

Forest conservation or forest fragmentation?

A GIS study to estimate forest landscape changes and evaluate land-use strategies in Ambohitantely Special Reserve in Madagascar

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Introduction

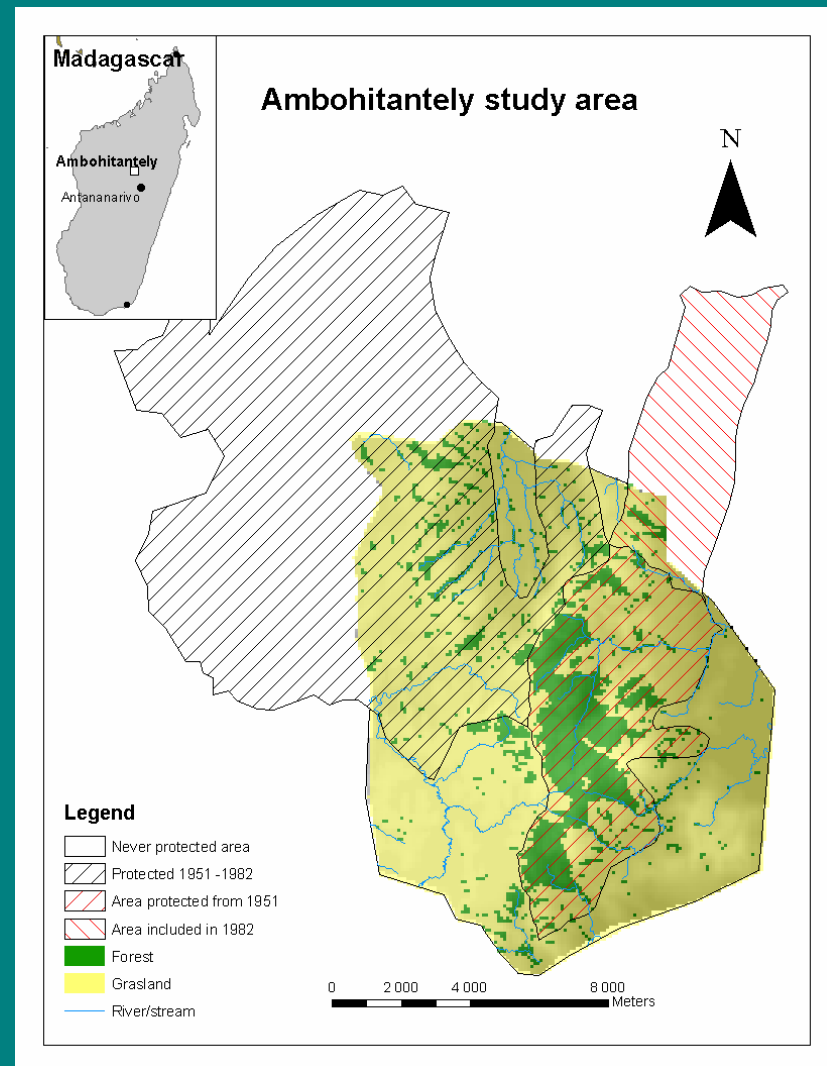
- Madagascar – biological hotspot
- Very high level of endemic species
 - Of 12,000 plants - 80 % endemic
- A world priority for conservation

Introduction

- High deforestation rate
- Fragmentation
 - Mainly a result of human activity
- Biological consequence - species extinction
- Loss of natural resources

Study area

- Station Forestière de Manankazo established in 1951
- Reserve Spécial d`Ambohitantely established 1982
- Covers an area of 5600 ha
- Several previous studies have claimed a decrease in the Ambohitantely forest area



