Antananarivo – June, 3rd 2016

BioSceneMada

Deforestation scenarios

Ghislain Vieilledent[1] Tom Allnutt[2] Clovis Grinand[3] Rija Ranaivosoa[4]
Miguel Pedrono[5] Jean-Roger Rakotoarijaona [4] Dimby Razafimpahanana[2]

[1] **Cirad BSEF**, [2] **WCS**, [3] **ETC Terra**, [4] **ONE**, [5] **Cirad AGIR**

FRB FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITÉ

FFEM Fonds Français pour l'Environnement Mondial

Biodiversity modelling and scenarios FRB FLAGSHIP PROGRAMME

Another approach

Barnes **1990** Afr. J. Ecol.

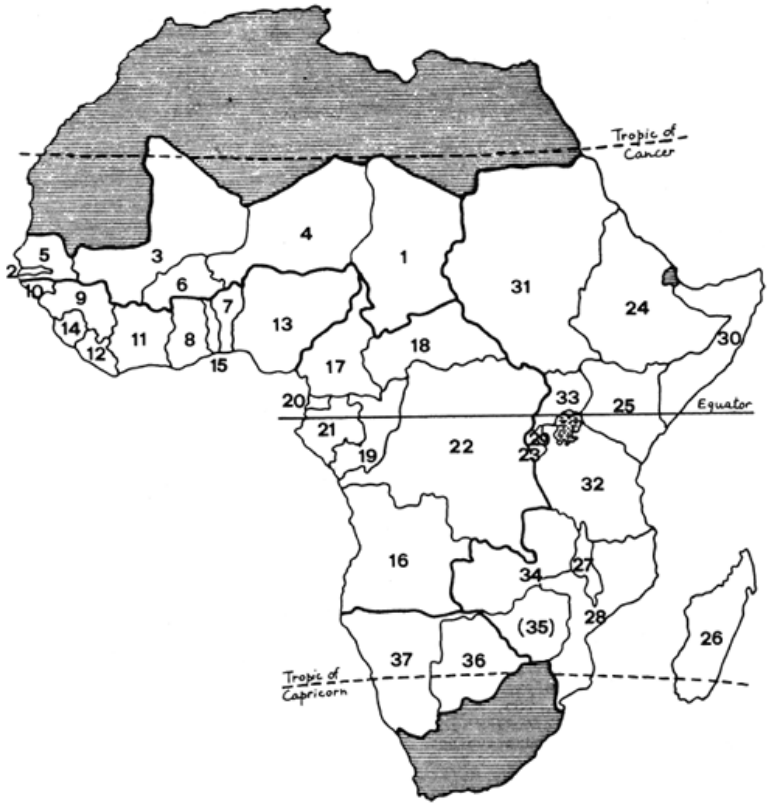
Afr. J. Ecol. 1990, Volume 28, pages 161–173

Deforestation trends in tropical Africa

R. F. W. BARNES*

Wildlife Conservation International, Department of Zoology, University of Cambridge

- deforestation = f(forest + people)
- deforestation increases with forest exent and number of people



Another approach

Barnes **1990** Afr. J. Ecol.

Afr. J. Ecol. 1990, Volume 28, pages 161–173

Deforestation trends in tropical Africa

R. F. W. BARNES*

Wildlife Conservation International, Department of Zoology, University of Cambridge

- $\log(D) = \beta_0 + \beta_1 \log(F) + \beta_2 \log(P)$
- Good model : $R^2 = 78\%$

