

## Mapping of regional land-use/land-cover distribution according to soil types in the semiarid region of Pernambuco State, Brazil

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### ABSTRACT

Geotechnology is a tool with high potential for management, processing, analysis and automatic representation of georeferenced data, providing fast and accurate information about land cover with low cost. Therefore, this study aimed to quantify the land-cover/land-use area of three mesoregions of Pernambuco State, Brazil. We used cross-checking analysis of the land-cover/land-use and soil type classification maps for Agreste, São Francisco, and Sertão mesoregions to obtain the most predominant soil-type/land-use classifications. The main classes observed in these mesoregions were: Dense Caatinga under Ustorthent (497,841 ha) and Utilsoils (291,984 ha). In the Agreste mesoregion was bare soil under Ustalfs (316,214 ha). Finally, in the sertão mesoregion the most important class was the Dense Caatinga under Ustorthent (497,841 ha). The results obtained in this study could be helpful as a tool to guide new modeling work in the semiarid region of Pernambuco State in Brazil.

Keywords: Agreste, São Francisco, Sertão, remote sensing

## Introdução

Currently, the understanding of the spatial distribution of human activities became the greatest challenge for scientists when the goal is to elucidate issues concerning the anthropic impacts on ecosystems (CAMARA, 2002). The utilization of geotechnologies has been shown as a tool with high potential for management, processing, and analysis of georeferenced databases. Such technologies provide quick and precise information of land with low cost.

Therefore, geotechnologies could help mapping the dynamic the land-cover and land-use of northeast region of Brazil. Presently, the data available about these procedures are scarce, even though they are very important for landscape planning.

Geographically, the state of Pernambuco has a substantial representation of climatic variability of the northeastern region of Brazil, regarding soil type, land-cover, and land-use. For example, if a transect is plotted from the west-east direction of the state we can see coastal zone, Atlantic rainforest, and three subdivisions of the Caatinga ecosystem (dry-forest) (Agreste, Sertão, and Araripe). However, also in the Caatinga ecosystem, it is possible to see isolated upland forest zones caused by a high elevation (MENEZES et al., 2012).

At present, there is a lack of information concerning the historical land-use and land-cover which encourage the scientific community to study the cause and effect interactions between the changes in land management practices and their potential impacts on the climate. Thus, the study aimed to quantify (hectares) the land-cover area in

each soil type of three different semiarid mesoregions of Pernambuco State - Brazil.

## Material e Métodos

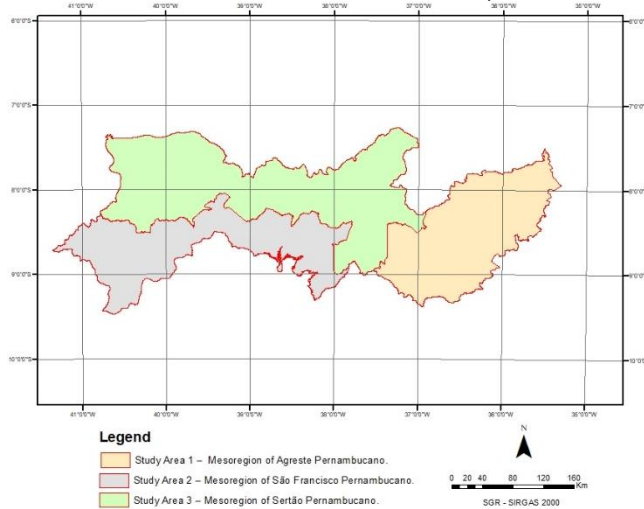
The databases used on this project were acquired from several sources. Overall, they showed different format and geographic projection systems. Thus, it was necessary a previous standardization of the information downloaded from the databases.

Using methodology described by Matos (2008) the maps used were subjected for fusion, intersection, identification, and cut for elaboration of the vector files. The final products of the process mentioned above were thematic maps in format shapefile for soil-class and land-cover plotted in the scale of 1:100:000 (Accioly et al. (2017).

Based upon the generated shapefiles was possible to create a new polygon containing the combination between the soil type and the land cover for each mesoregion studied.

The study area covered three semi-arid mesoregions located in Pernambuco state: 1- Agreste, 2- Sertão and 3 – São Francisco.

