

Land Use and Forests, Carbon Monitoring, and Global Change
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Product 3

Application of the Forest Area Change approach to baseline for Parana, Brazil

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Modelling deforestation in the Parana State – Brazil

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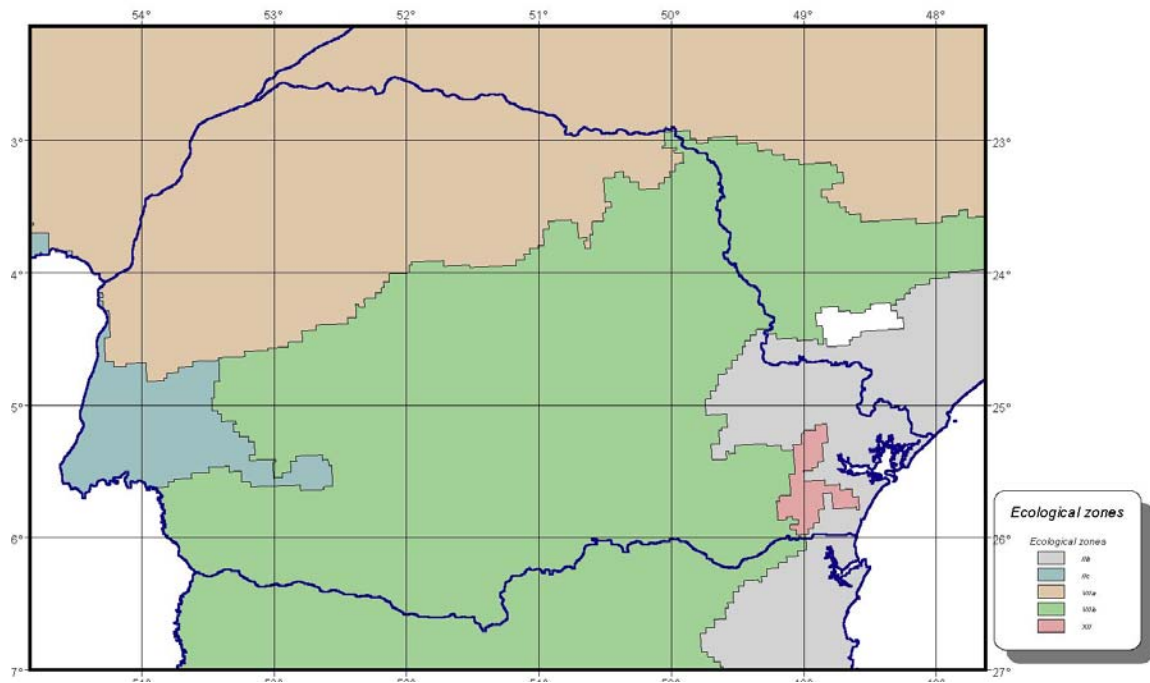
2003

1. Geography



2. Ecological zoning

Parana ecological zones



3. Demography

Population time series were taken from 'IPARDES, 2000. Parana projeção das populações municipais por sexo e idade 2000 – 2010', containing census data and projections up to 2010.

Date	Total population	Growth rate
1 July, 1980	7706212	
1 July, 1981	7786572	1.04279509
1 July, 1982	7866823	1.03063325
1 July, 1983	7946592	1.01399256
1 July, 1984	8025619	0.99447663
1 July, 1985	8103597	0.97161353
1 July, 1986	8180271	0.94617242
1 July, 1987	8255483	0.91943164
1 July, 1988	8329098	0.89171039
1 July, 1989	8401051	0.86387506
1 July, 1990	8471340	0.83666913
1 July, 1991	8540021	0.81074541
1 July, 1992	8710809	1.99985457
1 July, 1993	8821717	1.27322273
1 July, 1994	8931502	1.24448563
1 July, 1995	9040246	1.21753318
1 July, 1996	9148486	1.19731255
1 July, 1997	9256375	1.17930989
1 July, 1998	9363950	1.16217202
1 July, 1999	9471778	1.15152259
1 July, 2000	9580147	1.14412521
1 July, 2001	9688969	1.13591159
1 July, 2002	9798006	1.12537258
1 July, 2003	9906866	1.11104239
1 July, 2004	10015416	1.09570474
1 July, 2005	10123523	1.07940599
1 July, 2006	10230891	1.06057941
1 July, 2007	10336868	1.03585308
1 July, 2008	10441079	1.0081487
1 July, 2009	10543219	0.97825139
1 July, 2010	10642691	0.94346897