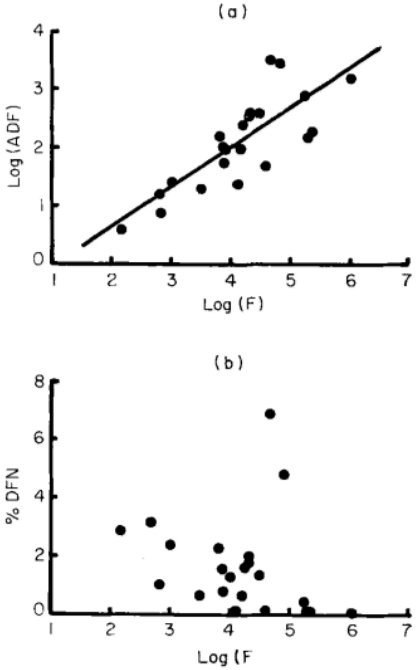
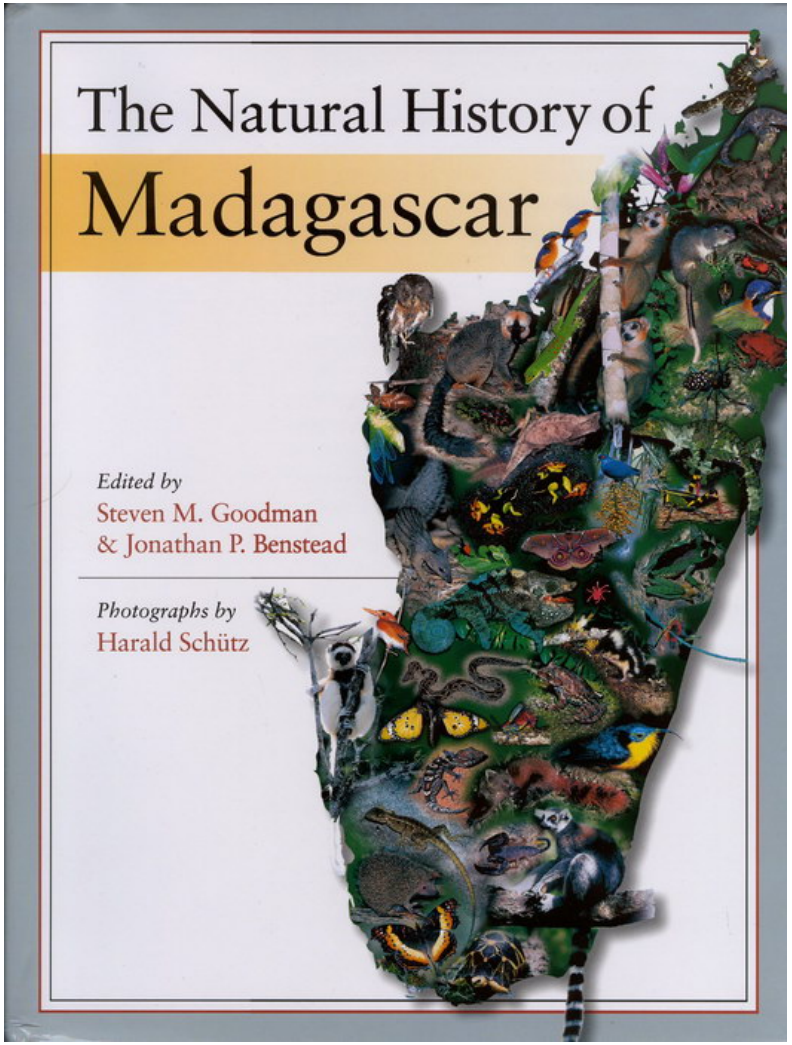


Fig. 2. Relationship between deforestation rates and forest area in km² (*F*). (a) ADF is absolute area (km²) deforested per annum. log(ADF) = 0·68 log(*F*) − 0·72, *r* = 0·81, d.f. = 20, *P* < 0·0001 (b) % DFN is the percentage area of forest that is felled per annum. *r* = 0·23, d.f. = 20, NS.