Study area



Objectives

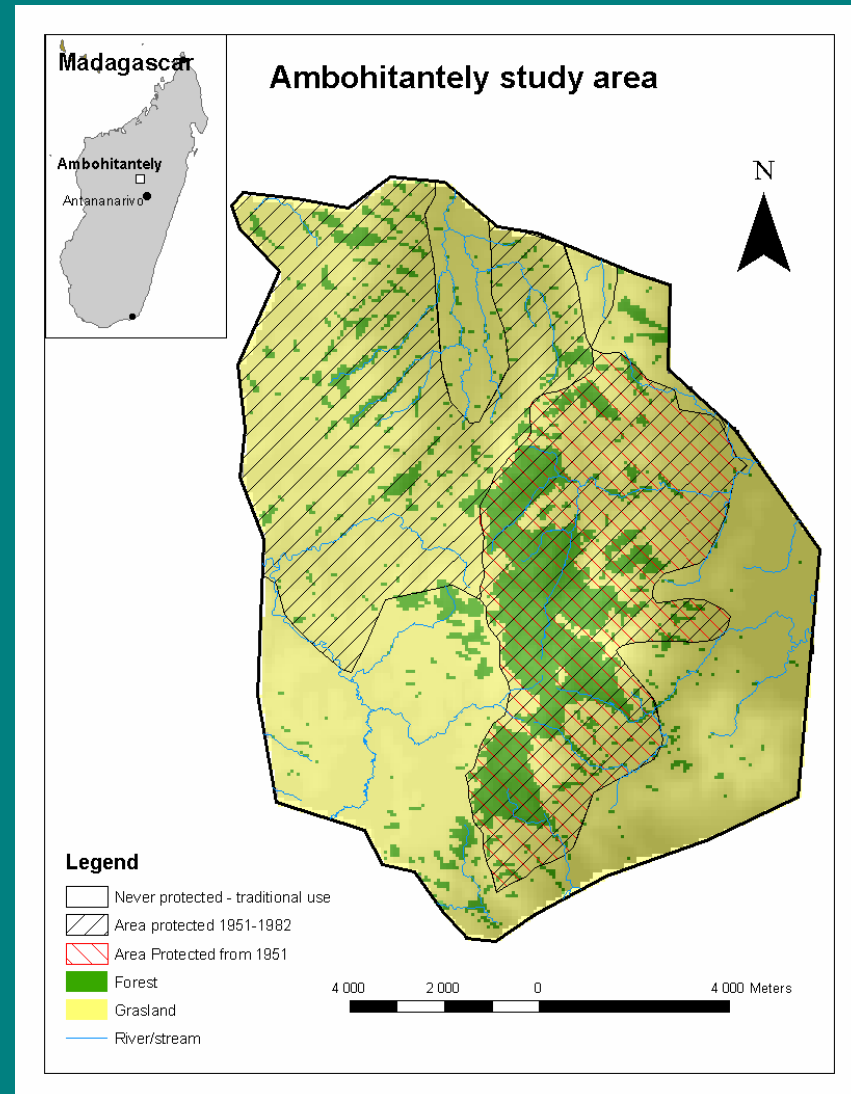
- Discover how the upland forest cover has altered in size and distribution
- Assess the influence of selected physical and human land-use factors on where the remnant forest occur
- Predict the size and distribution of the forest under different land-use strategies
- Predict a potential scenario for the size and distribution of the forest in future

Methods

- Aerial photos from 1949 and 1992
 - Forest area and other land data
 - Digital elevation model (DEM)
- Geographical Information System (GIS)
- Map from 1951
- Statistical analysis
 - GLM
 - Classification tree