In order to extend the time period, data were extrapolate up to year 2020, using regression analysis of the form

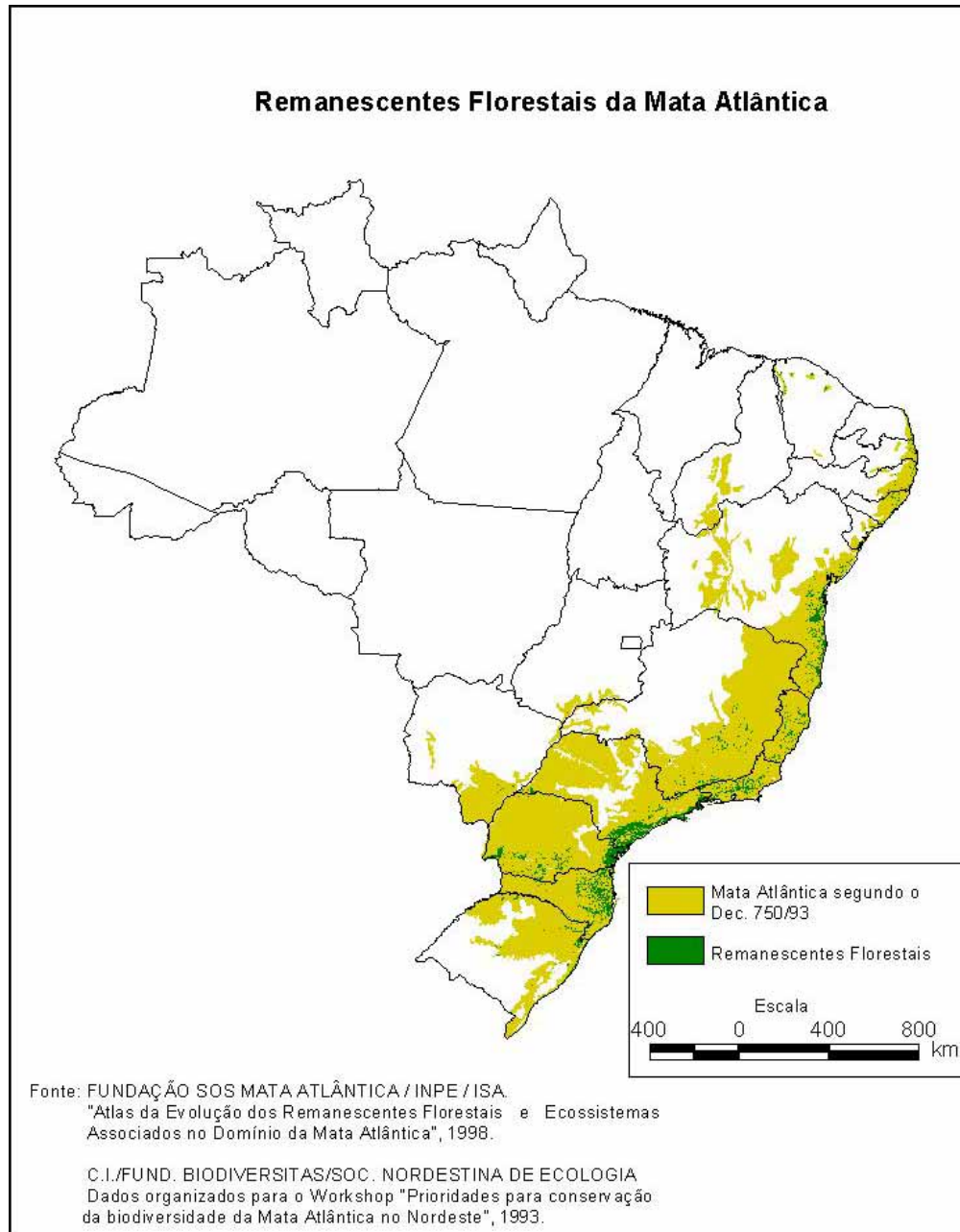
$$Y = a + bx + cx^2$$

where Y is total population and $x = \text{year}$, and a , b and c are regression coefficients. Using the coefficients computed the time series was extended to year 2020 for performing deforestation modelling for the period 1980-2020.