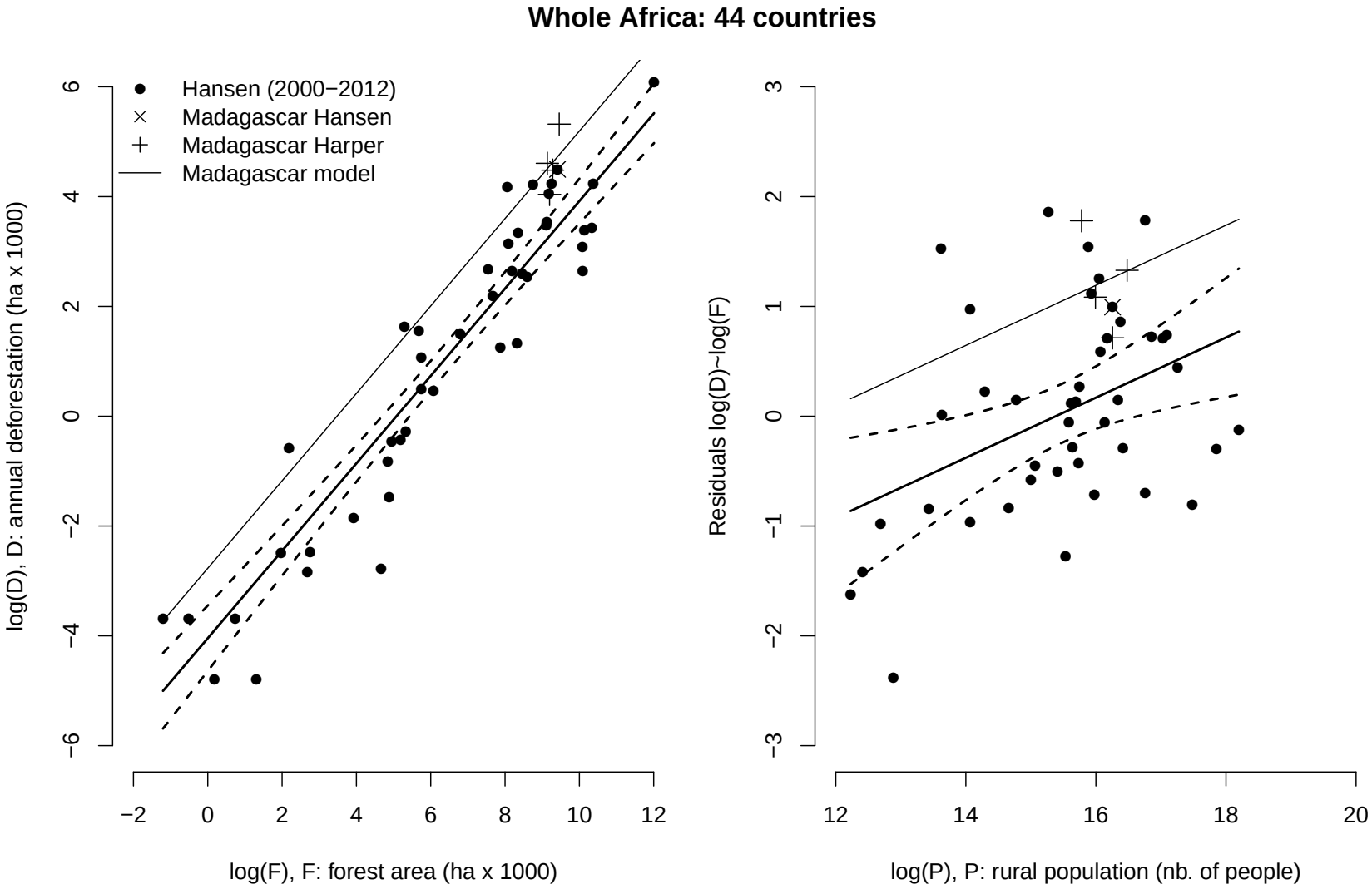
Objectives

Impact of deforestation on climate

- Actualize and improve Barnes' approach
- Spatialize deforestation
- Africa and Madagascar



Results


Whole Africa: 44 countries
Hansen (2000−2012)
Madagascar Hansen
Madagascar Harper
Madagascar model
log(D), D: annual deforestation (ha x 1000)
log(F), F: forest area (ha x 1000)
Residuals log(D)~log(F)
log(P), P: rural population (nb. of people)