**Figure 1 – Semi-arid Mesoregions semi-arid of Pernambuco state included in the study.**



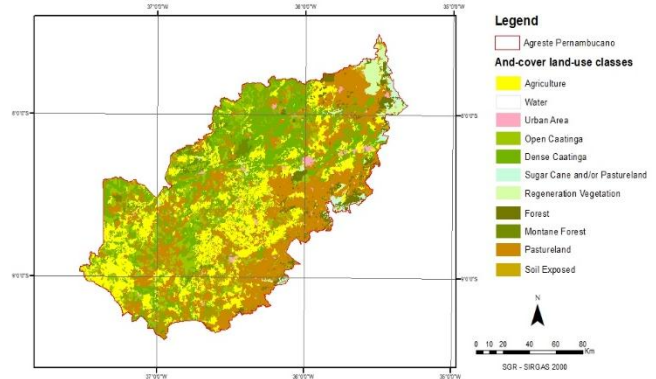
### Study area 1 – Agreste mesoregion of Pernambuco state

The “Agreste” region is located in a transitional zone between the coastal forest and the dry scrubland vegetation (Caatinga ecosystem) of the Pernambuco state. The long-term rainfall average is 607 mm, which the rain pattern is characterized by a high concentration of precipitation in the first six months of the year (Rainy season), and then six months of dry season. The concentration of the precipitation in six months promote recurrent erosion problems in this region (Santos; Montenegro, 2012). According to Köppen, the climate is classified as BSh, this zone shows a high frequency of

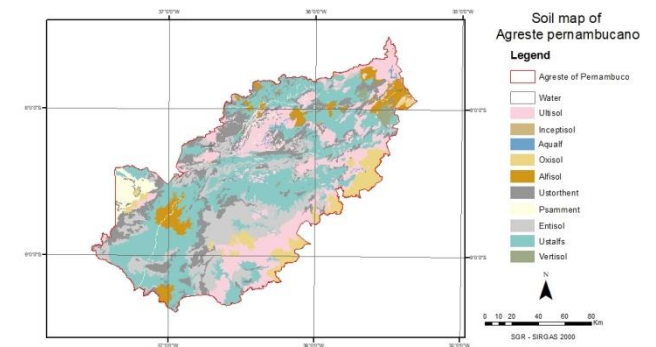
droughts, but the arid index of this zone is milder when compared with the Sertão and São Francisco mesoregions (NÓBREGA; FARIAS; SANTOS, 2015).

Currently, the Agreste mesoregion has been suffering an intense process of urbanization with a fast development of industry, trade and services activities. The agricultural trades are strongly dependent on cereal-grain commodities prices and dairy products (ITEP, 2012). Additionally, according to ITEP (2012) farm and timber industries have been enhancing the anthropic disturbs on the native vegetation, which is characterized to be an ecotone between the Caatinga and rainforest growing underdeveloped soils (Figure 3).

**Figure 2 - Map of land-use/land-cover of the Agreste mesoregion of Pernambuco State.**



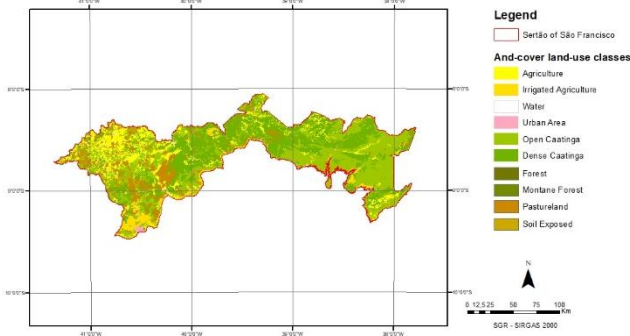
**Figure 3 - Soil map of Agreste mesoregion of Pernambuco State**



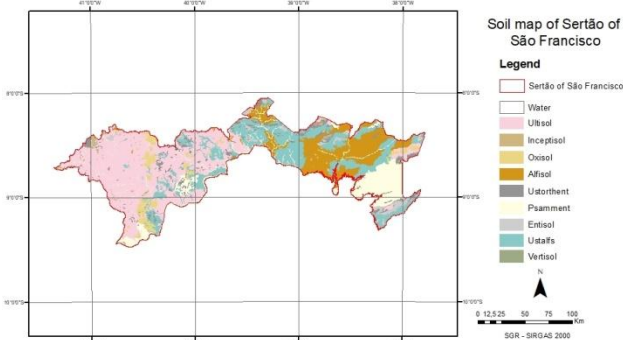
### Study area 2 – São Francisco mesoregion of Pernambuco state

The economy of São Francisco mesoregion is based on trades and agroindustry, mostly fruticulture and winery industry (EMBRAPA, 2009). The agricultural production is mainly under irrigation areas or using alluvial soils on the border of dams. The São Francisco mesoregion is classified as BShw semi-arid with a potential average evapotranspiration of 124 mm month<sup>-1</sup> (SILVA; QUELUZ; KLAR, 2013). This mesoregion has also as predominant vegetation the hyper-xerophyte Caatinga. The soil has a high incidence of rocky outcrops Figure 5.