4. Forest cover and deforestation estimates

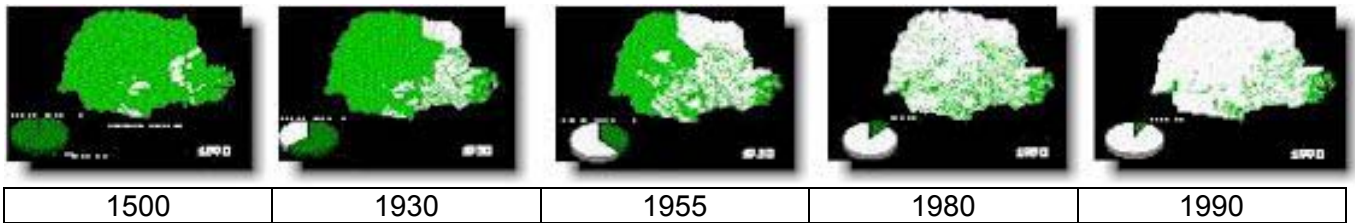
Parana falls within the area of the so-called Mata Atlantica, a dense evergreen and semi-deciduous forest formation originally covering vast areas along the Atlantic coast of Brazil. Such forests have been heavily deforested in the course of time and today only a few relicts are found, as shown in the following map.

Original area of Mata Atlantica and present distribution



In particular for the State of Parana the following information was found about the historical decline of forests

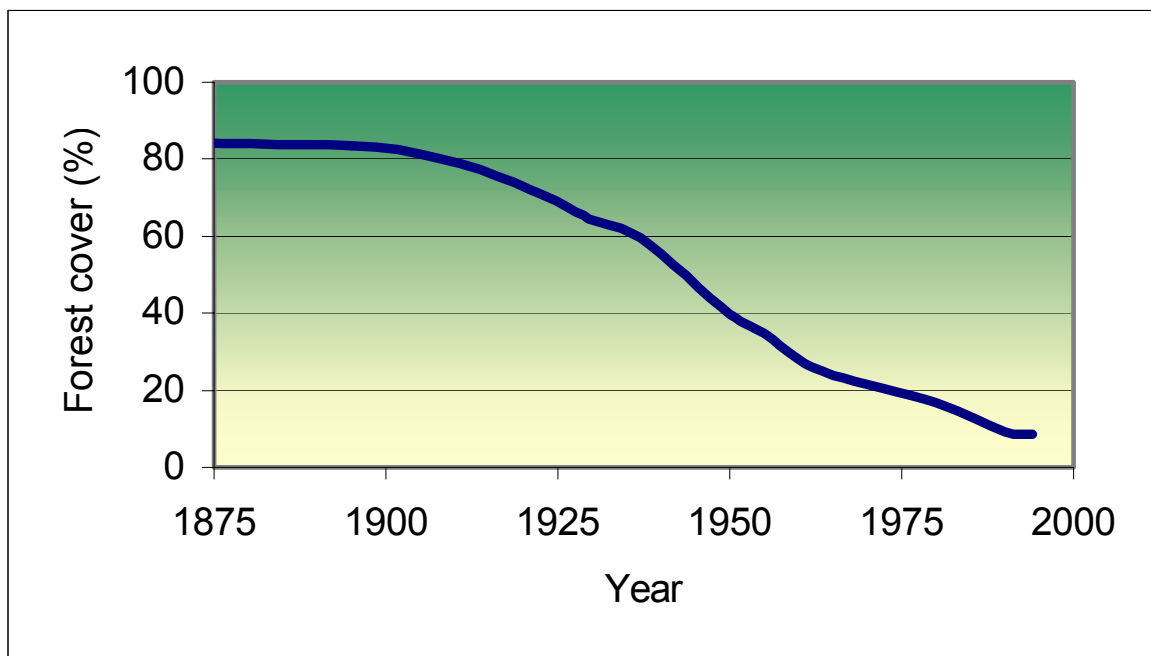
Historical evolution of forest cover in Parana