Results

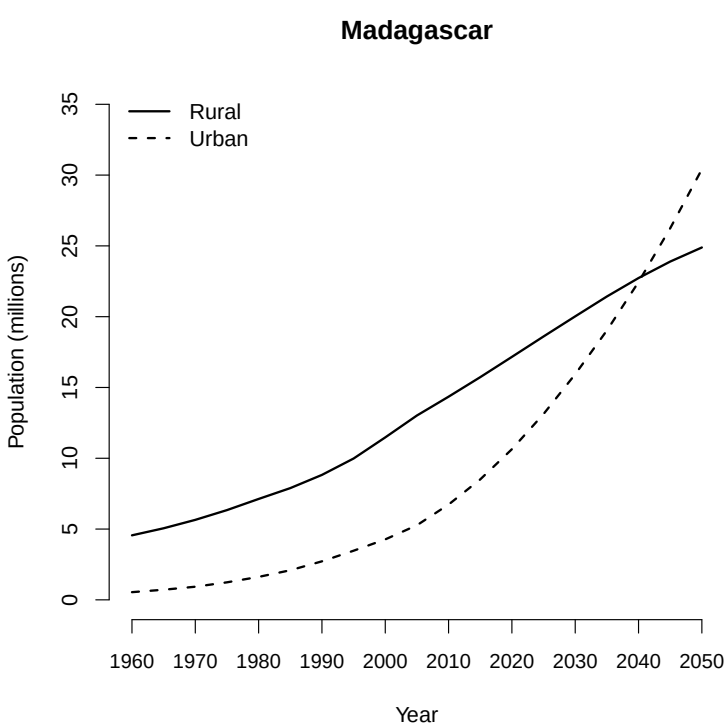
$$\log(D) = -8.450 + 0.796^{***} \log(F) + 0.286^{**} \log(P)$$

$$R^2 = 91\%,\ F = 206.8 \text{ on } 2 \text{ and } 40 \text{ DF, p-value} < 2.2e-16$$

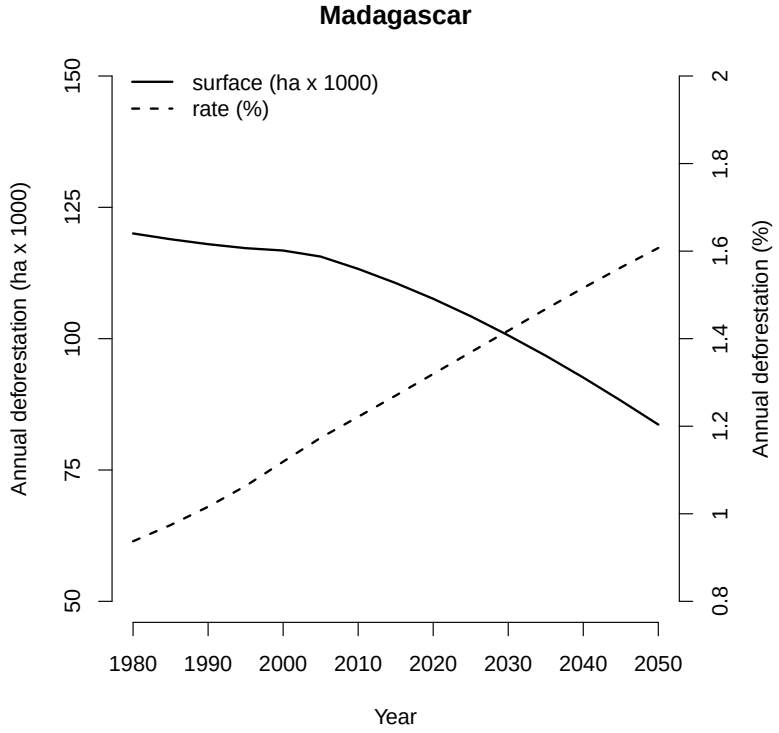
Improving Barnes' approach

- Hansen data (2000-2012) + WorldBank data for population
- **Rural population** in place of total population
- One **historical mean deforestation rate** by country

