Haute école de gestion Genève

UNIVERSITÉ DE NEUCHÂTEL

Workshop on economic valuation of forest ecosystem services :
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The value of Endangered Forest Elephant for local communities in a conservation landscape

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INRA SCIENCE & IMPACT

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CIFOR

Norad

UNIVERSITÉ DE LORRAINE

Laboratoire d'Economie Forestière

Organisation

- Background and key issues
- Literature review
- Objective and hypothesis
- Methodology
- Results
- Policy implications

BACKGROUND AND KEY ISSUES

Importance of Endangered Forest Elephants (EFE)



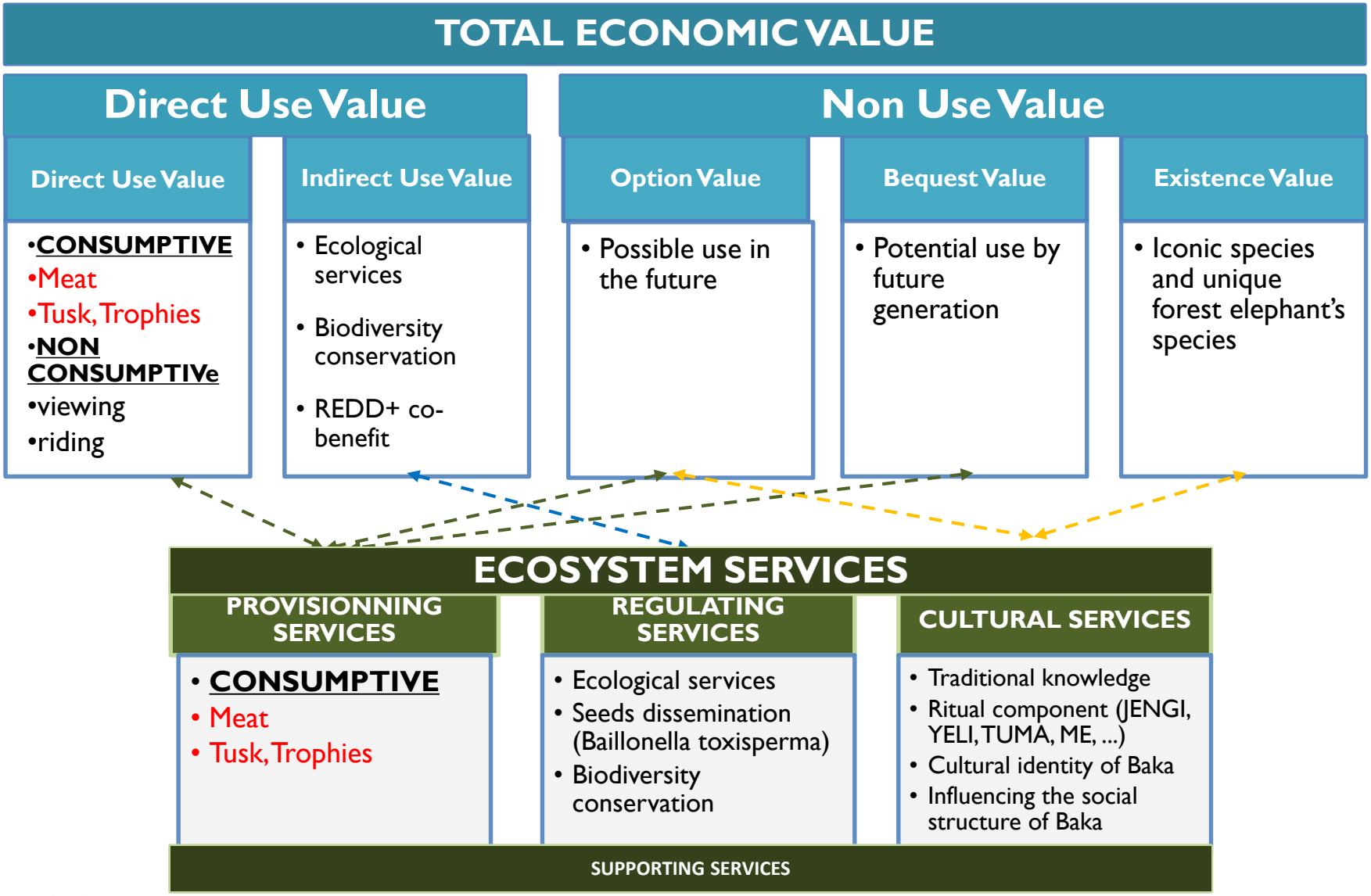






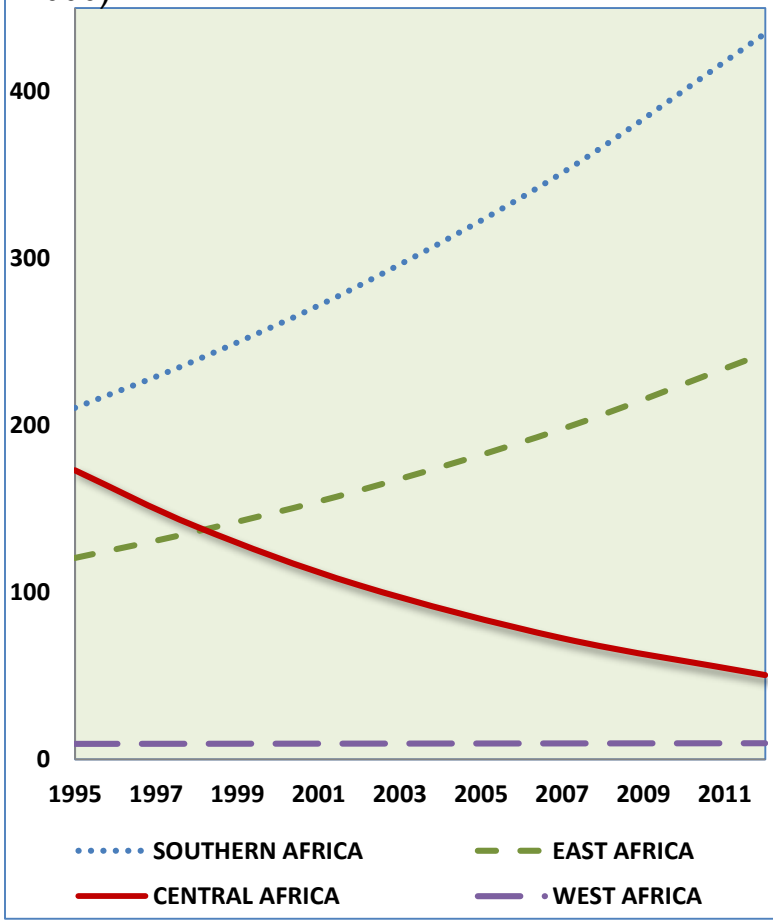
Background and key issues

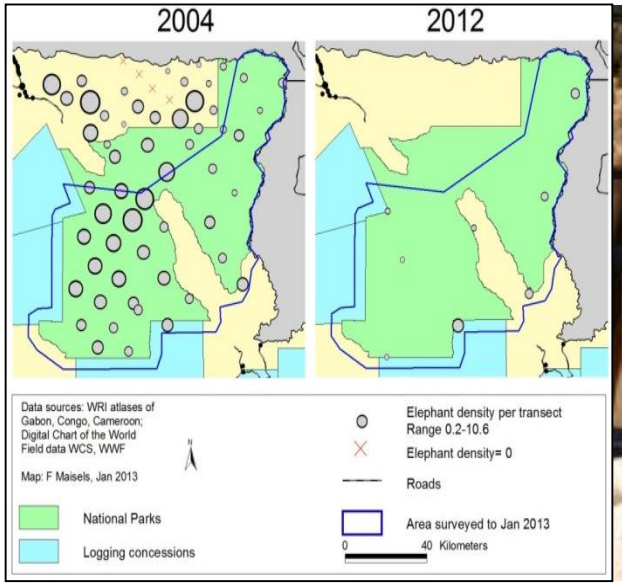
Importance of Forest Elephants (EFE)



Background and key issues

Fig. 1 : Devastating Decline (CITES, 2012, Maisels and Al, 2013; Blake et al., 2007; Martin and Stiles, 2000)





- < 10% of its potential size
- < 25% of its potential range
  - Large scale land grabbing
  - Tusk and Trophies' income, meat and Hunting lease fees
  - Poaching; Related illegal Ivory trade

Background and key issues

Importance of EFE








Background and key issues

Research question

Thus, Forest Elephants' Conservation : A priority for biodiversity conservation decision in the Congo Basin.

- ***what is the local households willingness to pay (WTP)to avoid a total loss of elephant?"***

Literature review

- Economics of endangered species conservation (Bishop, 1978; Barbier et al, 2013; Tisdell, 2002; Bulte and Kooten, 2002).
- **Few research on local people's valuation** of the indirect-use and non-use values Asian savannah elephants (Smith and Sullivan, 2014; Vredin, 1997; Bandara and Tisdell, 2003, 2004; Muchapondwa et al, 2009)
- **Bandara and Tisdell (2001, 2003, 2005)**
  - 300 residents in Colombo /Sri Lanka
  - **Kaldor–Hicks hypothetical** compensation
- **No research has addressed forest elephants.**
- **First paper on EFE depletion and preference for conservation**
- Landscape factors (distance, the elephants' density and land ownership).
- **New not previously exploited dataset .**

