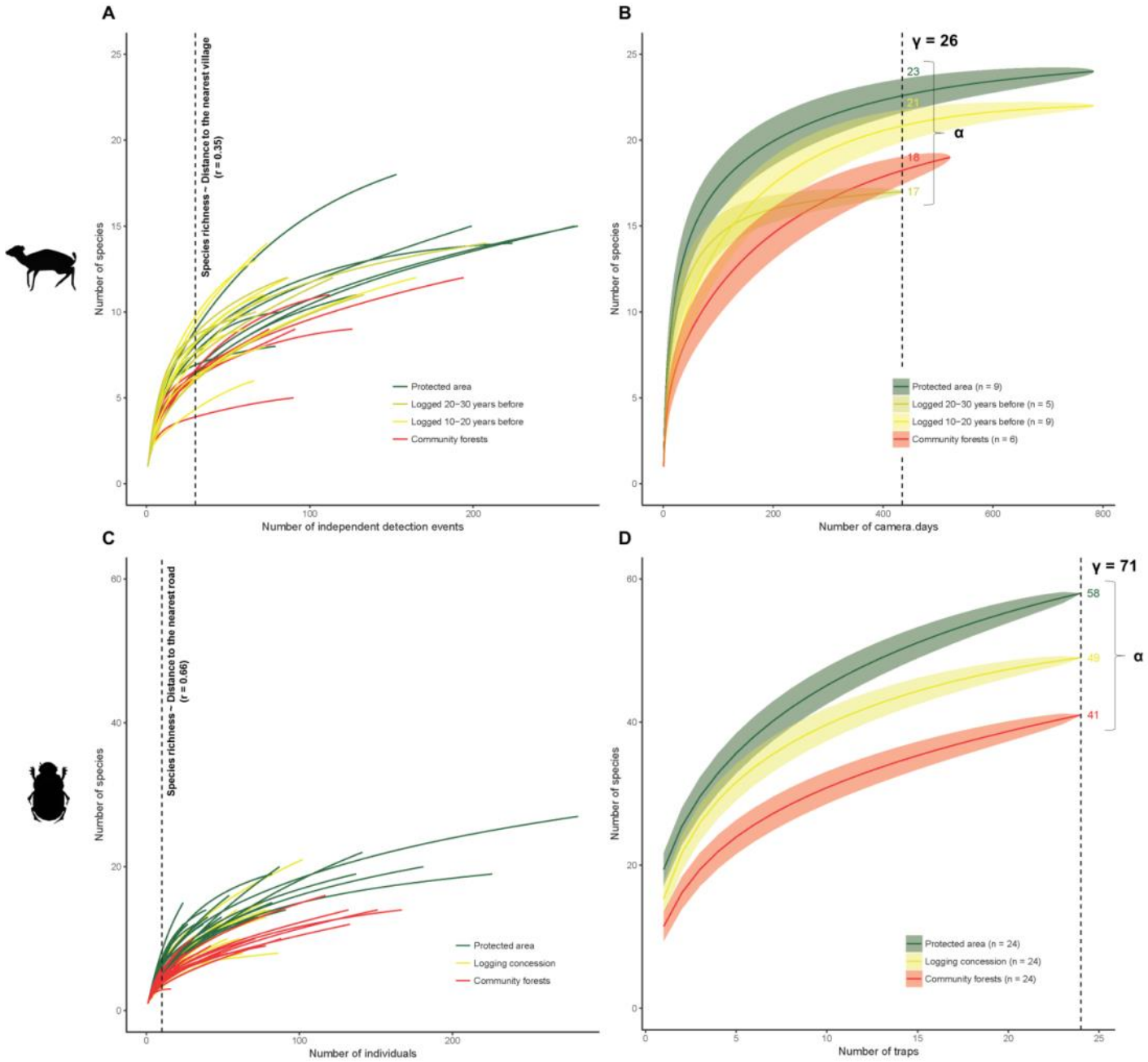

A
Ecosystem services demand
(percentages of spontaneous mentions)
Provisioning services (93.3%)
Regulating services (16.0%)
Cultural & amenity services (68.0%)
Vegetal NTFP (83.6%)
Meat (59.6%)
Fish (36.0%)
Wood (34.7%)
Medicine (30.2%)
Soil formation (1.8%)
Natural hazard (2.7%)
Air quality (4.0%)
Climate (4.4%)
Water quality (5.3%)
Recreation (1.8%)
Spiritual experience (5.8%)
Inspiration for culture(8.4%)
Education (10.2%)
Tourism (10.7%)
Housing (15.6%)
Cultural heritage (50.2%)
25%
50%
75%
100%