Results
Projections

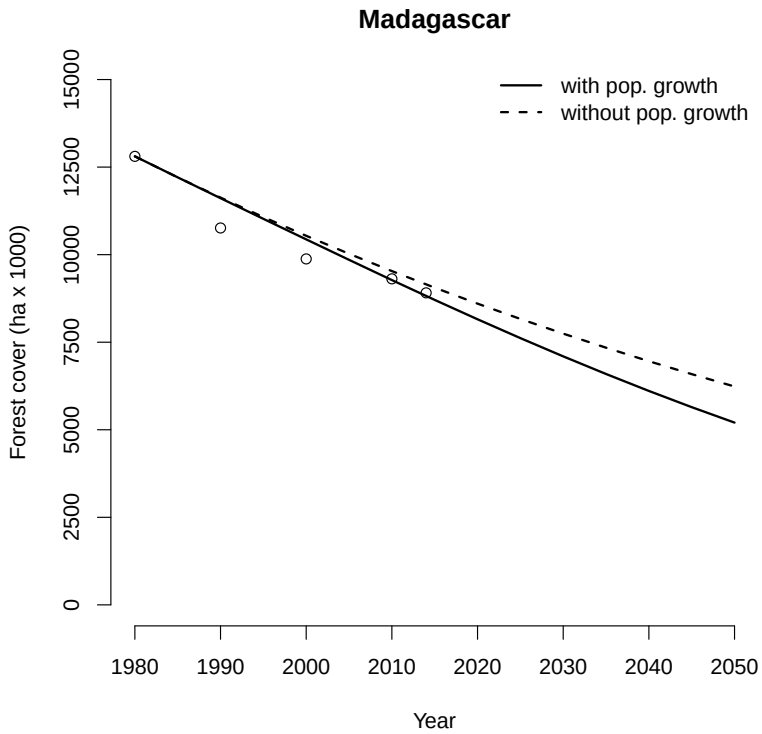


Population with time



Deforestation with time

Results
Projections

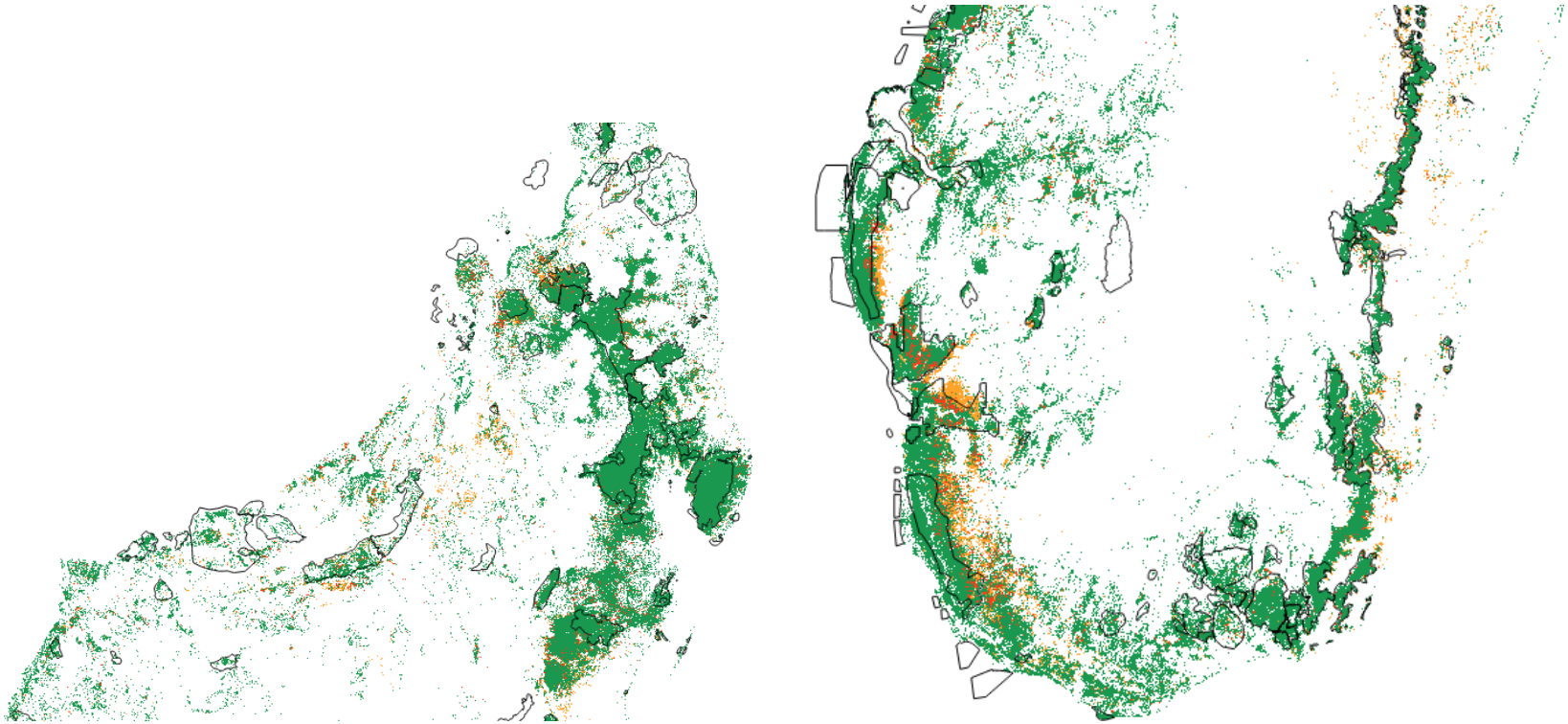


- Start = 1980 (12.8 Mha). Projections and validation on 1980-2015.
- Observed 2015 : 8.9 Mha, predicted 2015 : 8.7 Mha.
- Better predictions when accounting for demographic growth.
- Forest in 2050 : **5.2 Mha**.

Maps of past deforestation

- Past deforestation : 1990-2000-2010
- Without clouds