Forest area change in Parana

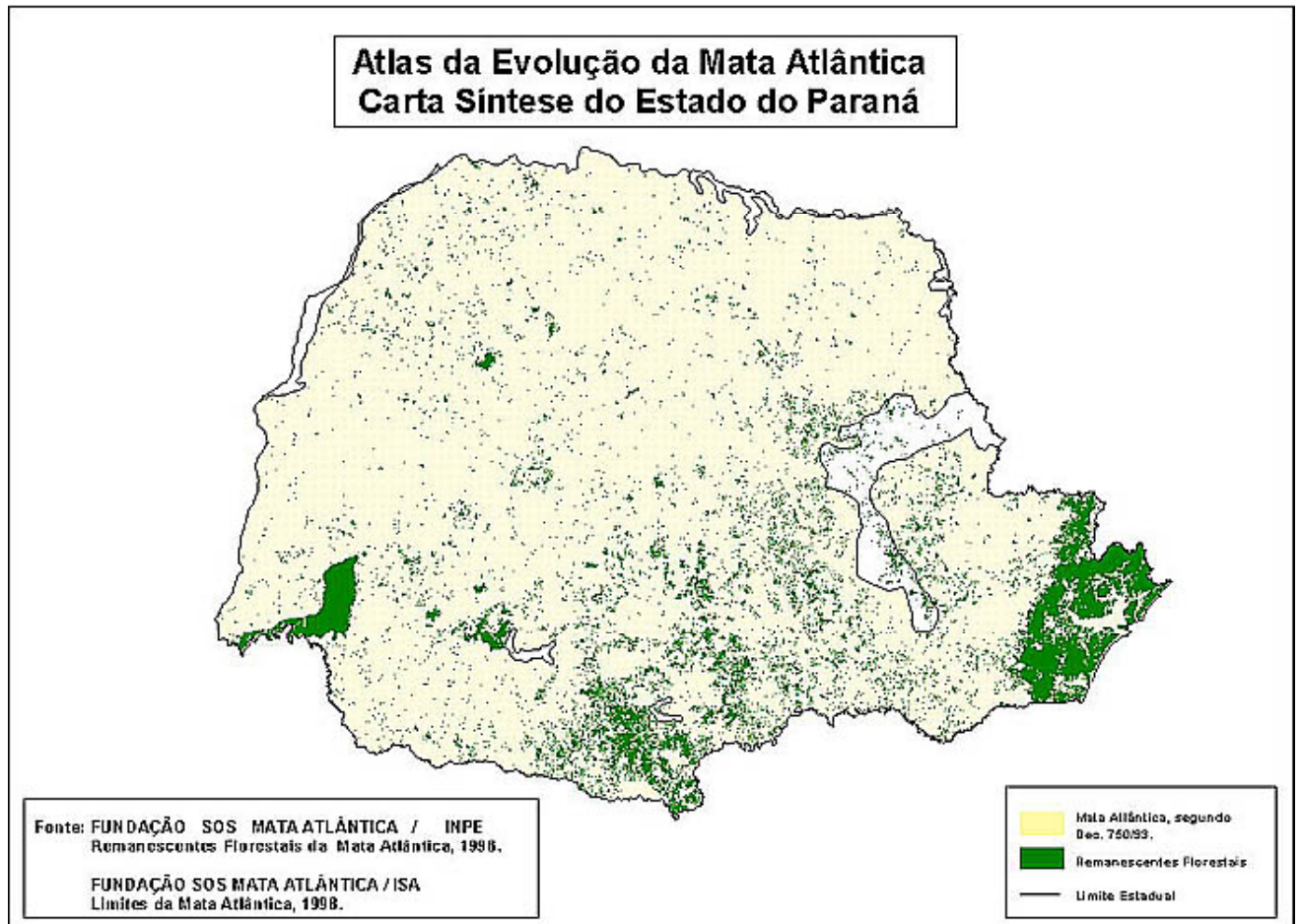
Year	Forest area ('000 ha)	Forest cover (%)
1500	17000	85.0
1895	16782	83.4
1930	12904	64.1
1937	11802	59.6
1950	7983	39.7
1955	6914	34.9
1960	5564	28.1
1965	4814	23.9
1980	3407	17.2
1985	2005	10.1
1990	1848	9,3
1995	1769	8.9

Forest cover curve for Parana



Deforestation in Parana has taken place massively since the beginning of 20th Century, today forest cover is reduced to less than 10%.

Present forest cover of Parana



Statistics about forest cover and deforestation were derived from a study carried out jointly by SOS Mata Atlantica Foundation and Brazilian Remote Sensing Agency (INPE). The Project was started in 1990 with the objective of mapping the remaining area of Mata Atlantica all over Brazil and to assess its deforestation using Landsat scenes. The first mapping was carried out at 1:1,000,000 scale and successively more details were added working at 1:250,000 scale for the period 1985-90 and finally the scale was further refined to 1:50,000 using Landsat 5 and 7 for the period 1995-2000.