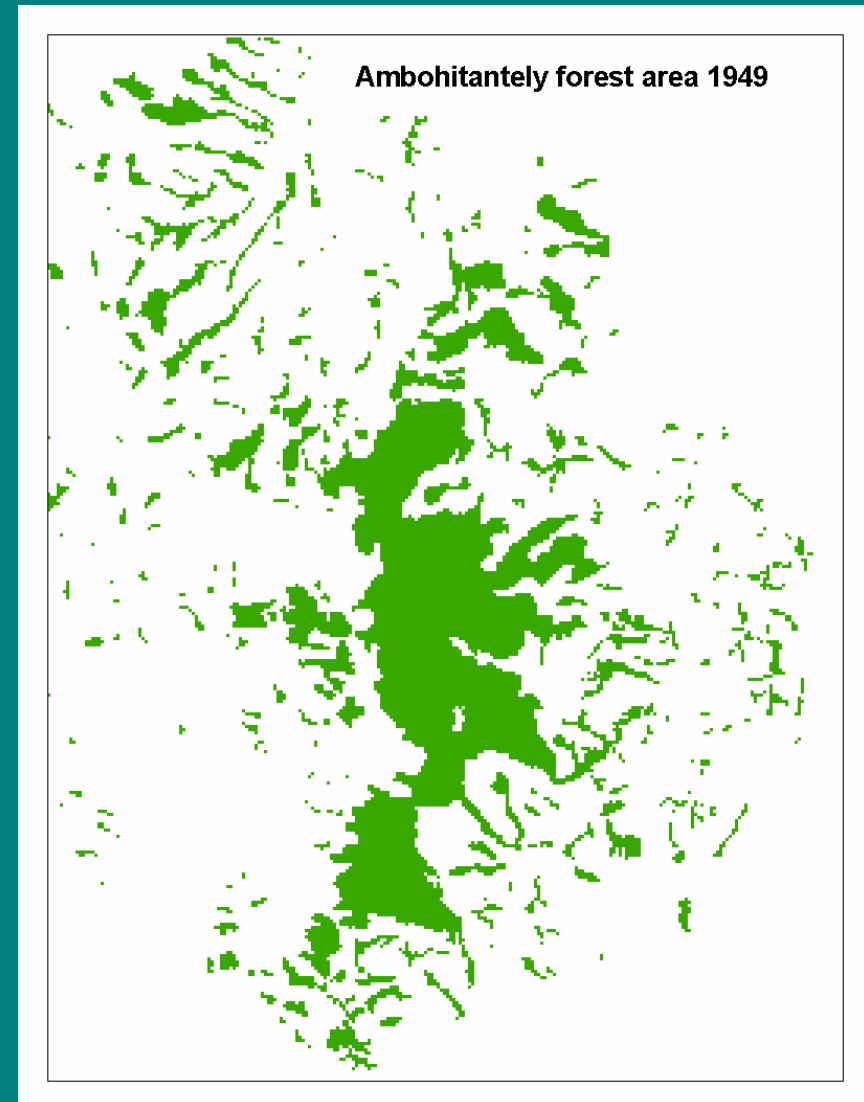
Methods

- Land-use strategies divided in 3 categories:
 - 1) No conservation
 - 2) Conservation from 1951-1982
 - 3) Conservation from 1951-1992