- At 30m resolution

Map of past deforestation



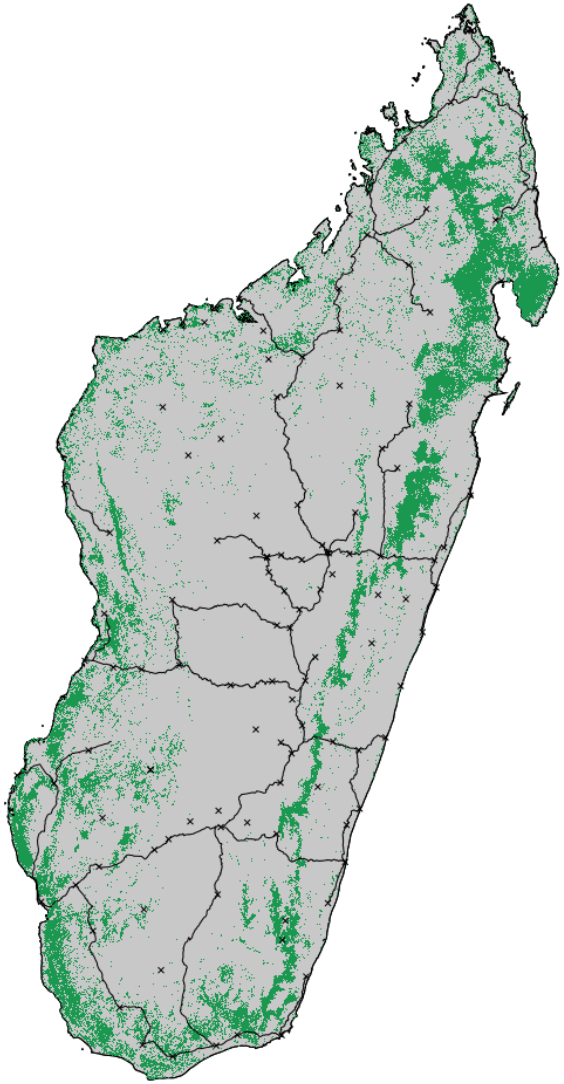
Model

Spatial probability of deforestation

- Sampling : 100,000 points
- $\text{logit}(\theta_i) = f(\text{spatial factors}_i) + \rho_j$
- Spatial factors : 30 m
- Period 2000-2010

Type of spatial factors

- **Landscape factors** : dist. to forest edge, dist. to past deforestation
- **Accessibility factors** : altitude, dist. to road, town
- **Land-policy factors** : protected area network