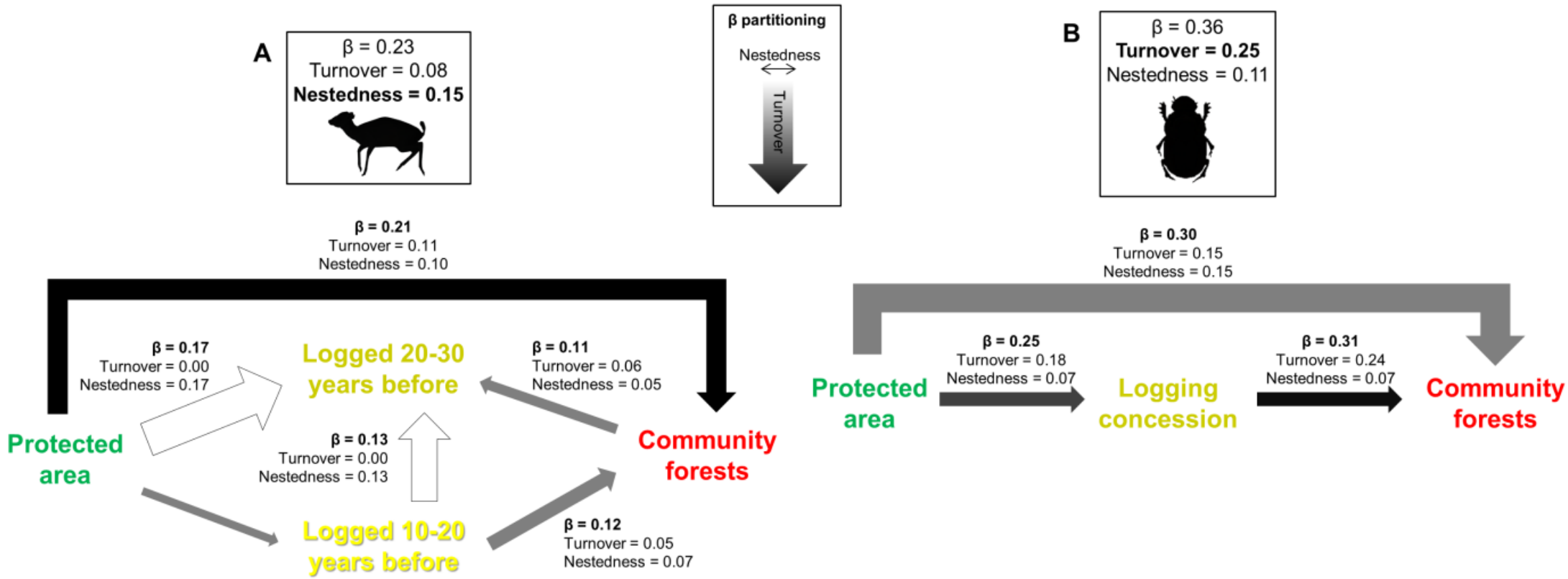

B
Perceptions of ecosystem services supply
(percentages of directed mentions)
Regulating services (100.0%)
Provisioning services (100.0%)
Cultural & amenity services (99.6%)
Vegetal NTFP (99.4%)
Meat (39.1%)
Fish (82.2%)
Firewood (71.6%)
Timber (55.1%)
Medicine (97.3%)
Soil formation (82.2%)
Natural hazard (93.3%)
Air quality (85.3%)
Climate (83.6%)
Water quality (76.0%)
Recreation (44.9%)
Spiritual experience (75.1%)
Inspiration for culture (69.3%)
Tourism (23.6%)
Cultural heritage (96.9%)
25%
50%
75%
100%