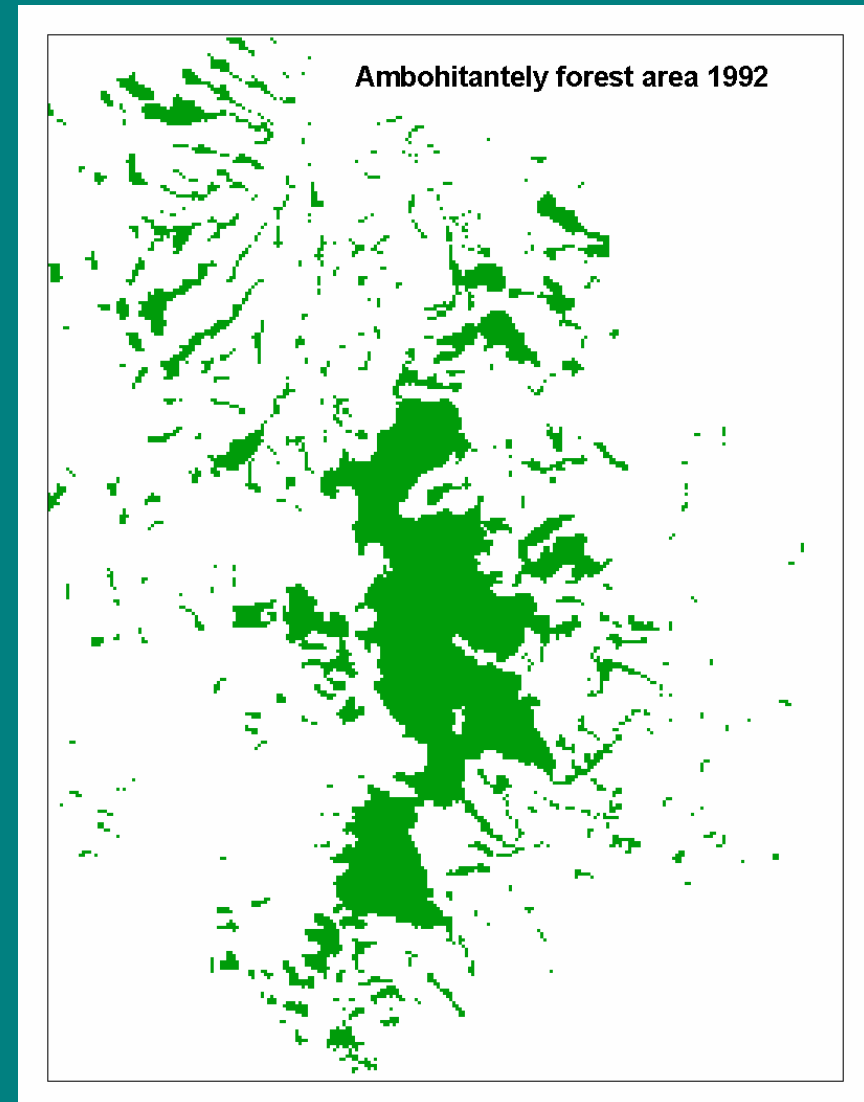
Results

- Total forest area
in 1949
2750 ha
- Main forest fragment
1400 ha



Results

- Total forest area
in 1992
2365 ha
- Main forest fragment
1275 ha

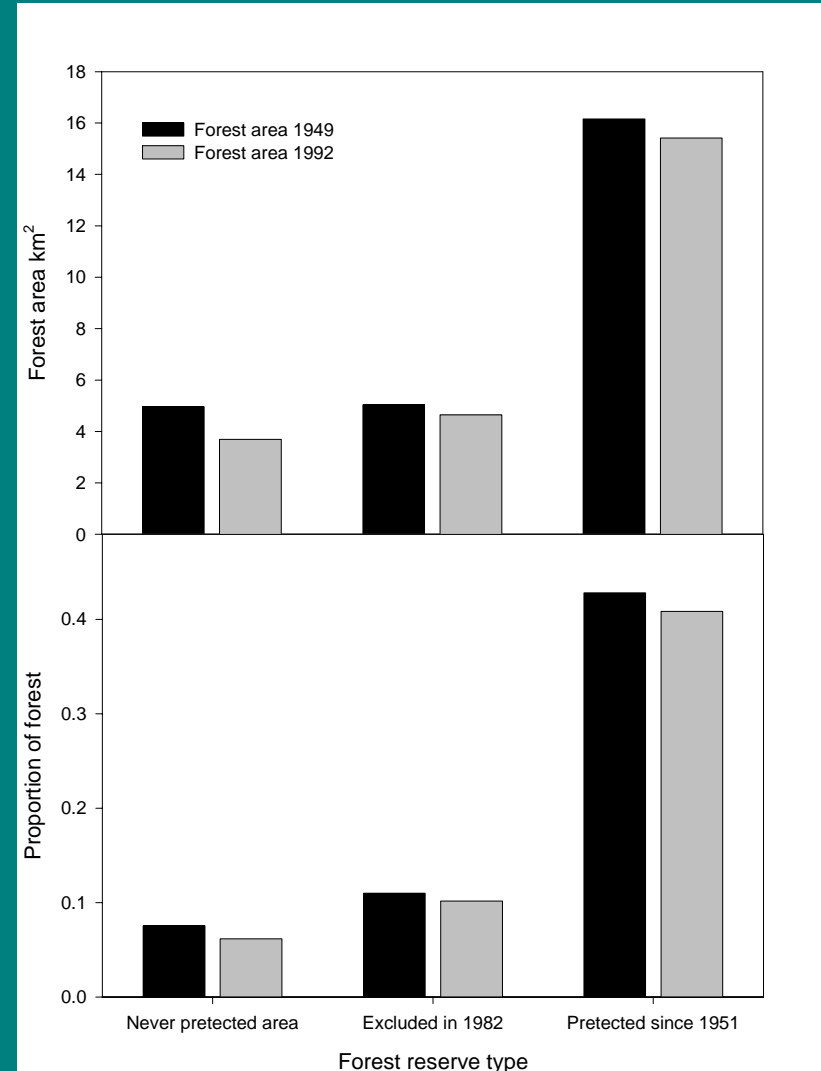


Results

	Fragments in 1949	Fragments in 1992
Land-use 1- area excluded in 1982	139	126
Land-use 2- never protected area	191	175
Land-use 3- area protected from 1951-	72	77
Total	402	378
Mean fragment polygon size	85180 m ²	75400 m ²
Mean fragment perimeter	1300 m	1130 m
Fractal dimension	1.60	1.59

Results

- The forest area never protected was reduced with 28 %
- The forest area protected from 1951 to 1992 was reduced by 8%
- The forest area protected from 1951 to 1992 was reduced by 5 %



Results

Variable	Analyses of parameter estimates			type III statistics			
	DF	β_0	SE	DF	Sum of square	F-value	Pr(F)
DISTANCE TO RIVER	1	-0.0012	0.0004		0.1979	8.3690	0.0039
DISTANCE TO VILLAGE	1	0.0001	0.0002		0.0406	2.2257	1.3599
DISTANCE TO ROAD	1	-0.0002	0.0006		0.0693	3.7664	0.0525
ELEVATION	1	0.0045	0.0009	1	0.3467	14.3495	0.0002
RADIATION	1	-0.0133	0.0041		0.2585	11.0208	0.0010
SLOPE	1	0.0363	0.0172		0.0079	3.3575	0.0673
ASPECT	1	0.0036	0.0023		0.0550	2.3351	0.1269
E-W				1	0.0600	2.5393	0.1115
Intercept	1	-1.3437	0.1181				
E-W	-	-0.3314	0.2011				