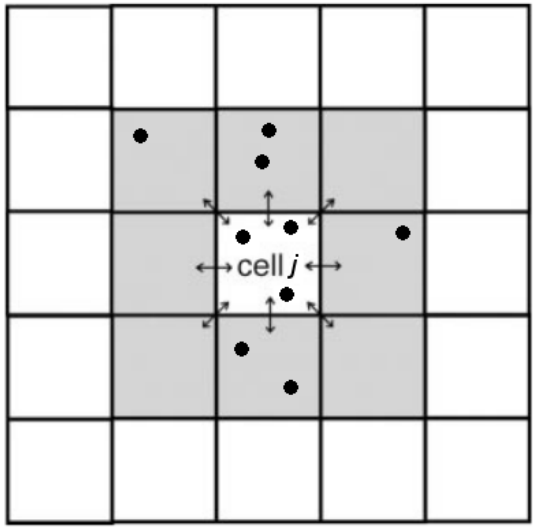
Model

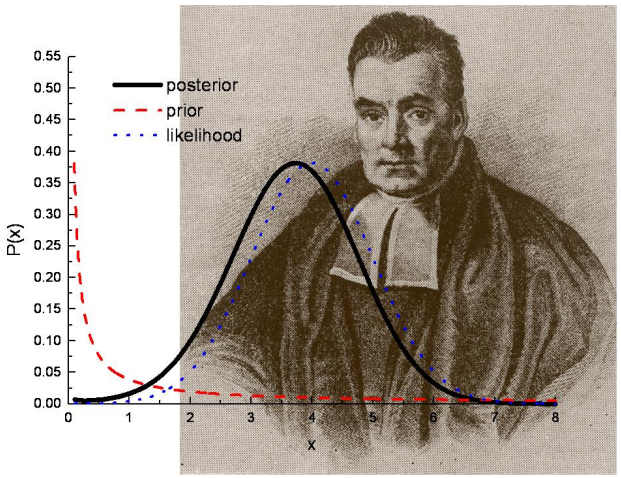
Spatial random effect

- $\text{logit}(\theta_i) = f(\text{spatial factors}_i) + \rho_j$
- ρ_j : spatial random effect
- ρ_j : 10 km ($\sim$ 1500 cells j), interpolated 1 km