1 Perceptions of biodiversity and ecosystem services

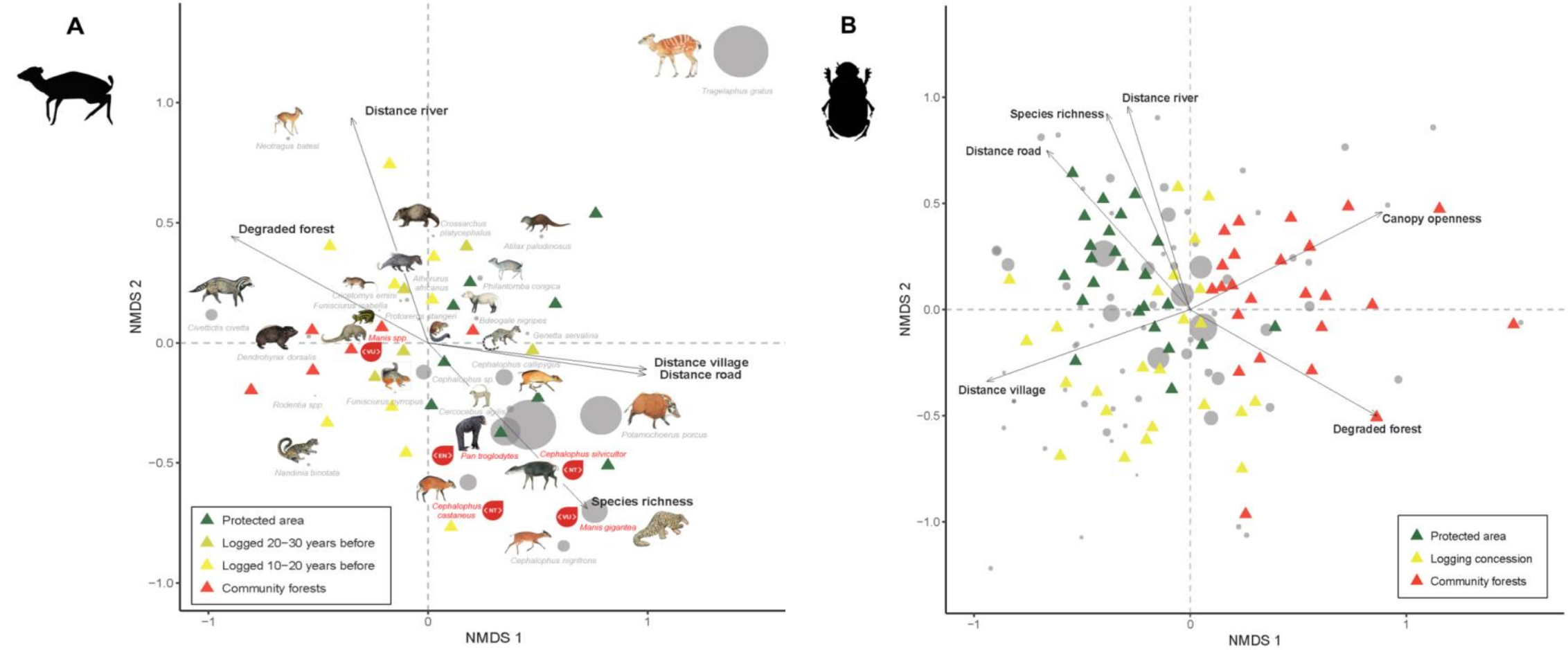
Services	Land allocation type: Protected area	Land allocation type: Logging concession	Land allocation type: Community forests	Deforestation	Gender: Man	Gender: Woman	Age	Ethnicity: Badjoué	Ethnicity: Nzimé	Ethnicity: Ndjem	Ethnicity: Baka	Ethnicity: Other Cameroonian	Ethnicity: Foreigner	Main occupation: Producer	Main occupation: Salaried	Main occupation: Student	Main occupation: Official	Main occupation: Other
Vegetal NTFP	n.s.			n.s.	n.s.		n.s.	n.s.										
Meat (hunting)	n.s.			n.s.	n.s.		n.s.	n.s.										
Fish (fishing)	n.s.			n.s.	n.s.		n.s.	n.s.										
Firewood	53% (a)	61% (a)	100% (b)	↓	n.s.		n.s.	n.s.										
Timber	55% (ab)	43% (a)	68% (b)	↓	50% (a)	74% (b)	n.s.	n.s.										
Traditional medicine	n.s.			n.s.	n.s.		n.s.	n.s.										
Cultural heritage and identity	n.s.			n.s.	n.s.		n.s.	n.s.										
Tourism	64% (b)	1% (a)	5% (a)	n.s.	n.s.		n.s.	n.s.										
Inspiration for culture	92% (c)	71% (b)	45% (a)	n.s.	n.s.		↓	n.s.										
Spiritual experience	79% (ab)	84% (b)	63% (a)	n.s.	n.s.		n.s.	n.s.										
Recreation	n.s.			n.s.	n.s.		n.s.	n.s.										
Water quality regulation	n.s.			n.s.	n.s.		n.s.	89% (b)	59% (a)	50% (ab)	93% (ab)	68% (a)	60% (ab)					
Climate regulation	n.s.			n.s.	n.s.		n.s.	n.s.										
Air quality regulation	n.s.			n.s.	n.s.		n.s.	n.s.										
Natural hazard mitigation	n.s.			n.s.	n.s.		n.s.	n.s.										
Soil formation and regeneration	n.s.			n.s.	n.s.		n.s.	n.s.										

❷ Biodiversity assessment


A
Species richness ~ Distance to the nearest village (r = 0.35)
Number of species
Number of independent detection events
Protected area
Logged 20–30 years before
Logged 10–20 years before
Community forests
B
γ = 26
23
21
α
18
17
Number of species
Number of camera.days
Protected area (n = 9)
Logged 20–30 years before (n = 5)
Logged 10–20 years before (n = 9)
Community forests (n = 6)
C
Species richness ~ Distance to the nearest road (r = 0.66)
Number of species
Number of individuals
Protected area
Logging concession
Community forests
D
γ = 71
58
49
α
41
Number of species
Number of traps
Protected area (n = 24)
Logging concession (n = 24)
Community forests (n = 24)