N-S				1	0.0663	2.8139	0.0939
Intercept	1	-1.6699	0.1559				
N-S	-	0.3404	0.1973				
LAND-USE				2	2.4111	53.4488	<0.0001
Intercept	1	-2.5110	0.2202				
LAND-USE1	1	0.4934	0.3061				
LAND-USE3	-	2.1811	0.2612				

Results

Analyses of parameter estimates					type III		
statistics							
Variable	DF	β_0	SE	DF	Sum of square	F-value	Pr(F)
LAND-USE				2	0.8950	29.4640	<0.0001
Intercept	1	-4.9492	2.2696				
LAND-USE 1	1	5.3651	5.0481				
LAND-USE 2	1	-13.4295	3.5930				
LAND-USE 3	-						
DISTANCE TO RIVER		-0.0030	0.0018	1	0.5214	34.3330	<0.0001
DISTANCE TO VILLAGE		0.0011	0.0002	1	0.3421	21.6534	<0.0001
ELEVATION		0.0034	0.0016	1	0.5442	35.8325	<0.0001
RADIATION		-0.0122	0.0051	1	0.0631	4.1529	0.0419
LAND-USE*DISTANCE	-			2	0.5522	18.1790	<0.0001
LAND-USE1*DISTANCE	1	0.0025	0.0019				
LAND-USE3*DISTANCE	1	-0.0023	0.0023				
LAND-USE*ELEVATION	-			2	1.1269	37.0999	<0.0001
LAND-USE1*ELEVATION	1	-0.0035	0.0035				
LAND-USE3*ELEVATION	1	0.0109	0.0025				

Results

Actual forest area 1992	2200 ha
Forest area 1949	2750 ha
Reduction	14 %



Results

Predicted forest area if total conservation

Classification tree:

- All variables except distance to road included

Correctly classified instances 89.078 %
Incorrectly classified instances 10.092 %
Kappa statistics: 0.6122