The classification system used was the following.

Remanescentes Florestais: Primary or secondary forests in advanced stage of regeneration corresponding to dense evergreen, seasonal semi-deciduous and mixed forest formations

Remanescentes de Vegetação de Restinga: refer to forests and woodlands located on sandy soils along the coastal areas. It includes dense evergreen forests of the lowlands (Restinga Higrofila)

Remanescentes de Vegetação de Mangue: Mangroves

For the entire State the following statistics have been produced

Deforestation in Parana during 1990-95

Forest formation	1990		1995		Annual change	Annual rate (%)
	ha	%	ha	%		
Remanescentes florestais	1815137	9.47	1730528	8.90	-16921.8	-0.95
Restinga	90845	0.47	89691	0.46	-230.8	-0.26
Mangue	24622	0.12	24461	0.12	-32.2	-0.13
Total	1930604	10.06	1844680	9.48	-17184.8	-0.91

Deforestation in Parana during 1995-2000

Forest formation	1995		2000		Annual change	Annual rate (%)
	ha	%	ha	%		
Remanescentes florestais	1654444	8.67	1594298	8.27	-12029.2	-0.74
Restinga	97971	0.51	97093	0.50	-175.6	-0.18
Mangue	28110	0.15	28106	0.15	-0.8	0.00
Total	1780525	9.33	1719497	8.92	-12205.6	-0.70

The tables above show the magnitude of deforestation over a 10 years period. Deforestation in the whole State appears to be slightly decreasing passing from 17,000 ha (0.91%) to 12,000 ha (0.70%), however it is not negligible, given the limited area of remaining forests. Please note that the two areas given for year 1995 are not identical and this is due to reinterpretation of 1995 images done in 2000 and to small differences in cloud coverage.

The deforestation estimates presented above can be considered sufficiently reliable for modelling deforestation using local fit of parameters.

5. Deforestation model results

As discussed in previous case studies based on the Forest Area Change Model, the model can be applied using the general model equation based on ecological conditions (plus and minus models) or on local fit of parameters. In the case of Parana reliable deforestation estimates exist, and the results of the local fit should be superior. However, for completeness, forest and deforestation projections for the period 1980-2020 have been computed for Plus Model, Minus Model and Local Fit, as shown in the following tables.

Local fit

Year	Forest area (thousands ha)	Forest cover (% of land)	Annual deforestation (thousands ha)	Deforestation rate (%)
1980	1971.1	9.9	-12.4	-0.64
1985	1909.2	9.6	-10.4	-0.55
1990	1857.3	9.3	-14.8	-0.81
1995	1783.4	8.9	-12.8	-0.73
2000	1719.5	8.6	-12.8	-0.73
2005	1655.6	8.3	-12.8	-0.75
2010	1595.7	8.0	-12.0	-0.73
2015	1543.8	7.7	-10.4	-0.66
2020	1479.8	7.4	-12.8	-0.84

Minus model

Year	Forest area (thousands ha)	Forest cover (% of land)	Annual deforestation (thousands ha)	Deforestation rate (%)
1980	2297.4	11.5	-29.9	-1.33
1985	2148.1	10.8	-25.1	-1.20
1990	2022.6	10.2	-33.8	-1.73
1995	1853.4	9.3	-26.8	-1.49
2000	1719.5	8.6	-26.8	-1.49
2005	1574.7	7.9	-29.0	-1.74
2010	1451.3	7.3	-24.7	-1.62
2015	1347.8	6.8	-20.7	-1.47
2020	1226.3	6.2	-24.3	-1.87

Plus model

Year	Forest area (thousands ha)	Forest cover (% of land)	Annual deforestation (thousands ha)	Deforestation rate (%)
1980	2351.1	11.8	-33.0	-1.45
1985	2185.9	11.0	-27.5	-1.29
1990	2048.5	10.3	-36.6	-1.86
1995	1865.4	9.4	-29.2	-1.62
2000	1719.5	8.6	-29.2	-1.62
2005	1570.7	7.9	-29.8	-1.79
2010	1451.3	7.3	-23.9	-1.57
2015	1311.9	6.6	-27.9	-2.00
2020	1196.5	6.0	-23.1	-1.82