A
β = 0.23
Turnover = 0.08
Nestedness = 0.15
β partitioning
Nestedness
Turnover
B
β = 0.36
Turnover = 0.25
Nestedness = 0.11
β = 0.21
Turnover = 0.11
Nestedness = 0.10
β = 0.17
Turnover = 0.00
Nestedness = 0.17
Logged 20-30 years before
β = 0.11
Turnover = 0.06
Nestedness = 0.05
Protected area
β = 0.13
Turnover = 0.00
Nestedness = 0.13
Community forests
Logged 10-20 years before
β = 0.12
Turnover = 0.05
Nestedness = 0.07
β = 0.30
Turnover = 0.15
Nestedness = 0.15
Protected area
β = 0.25
Turnover = 0.18
Nestedness = 0.07
Logging concession
β = 0.31
Turnover = 0.24
Nestedness = 0.07
Community forests

❷ Biodiversity assessment



❸ Ecosystem services assessment

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Provisioning


Timber


Firewood


Meat

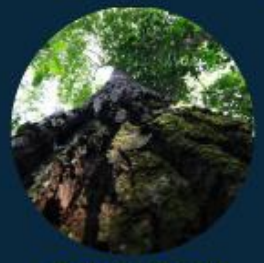

Fish


NTFP


Medicines

Regulating


Water quality


Climate & air quality regulation


Soil quality

Cultural


Heritage, rites & traditions


Education, science & tourism


Relaxation

Assessment with biophysical & social approaches

❸ Ecosystem services assessment

Timber

75 Interviews:

- Properties of timber used: distance, variety, date, price, …
- Perceptions of durability, preferences, …

Social

➔ **Origin of timber, mode of acquisition (collection / purchase / donation)**

293 m² of facade measured
Mean conversion coefficient = 0.02 m³ / m²
Estimation of the timber volume for 81 houses

Biophysical

➔ **Mean annual timber consumption (m³ / household / year)**

❸ Ecosystem services assessment

Firewood

Daily monitoring of 55 households during 3 months:

- Firewood collection (who + where + mass collected)
- Mass bought and sold

Biophysical

➔ **Mean daily collection and consumption (kg / person / day)**
➔ **Proportions of firewood bought and sold**
➔ **Mean price of firewood (FCFA / kg)**