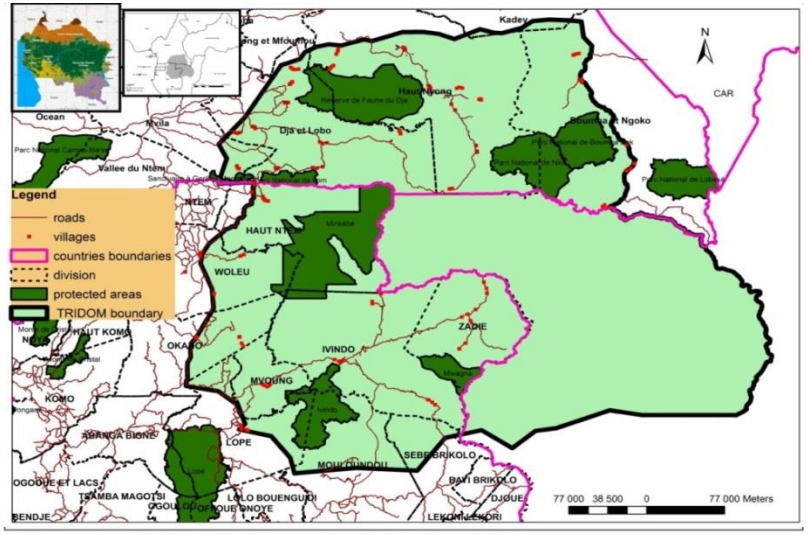
Objective and hypothesis

- **Twofold purpose**
  - determine the social and cultural preferences for EFE conservation.
  - analyses the factors that influence its value.

- **It tests the following hypothesis.**
  - The extinction EFE (-) welfare (**WTP>0** indirect utility theory).
  - Distance to PA (+/-)
  - Human-Elephant Conflicts (-)
  - Indigenousness (+)

Methodology: Sampling and Study Area

- **Study area**
  - 191.541 km², (7.5% CBF)
  - 2/3 of 40,000km² livable inter-zone
  - **One of The 12 CBFP priority landscapes**
  - **3 objectives**
  - 1-7 inh./ km² , migration
  - Economic stakes,
  - 26 administrative units



- **Survey**
  - Face-to-face questionnaires
  - Random and Stratified Sample **(1035/ 65140)**
  - 8 months field work
  - 8 GPS

Methodology : Valuation Technique - Implementation

- Stated Preferences – Contingent Valuation Questions
- Attributes **Description** of EFE
- Hypothetical scenario(non-market good without implicit market)

  "10 years elephant conservation's program
  - seizing weapons used by poachers,
  - fighting against cross-border poaching by

  (1) creating joined checkpoints at the landscape scale,

  (2) recruiting more young people
- Question : are you willing to contribute to the program by paying some monthly amount if finance support is demanded from all the inhabitants of the village?

Methodology : Survey Design

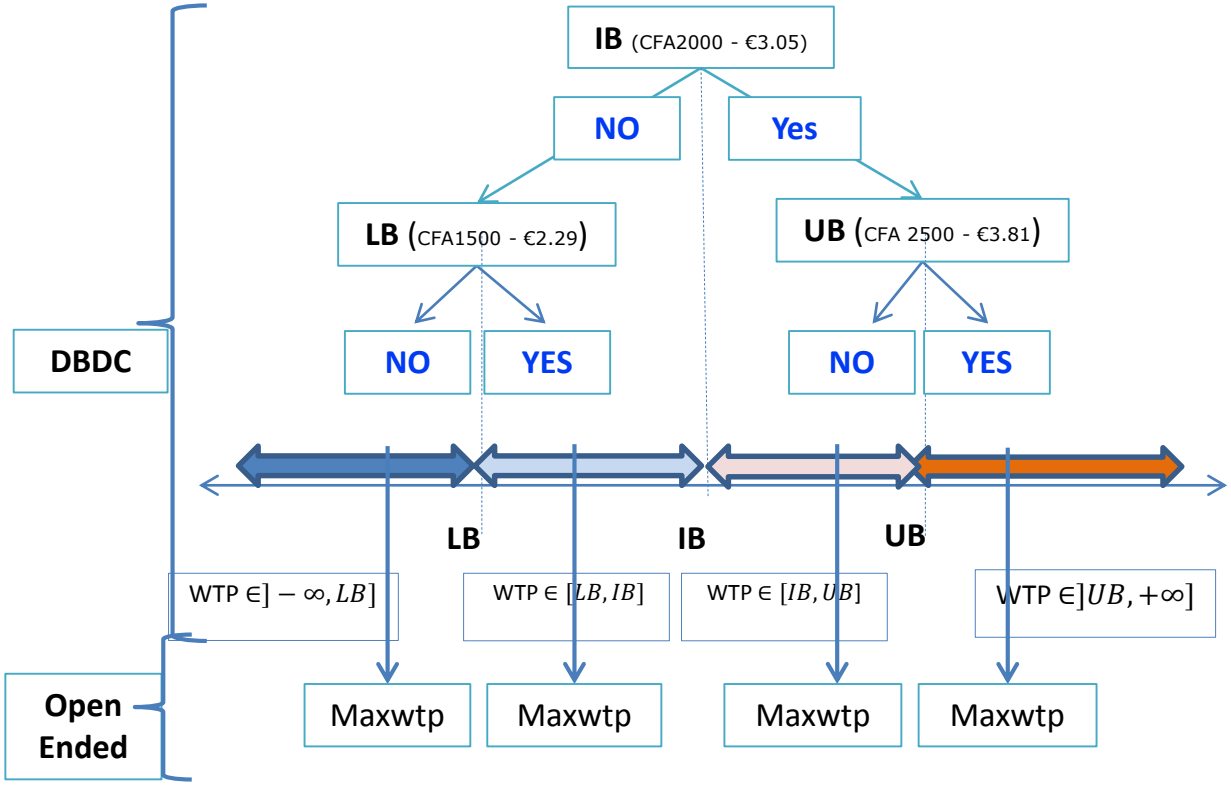
- **Open-ended** (OE) and **Closed-Ended elicitation formats** (Cameron & James, 1987; Hanemann, 1985 ; Carson, 1985 ; Hanemann & Kanninen, 1998)