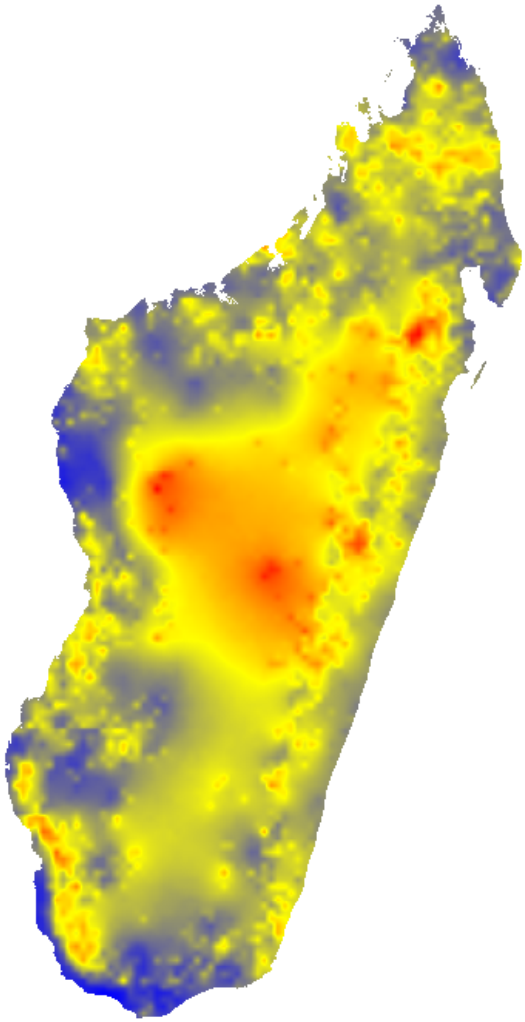
Inference

- hierarchical Bayesian approach
- `hSDM` **R** package

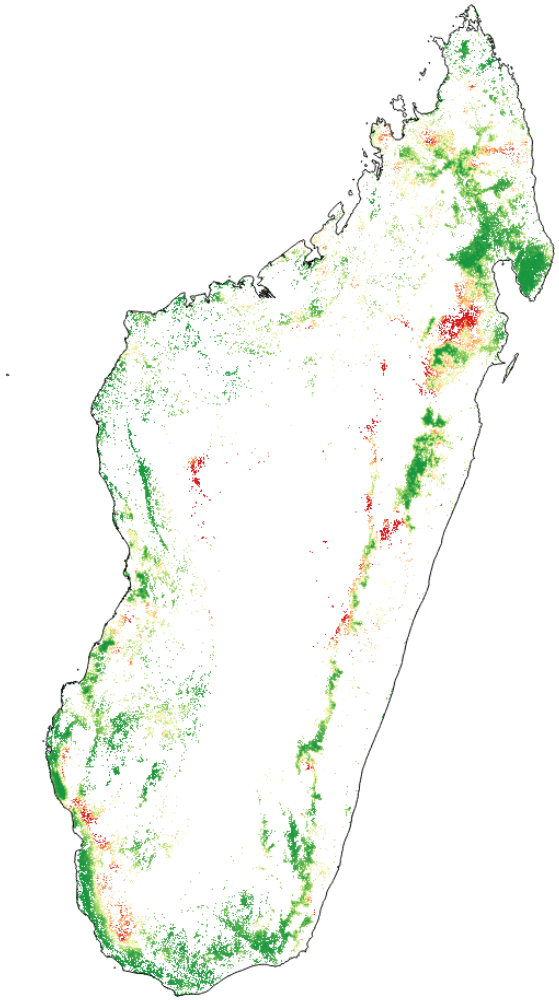




Spatial probability of deforestation



Spatial random effect



Probability of deforestation

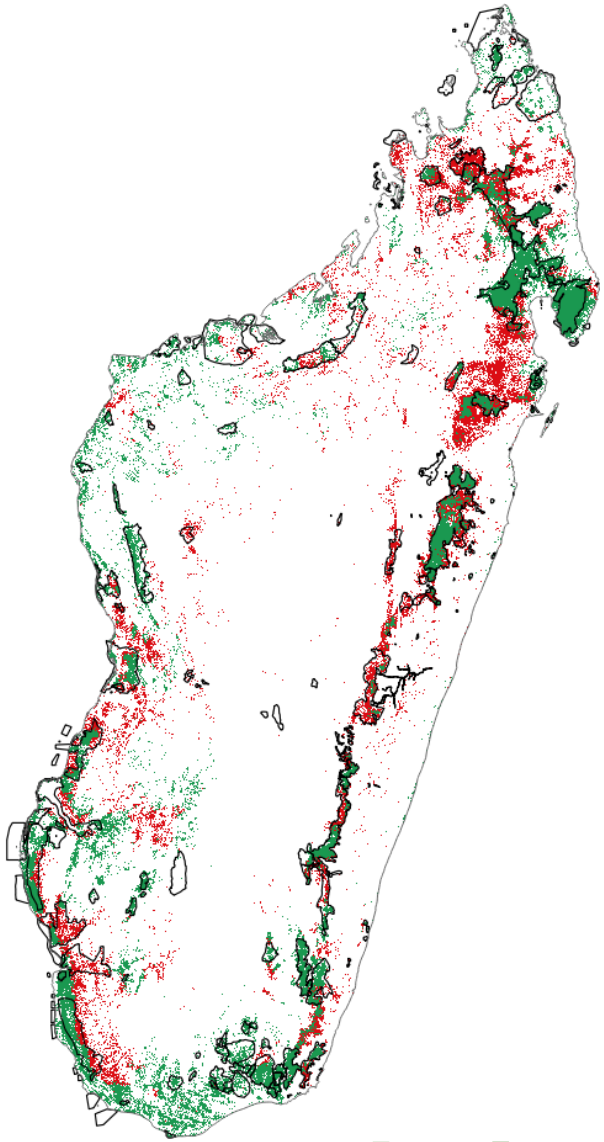
Future deforestation

Forest cover in 2050

- Forest in **2010** : 9.3 Mha
- Forest in **2050** : 5.2 Mha

Forest cover in 2050

- Coherent pattern at fine scale
- Forest concentrated in protected areas
- and in remote areas




. . . Thank you for attention . . .