Validation with 62 complementary interviews

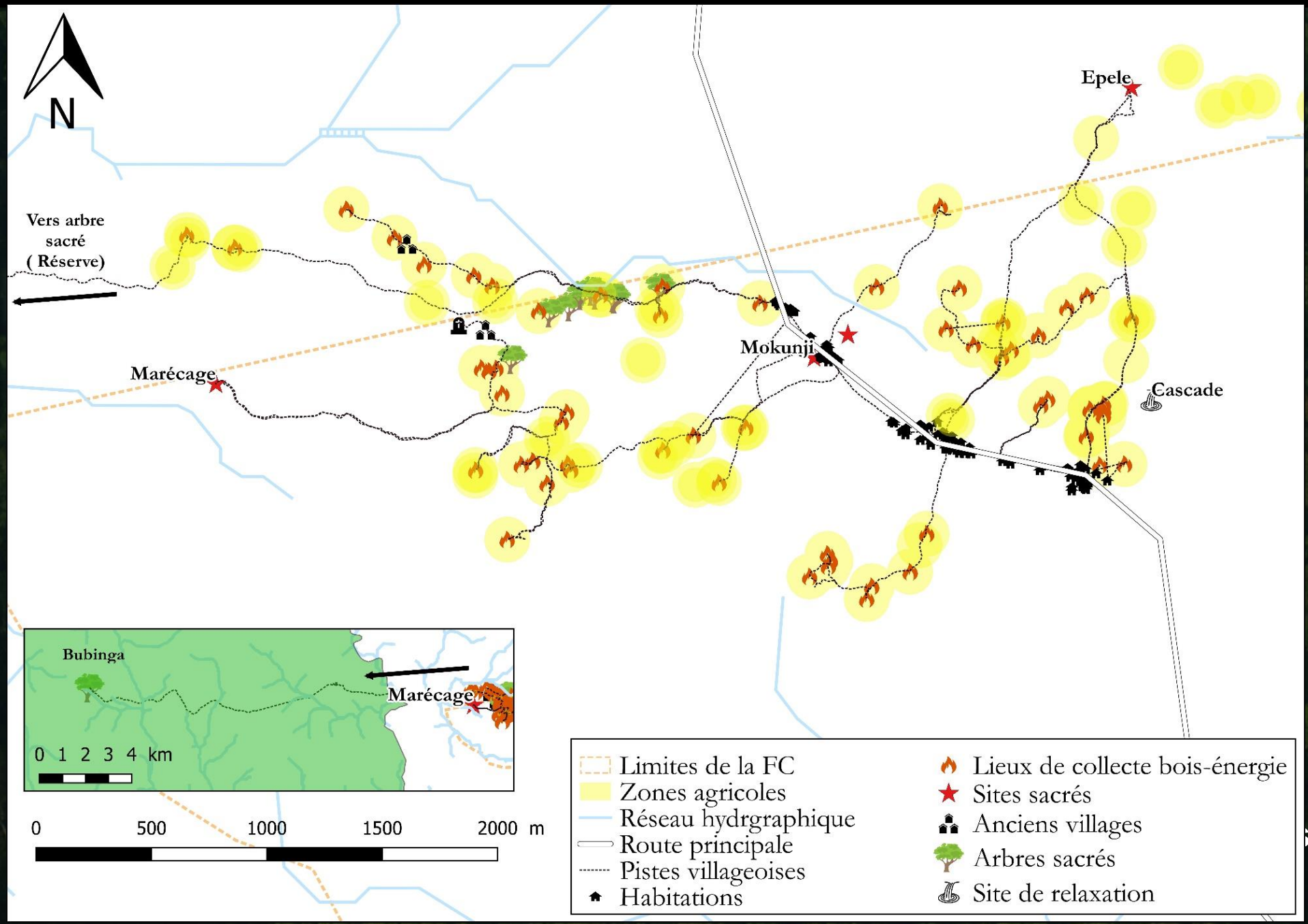
Social

Origin of firewood: participatory observation + GPS points

➔ **Collection zones, mean distances, maximal distances**

Mapping

❸ Ecosystem services assessment



Biophysical

day)

Social

Mapping

Bushmeat

Hunting

Social

34 interviews with hunters:
- Hunting techniques and habits
- Hunting sites

Biophysical

137 hunted animals:
- Mass
- Monetary value
- Destination (sale / consumption)
- Hunting « yield »

Mapping

651 km of field tracking:
- 23 Hunting camps
- 71 Cartridges
- 1182 Traps

Bushmeat consumption

Daily monitoring of 55 households during 3 months:
- Composition of meals
- Mass / value of bushmeat
- Origin of bushmeat
- Mode of acquisition (hunting / purchase / donation)

Biophysical

Social

❸ Ecosystem services assessment

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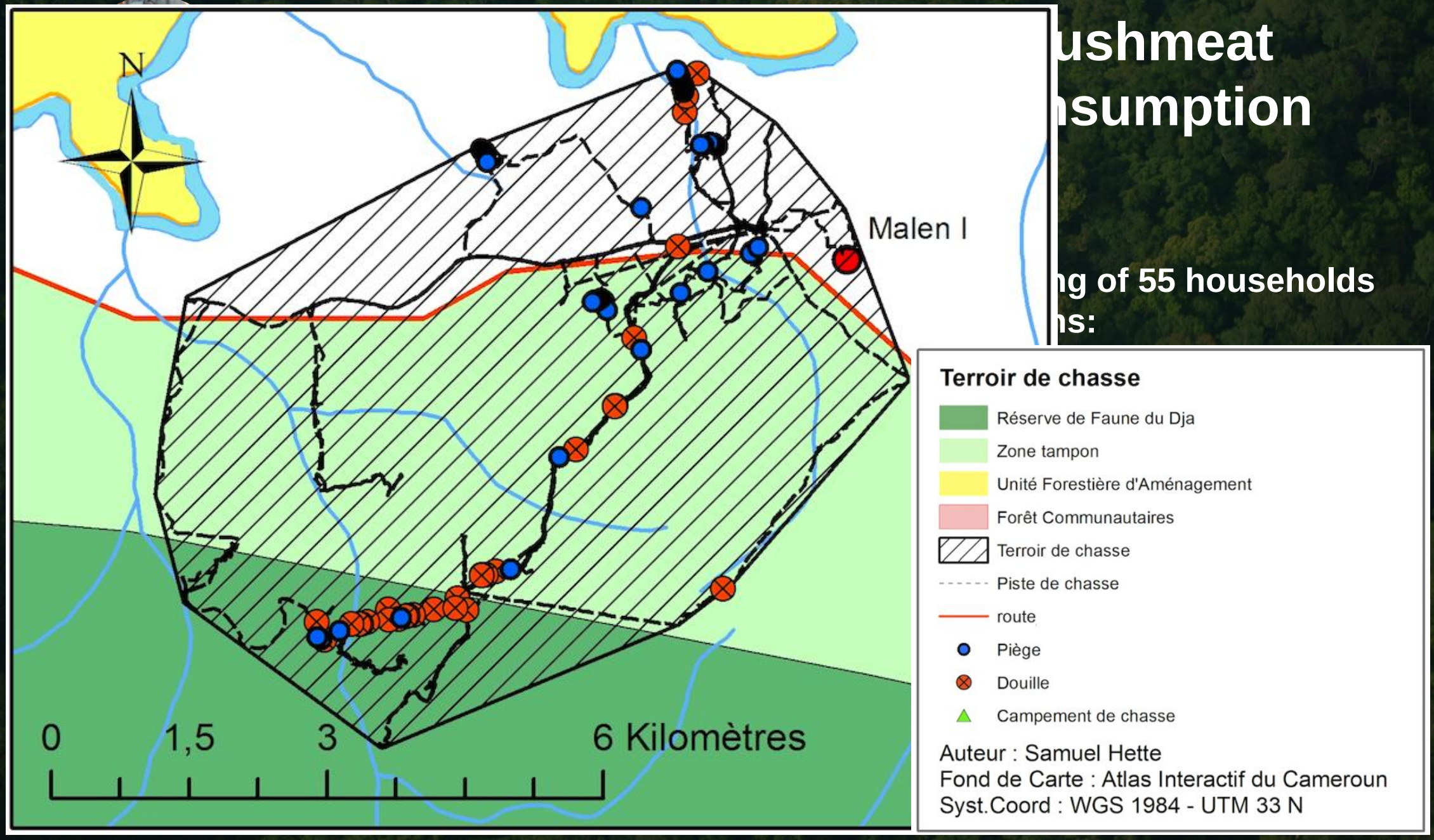
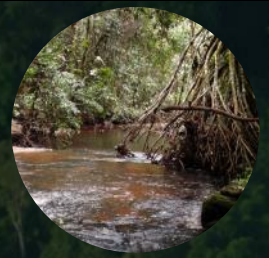
nsumption