	Open Ended	Closed-ended	
		Single Bounded	Double Bounded
Advantage	• Simple to calculate	• quick and to administer • easy to analyse	• More information • asymptotically more efficient (Alberini, 1995), Cooper, Hanemann & Signorello, 2002)
Inconvenient	• unrealistically WTP • high % of protestors • Unusual Valuation	• strategic bias • Poor information level on the WTP	• Possible strategic bias • More complicated

DBDC format : **partial information** about the WTP of all the respondents, (below, above or within a specified interval), **Down paying the WTP**

Methodology : Valuation Technique

Combining both formats (3 ways improvement)



Follow-up questions - motives behind the answers

- Additional information
- **- learning design** "discovered preference hypothesis" (Bateman , 2008)
- Convergence (**Brouwer** and Martín-Ortega; **Mahieu** et al. (2012b))
- **Combining both (offsets the limits of censoring data, as well as limits of the OE formats when applied alone)**

Methodology : Valuation Technique

- **Bias minimisation:**
  - Consideration of **monthly income, sources of income, usual monthly expenditure**
  - be **realistic**, paying for **10 years**
  - **Random assignment** of one of six starting points developed and validated during two pretest steps with 40 households

Methodology : Data

Closed Ended Elicitation Format

Bid cards $a^s/a^l/a^u$	Stat bid cards		Ansews to bids		Perc (%)	
	Freq	Perc (%)	YY	NY	YY	NY
			YN	NN	YN	NN
1000/500/1500	191	20	56	15	5,98	1,60
			31	89	3,31	9,51
1500/1000/2000	161	17	53	5	5,66	0,53
			22	81	2,35	8,65
2000/1500/2500	148	16	33	14	3,53	1,50
			18	83	1,92	8,87
2500/1000/3000	163	17	40	5	4,27	0,53
			13	105	1,39	11,22
3000/1500/3500	115	12	31	10	3,31	1,07
			3	71	0,32	7,59
3500/2000/4000	158	17	25	12	2,67	1,28
			24	77	2,56	10,36
Total	936	100	238	61	25,43	6,52
			111	526	11,86	56,20

Open-Ended

	Abs freq.	Perc.
Maxwtp>0	578	62%
Maxwtp=0	358	38%

- 1035 households,
- 99 **Protestors**
- 169 no/no ==> maxwtp>0
- Non trivial 0 WTP

Methodology : Econometric Models

❑ Interval Data Models - IRM

$$ln\,L(\beta) = \sum_{i=1}^{N}\left\{b_i^{id}\,ln\left[\Psi\left(\frac{SB_i - X'_i\,\beta}{\sigma}\right) - \Psi\left(\frac{FB_i - X'_i\,\beta}{\sigma}\right)\right] + b_i^{lc}\,ln\left[\Psi\left(\frac{FB_i - X'_i\,\beta}{\sigma}\right)\right] - \frac{1}{2}b_i^{OE}\left[\left(\frac{a_i^{OE} - X'_i\,\beta}{\sigma}\right)^2 + \ln 2\pi\sigma^2\right]\right\}$$

❑ Corner solution models – Cragg's Heteroscedastic double Hurdle Model

$$\text{Log L} = \sum_{Y_{2i}=0} ln\left[1 - \psi(X_{1_i}\alpha)\Psi\left(\frac{X_{2_i}\gamma}{\sigma_i}\right)\right] + \sum_{Y_{2i}>0} ln\left[\frac{1}{\sigma_i}\psi\left(\frac{Y_{2_i} - X_{2_i}\gamma}{\sigma_i}\right)\Psi\left(\frac{X_{1_i}\alpha}{\sigma_i}\right)\right]$$

- **One-shot parametrization VS Double Parametrization**
- **3 Values of Interest**
  - ***Partial Effects of the covariates j on the probability of participation:***

$$\frac{\partial P(Y_1^* > 0|X_1)}{\partial X_{1_j}} = \alpha_j \psi(X_1\alpha)$$