Predicted forest area	2475 ha
Forest area 1949	2750 ha
Reduction	10 %



Results

Predicted forest area if no conservation

Classification tree:

- All variables except distance to road included

Correctly classified instances 89.078 %
Incorrectly classified instances 10.092 %
Kappa statistics: 0.6122

Predicted forest area 2200 ha
Forest area 1949 2750 ha
Reduction 20 %



Results

Actual forest area 1992	2200 ha
Forest area 1949	2750 ha
Reduction	14 %



Results

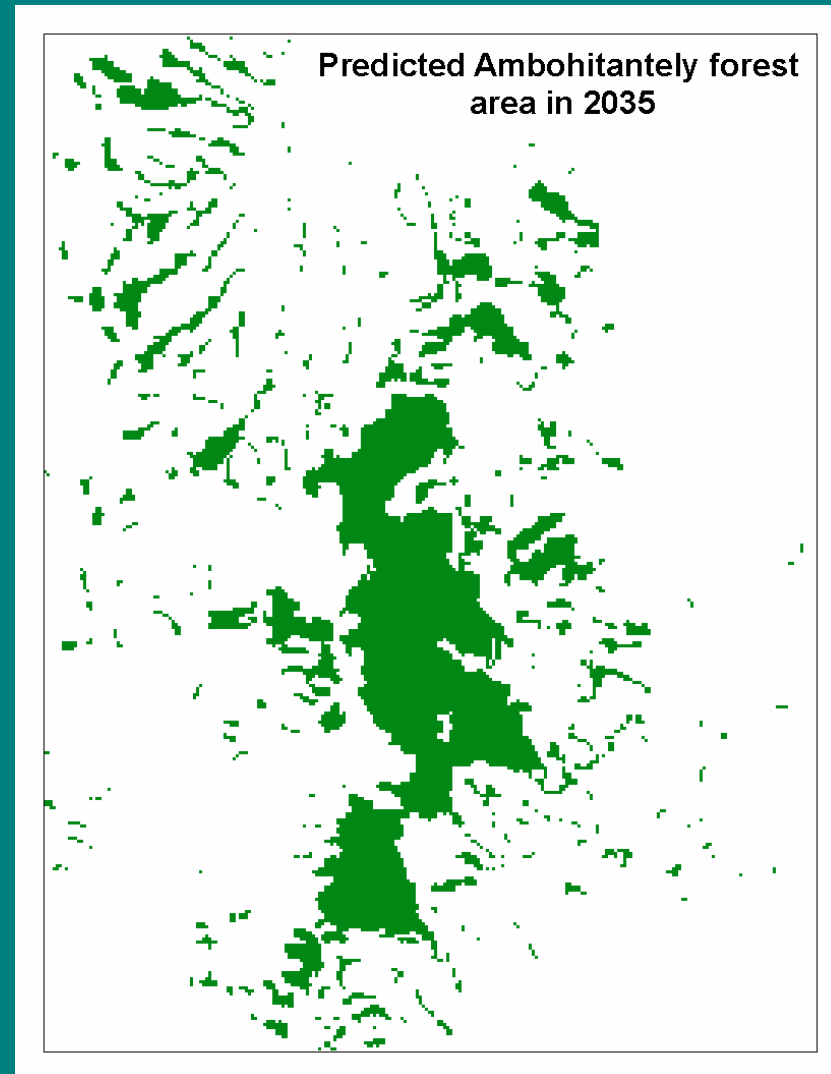
Predicted forest area in 2035

Classification tree:

- All variables except distance to road included

Correctly classified instances 89.775 %
Incorrectly classified instances 10.225 %
Kappa statistics: 0.6389

Predicted forest area 2180 ha
Forest area 1949 2750 ha
Reduction 21 %



Conclusion

- Forest decrease in all land-use categories in the period between 1949-1992
- The reduction is not as severe as assumed
- Increased fragmentation in the forest protected during the whole the period
- Loss of the smaller forest fragments in the area surrounding the protected area
- The predictions indicates a reduction in forest area in all scenarios, even if the total area has been under conservation

Further investigations

Recent fire history in Ambohitantely