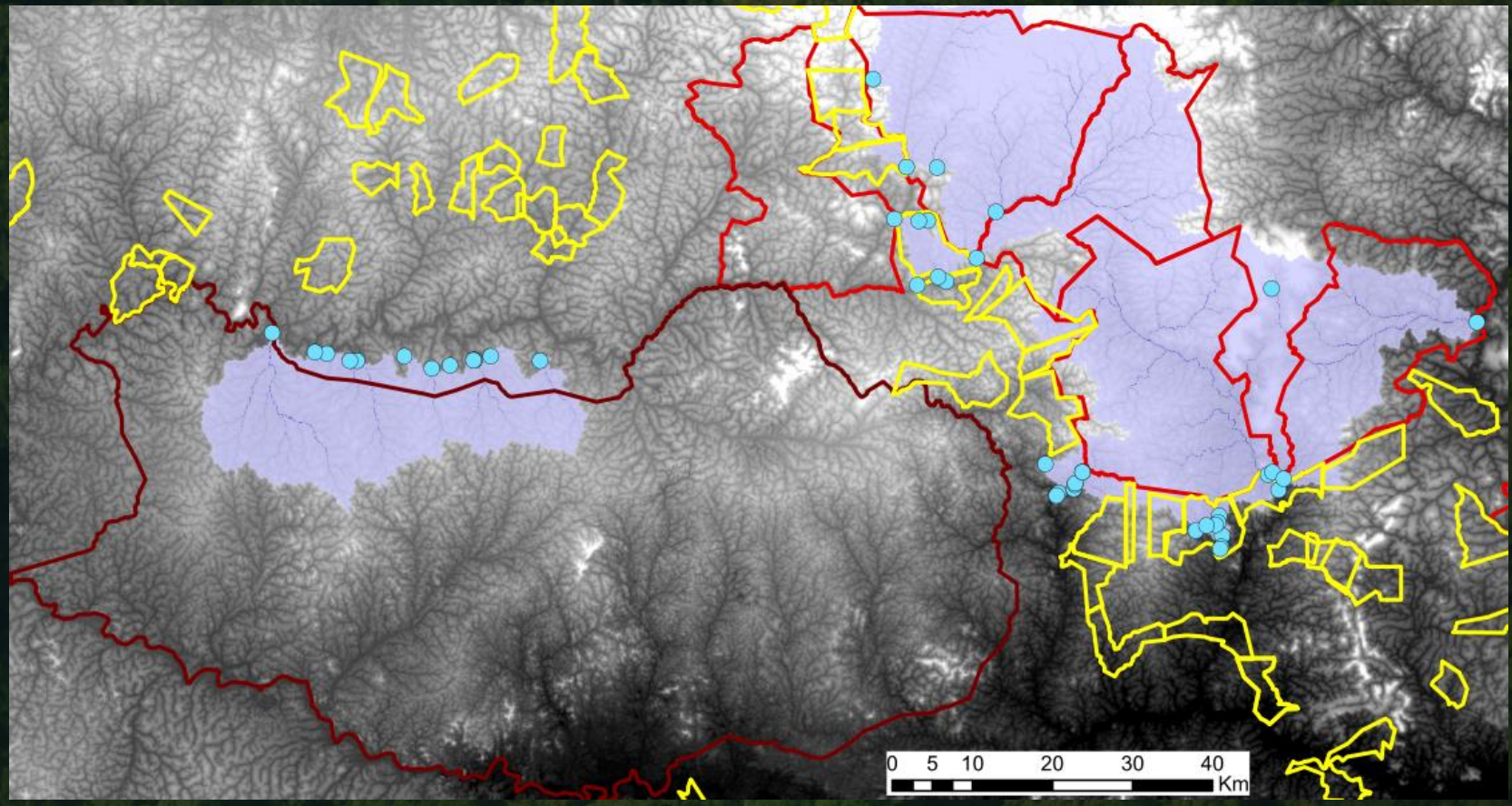
ng of 55 households
ns:



❸ Ecosystem services assessment



Water quality



Biophysical

Measure of 5 physico-chemical parameters:

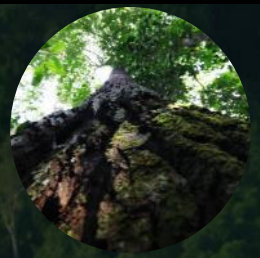
pH, conductivity, [dissolved oxygen], [nitrates], [ammonium]

Biophysical

Soil quality

In 36 x 1-ha plots:
Collection of soil samples for the quantification of physico-chemical parameters

❸ Ecosystem services assessment

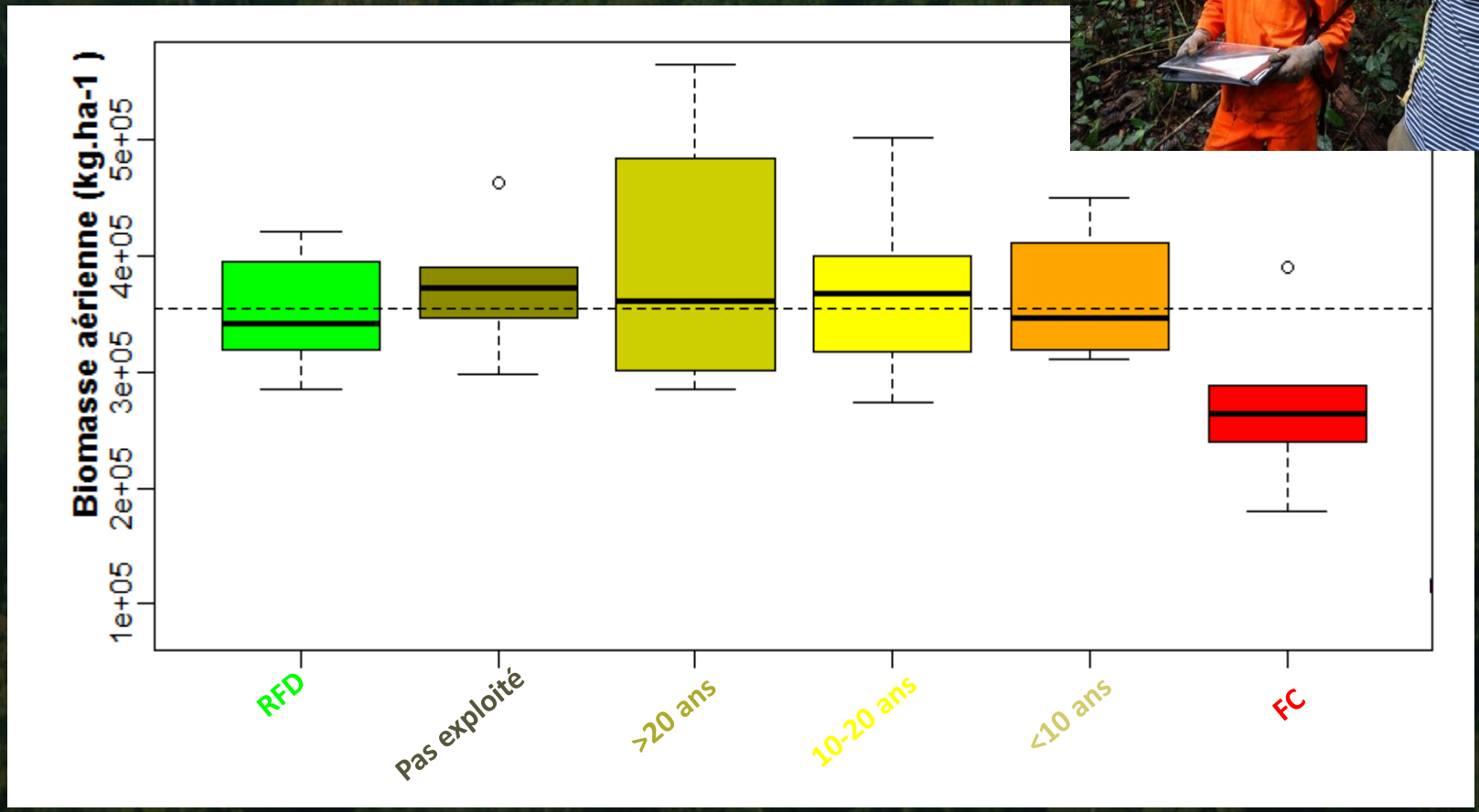


Climate regulation

Biophysical

In 36 x 1-ha plots, measure of:

- Diameter of 17 370 trees (10 – 239 cm)
- Height of 2 274 trees (up to 51.6 m)