  - ***Partial Effects on the Conditional expected preferences,***

$$\frac{\partial E(Y_{2_i}|Y_{2_i} > 0,\ X_{2_i})}{\partial X_{1_j}} = \gamma_j\left[1 - \lambda\left(\frac{X_2\gamma}{\sigma}\right)\left(\frac{X_2\gamma}{\sigma} + \lambda\left(\frac{X_2\gamma}{\sigma}\right)\right)\right]$$

  - ***Partial Effects on the unconditional expected preferences***

$$\frac{\partial E(Y_2|X_1, X_2)}{\partial X_{1_j}} = \alpha_j\psi(X_1\alpha)\left\{X_2\gamma + \sigma\lambda\left(\frac{X_2\gamma}{\sigma}\right)\right\} + \Psi(X_1\alpha) * \gamma_j\left[1 - \lambda\left(\frac{X_2\gamma}{\sigma}\right)\left(\frac{X_2\gamma}{\sigma} + \lambda\left(\frac{X_2\gamma}{\sigma}\right)\right)\right]$$

Variables and descriptive statistiques

Variable	No Protest (n=936)	Protest bidders (n=99)	Comparison test Chi 2 (1) <3,84 [t-test (5%, 1033)] <1,96
	Mean (Std. Dev.)	Mean (Std. Dev.)	
Sex	**0,76 (0,42)**	0,77 (0,42)	0.007
Age	**48,29 (14,68)**	50,79 (13,52)	[-14,07]
Hsize	**6,43 (4,05)**	7,02 (3,90)	[-0,0194]
Education level	0,55 (0,50)	0,68 (0,47)	6.21
Monthly exp.	46604 (59463)	59792 (68242)	[-2,40E+19]
Indigenousness	0,05 (0,22)	0,03 (0,17)	0.77
Small farmer	0,41 (0,49)	0,42 (0,50)	0.09
Trad gold miner	0,03 (0,16)	0,00 (0,00)	2.82
Hunther gatherer	0,15 (0,36)	0,09 (0,29)	2.81
Fmu or forest ad	0,03 (0,18)	0,02 (0,14)	0.48
Other admin	0,09 (0,28)	0,10 (0,30)	0.16
Hum/eleph conflict	0,28 (0,45)	0,23 (0,42)	0.88
Land tenure	4,32 (5,32)	5,36 (4,32)	[-0,09,73]
Dist_narea	28,98 (22,26)	27,60 (22,14)	[40,17]
Elephantdensity	0,94 (0,84)	0,83 (0,72)	[0,01,51]

School/diploma

< 5% - University
<17% secondary education
75% primary school
29% have no diploma.

Main activity

19% make cash crop (Cocoa)
41% are small scale farmers,
3% traditional gold mining,
15% hunting and gathering
3% biodiversity forest,

Human-Elephants Conflicts

- 259 conflicts (28%)
- CFA **28140** (€43) damage cost / household.

Land Holding

- 70% - 0,1 and 5 ha,
- 8% no acces to land,
- 29 % - 5 and 15 ha,
- 3% 15 and 25 ha.

Results

Predicted Values of WTP - IRM

	Double Bounded With protest bidders	Double Bounded Without protest bidders	Tobit model	Heteroscedastic Double Hurdle ML Estimates	Interval Regression Model	
				Second Hurdle	**INTREG effective neg**	INTREG Potential neg
Unconditional WTP ($E(y_i \mid x_i, z_i)$)	**368,84 (€0,56)**	**742,92 (€1,13)**		**1326,873 (€2,02)**	**1245,66 (€1,89)**	**1138,17 (€1,74)**
Conditional WTP ($E(y_i \mid y_i>0, z_i)$)			**2081,839 (€3,17)**			

RESULTS

Drivers of participation and intensity's decisions

	OPEN-ENDED (OE) – CORNER SOLUTION MODELS			
Predictors	Tobit model	Heteroscedastic Double Hurdle ML Estimates		
		First Hurdle	Second Hurdle	Het
	Estimates (Std Dv)	Estimates - α (Std Dv)	Estimates - γ (Std Dv)	sigma (Std Dv)
AGE	-22,153*** (7,482)	**-0,008** (0,003)**	16,136 (15,671)	-20,297** (8,669)
EDUCATION LEVEL	639,181*** (197,365)	**0,296*** (0,092)**	2204,333*** (643,792)	-678,365*** (247,065)
MONTHLY EXP.	0,00784*** (0,002)	6E-07 (8E-07)	-0,005 (0,011)	0,022*** (0,005)
INDIGENOUSNESS	881,164** (347,409)	**0,417** (0,210)**	2802,750*** (666,533)	-1002,568*** (283,159)
SMALL FARMER	181,726 (218,536)	0,126 (0,103)	-	-
TRAD GOLD MINER	1776,781** (686,945)	**0,660** (0,305)**	-	-
HUNTHER GATHERER	406,523 (280,632)	0,195 (0,141)	-	-
FMU OR FOREST AD	1408,703*** (456,845)	**0,962*** (0,304)**	-	-
OTHER ADMIN	868,687** (355,409)	**0,418** (0,177)**	-	-
LAND TENURE	589,087*** (211,915)	**0,177* (0,096)**	-8663,312 (7696,3)	2960,953* (1642,55)
HUM/ELEPH CONFLICT	48,305 (202,818)	-0,013 (0,098)	-1394,463 (1231,3)	905,122** (452,839)
DISTANCE*DENSITY	-0,763 (1,911)	-0,001 (0,001)	7,398** (2,890)	0,315 (2,409)
INTERCEPT	336,557 (393,581)	0,298 (0,196)	-1956,741 (1203,5)	2553,671*** (582,020)
/lnsigma	-	-	-	-
SIGMA _CONS	2582,161 (314,105)	-	-	-

- **Log-likelihood ratio test,**
- L-statistic *-2*(Double-hurdle LL – Tobit LL)* =178 > χ^2(13, 5%) =27,69
- Double parametrization of Participation decision and the size of the contribution

  Indeed, Different covariates for both decisions
  Example:
  Household **activities**
  Monthly Expense
- (-) influence of age
- (+) influence of education level; indigenousness; specific activities, and land holdings

RESULTS

Drivers of participation and intensity's decisions

- **Indigenousness** (+)
- **Human-Elephant Conflict** Neutral
- **Distance**: Local communities prefer elephant but far from their crops
- Distance as an indicator of scarcity holds compare to the distance decay assumption

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Results

Impact of change in covariate (Partial Effects)

Predictors	Partial Effect on the probability of participation to elephants' conservation	APE of on the Conditional expected WTP for Elephants' Conservation	APE on the unconditional expected WTPfor Elephants' Conservation
	$\frac{\partial P(y_i > 0/x_i)}{\partial x_j}$	$\frac{\partial E(y_i/y_i > 0, z_i)}{\partial x_j}$	$\frac{\partial E(y_i/x_i, z_i)}{\partial x_j}$
Age	-0,003	**4,648**	-3,036
Education level	**0,107**	**635,031**	615,652
Monthly exp.	2,29E-07	-0,001	0,0004
Indigenousness	**0,151**	**807,42**	813,368
Trad gold miner	**0,239**		-260,821
Fmu or forest ad	**0,348**		93,277
Other admin	**0,152**		487,291
Land tenure	0,064	-2495,752	143,959
Hum/eleph conflict	-0,005	-401,721	709,561
Distance*density	-4,14E-04	**2,131**	308,764
Unconditional wtp ($E(y_i \mid x_i, z_i)$)		1326,873	
Conditional wtp ($E(y_i \mid y_i > 0, z_i)$)		2081,839	
inverse mills ratio ($\lambda \left[\phi\left(\frac{z_i\beta}{\sigma_i}\right)/\Phi\left(\frac{z_i\beta}{\sigma_i}\right)\right]$)		1,344296	

MAJOR OUTCOMES AND POLICY ISSUES

OUTCOME I

The **extinction** of *Loxodonta cyclotis* ➔**net loss of welfare**.

- **Predicted monthly WTP** by household head : CFA **1138.17 (€1.74)**
- Closed to **Bandara and Tisdel** (2005) : **Rs. 110.17 (€1.65)**
- Annual social value : CFA 889.7 million (€1.36 million)
- **NPV over 10 years : CFA 8.67billion (€13.2 million)**.

POLICY ISSUES I

- Expected annual budget of € 1,5 million for the Tridom conservation
- Completed annual budget : € 0,9 million on average between 2007 – 2011

As a matter of comparison,

- The social value of EFE only =150% of the total conservation cost.
- **The program is under-funded compared to the social benefits that brings biodiversity conservation.**