❸ Ecosystem services assessment

Heritage, rites & traditions

Education, science & tourism

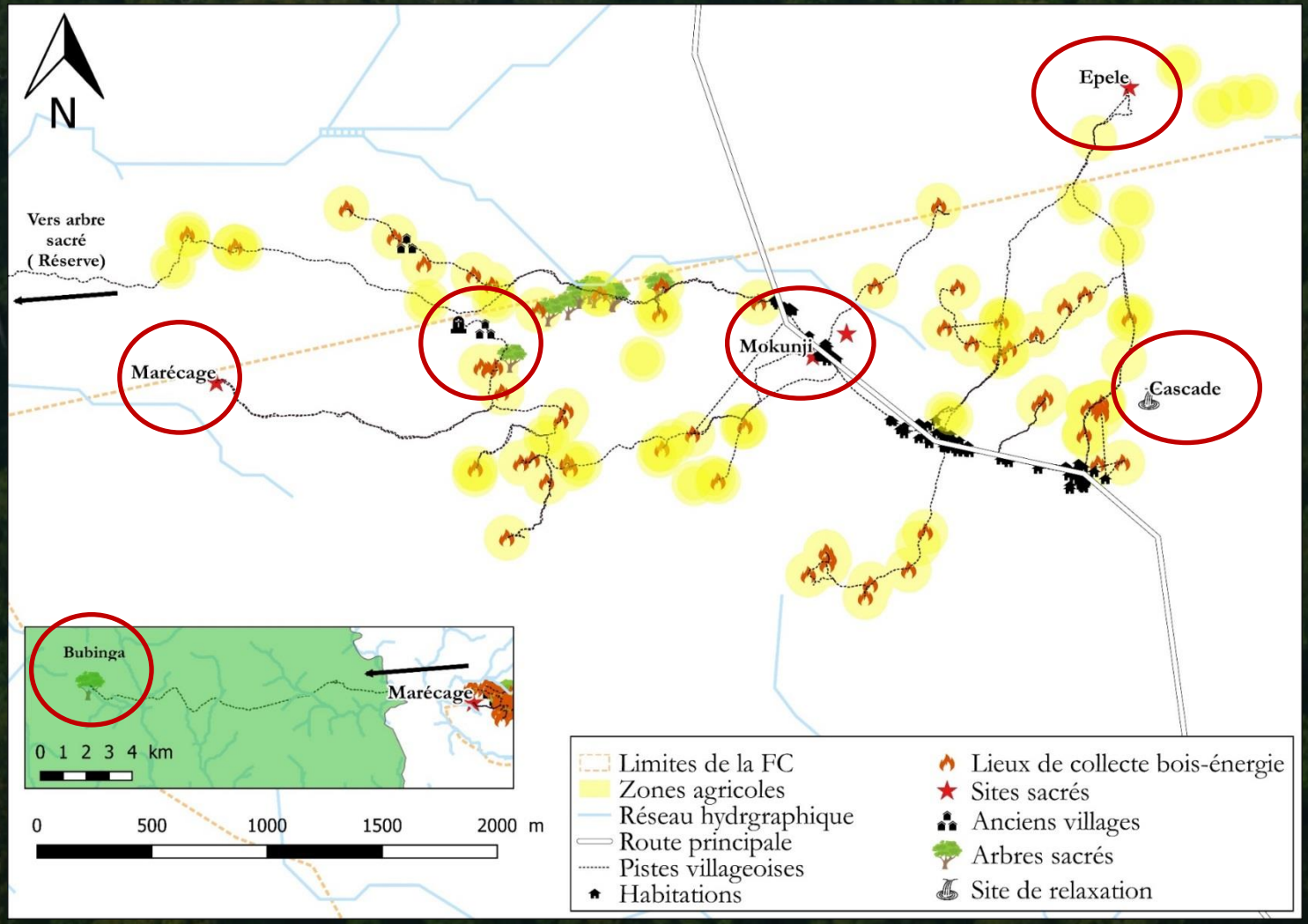
Relaxation

148 individual interviews:

Semi-quantitative [0-1-2] + qualitative evaluation of ES

Social

Mapping



Mapping of sacred sites, sacred trees, and relaxation sites

Unique beneficiaries: local populations (Bantu & Pygmy)

	Supply	Demand
Social	• All ES perceptions	• Timber & firewood • Meat • Cultural heritage • Relaxation • Rites & traditions
Biophysical	• Climate regulation • Water quality regulation	• Timber & firewood • Meat • Tourism

Indicators of well-being derived from the forest

1. **Elimination of poverty**:
   Income from the forest & employment + expenses in education, healthcare, water, energy, consumer goods, land ownership, infrastructures

2. **Elimination of hunger & contribution to food security and nutrition**:
   Diversity & frequency of forest products consumption, quality of daily diet

3. **Contribution to healthcare**:
   Traditional medicine

?

4. **Contribution to gender equality**:
   Level of involvement of women in forest activities and proportion of income

How to synthesize this assessment of ecosystem services in a unique paper?

Definition of 1 indicator / ES

➔ Spider plots with 1 value = 1 management?

Mapping, spatial analysis?

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Thanks for your attention!