MAJOR OUTCOMES AND POLICY ISSUES

OUTCOME 2 and 3

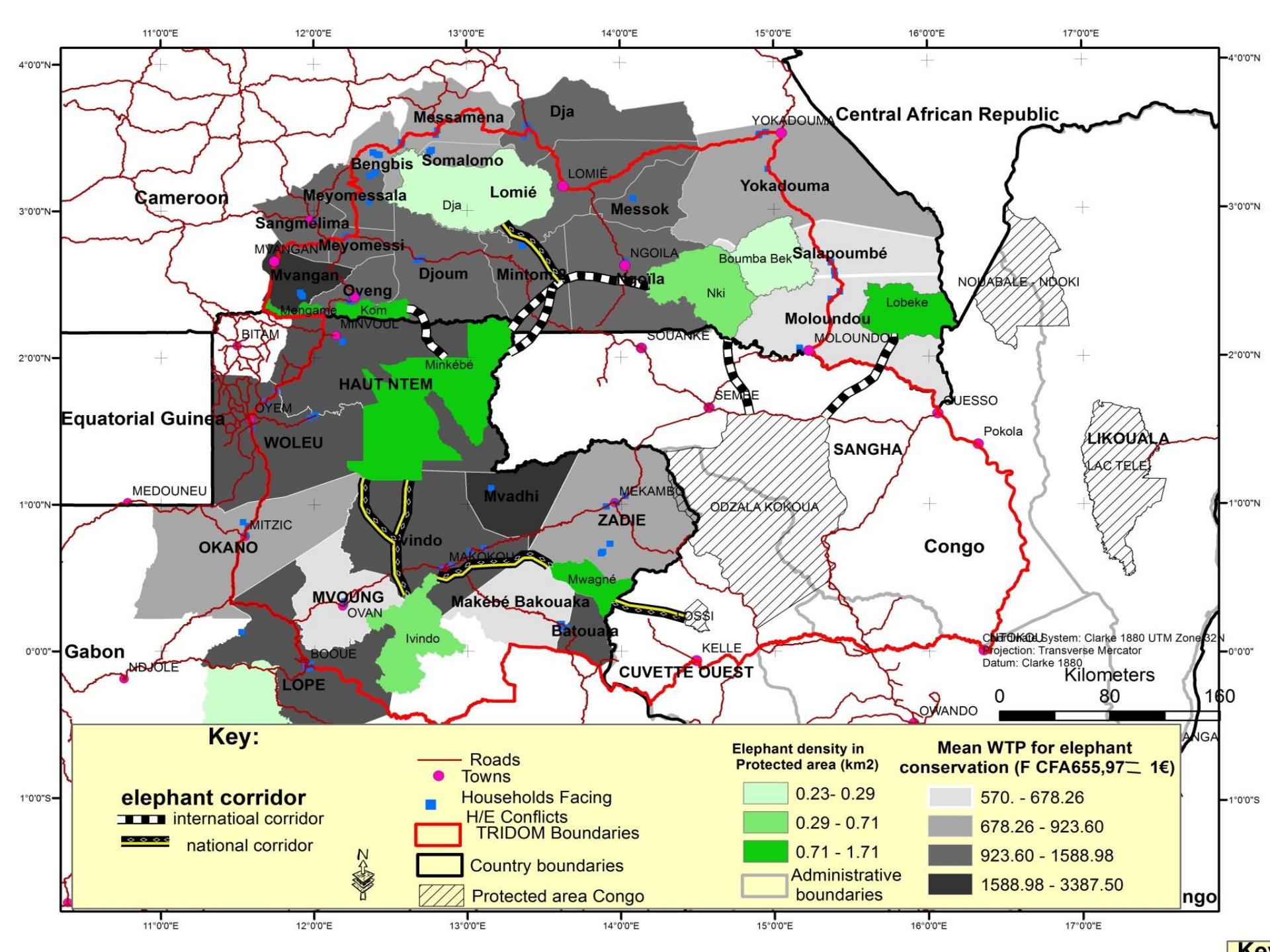
- **Distance:** Local communities prefer elephant but far from their crops
- Distance as an indicator of scarcity and security

- **Human-Elephant Conflict Neutral;** tolerance (Belief)
- Non-negligible demand under ineffectiveness : **NPV > Value of Crop Damage** (annual damage cost : €43 faced by 27,7% households,)
- Conditional to the Hypothetical Scenario, EFE conservation is socially beneficial,
- **Participating for EFE conservation ?? Or for avoiding HEC??? A crictical issue remain (ability to cope with public benefit of conservation and private benefits of reducing HEC)**

POLICY ISSUES 2

Overlaping maps of social value, HEC and elephants density to optimizing trade-off between Land use activities and fauna natural habitat.

The issue of where the habitat is needed and how it should be managed are the core of the problem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Djoum
Mintom
Messok
Yokadouma
Salapoumbé
Boumba Bek
Nki
Lobeke
Moloundou
NOUABALE - NDOKI
Minkébé
HAUT NTEM
WOLEU
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ZADIE
Vindo
OKANO
MVOUNG
Makébé Bakouaka
Batouala
Ivindo
LOPE
CUVETTE OUEST
SANGHA
ODZALA KOKOUA
Congo
LIKOUALA
LAC TELE
Cameroon
Central African Republic
Equatorial Guinea
Gabon
Key:
elephant corridor
internatioal corridor
national corridor
Roads
Towns
Households Facing H/E Conflicts
TRIDOM Boundaries
Country boundaries
Protected area Congo
Elephant density in Protected area (km2)
0.23- 0.29
0.29 - 0.71
0.71 - 1.71
Administrative boundaries
Mean WTP for elephant conservation (F CFA655,97 = 1€)
570. - 678.26
678.26 - 923.60
923.60 - 1588.98
1588.98 - 3387.50
Kilometers
0
80
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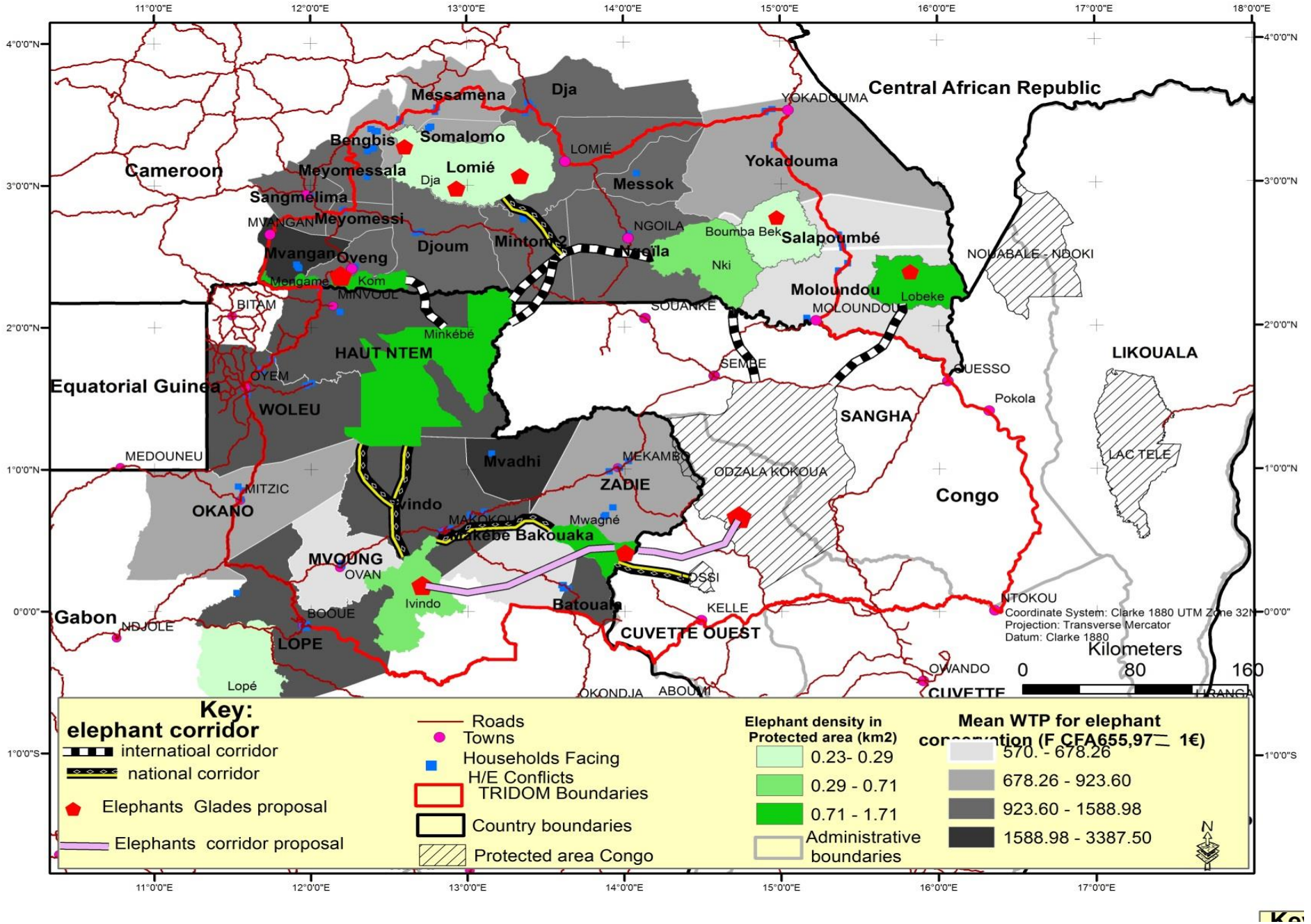
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Makebe Bakouaka
MVOUNG
OVAN
Ivindo
BOOUE
NDJOLE
LOPE
Lopé
Batouala
KELLE
CUVETTE OUEST
OKONDJA
ABOUMI
OWANDO
NTOKOU
LOMIÉ
Messok
YOKADOUMA
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NGOILA
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Salapoumbé
Moloundou
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NOUABALE - NDOKI
SOUANKE
SEMBE
OUESSO
Pokola
SANGHA
LIKOUALA
LAC TELE
ODZALA KOKOUA
Coordinate System: Clarke 1880 UTM Zone 32N
Projection: Transverse Mercator
Datum: Clarke 1880
Kilometers
0
80
160
Key:
elephant corridor
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Elephants Glades proposal
Elephants corridor proposal
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N

POLICY ISSUES 3

- additional effort to reducing poaching.
- The international standard for management of protected areas : 1 guard for 5000 ha“. In the Tridom, it is 1 guard for 6000 ha to 9000 ha
- Recruiting and training additional 18 guards on average per protected area for a total of 160 guards (12.4% of the social value), employed to (1) create additional checkpoint in intensive poaching areas, such as Bengbis, Somalomo, Mouloundou, Ngoyla Mintom, Ouésso and Ntam-Carrefour, and to (2) create vehicle and foot transboundary patrols to strengthen cross-border cooperation for anti-poaching surveillance.
- Recruiting young people from the villages and involving (4% of the social value).

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- FGS, SCAC
- **Accepted** for publication with **minor comments**

THANK YOU