**Figure 4** - Map of land-use/land-cover of the São Francisco mesoregion of Pernambuco State.



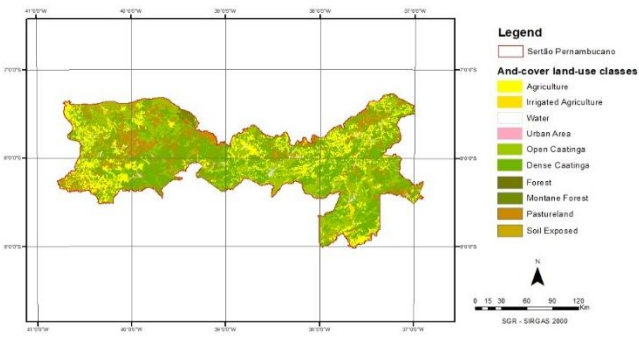
**Figure 5** - Soil map of São Francisco mesoregion of Pernambuco State.



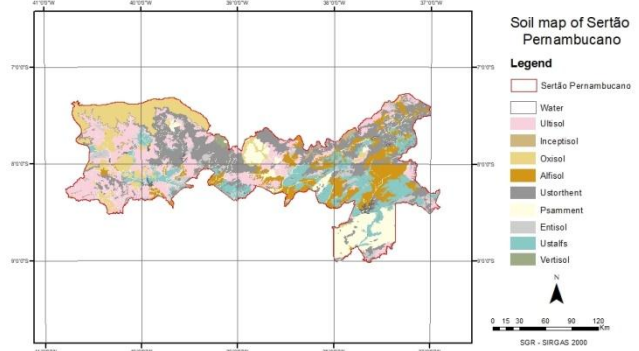
**Study area 3 – Sertão mesoregion of Pernambuco state**

The potential evapotranspiration in the Sertão mesoregion is up to 100 mm month<sup>-1</sup>. According to Koppen, this mesoregion is classified as BSh semi-arid marked for a long dry season with high temperatures (SILVA; QUELUZ; KLAR, 2013). The Sertão mesoregion exhibits limited water resources with temporary rivers and streams. The economy is mainly concentrated in gypsum industry, but goat and sheep production are also important for the economy of the region (COMDEPE/FIDEM, 2011). Due to a long dry season, the soils of the sertão are shallow showing a vegetation type savanna-steppe characterized for a mix of shrubs, tree, cactus and herbaceous plants. Most of these plants are also of common occurrence in the Caatinga ecosystem (JUNIOR et al., 2013).

**Figure 6** - Map of land-use/land-cover of the Sertão mesoregion of Pernambuco State.



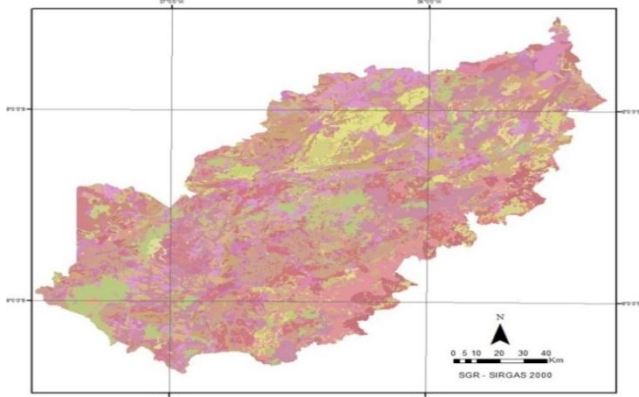
**Figure 7** - Soil map of Sertão mesoregion of Pernambuco State.



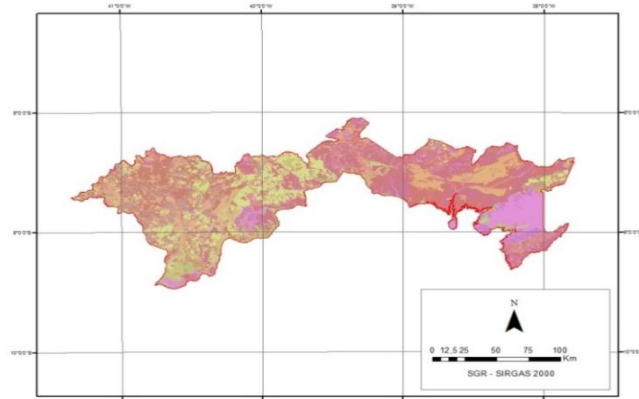
**Resultados e Discussão**

Maps were generated from cross-checking soil type and land use-cover maps of the mesoregions studied: Agreste mesoregion (Figure 8); São Francisco mesoregion (Figure 9) and Sertão mesoregion (Figure 10). For each mesoregion studied tables were elaborated (Tables 1,2 and 3) showing the area covered (hectares) and their respective percentage based on the total land covered by soil type.

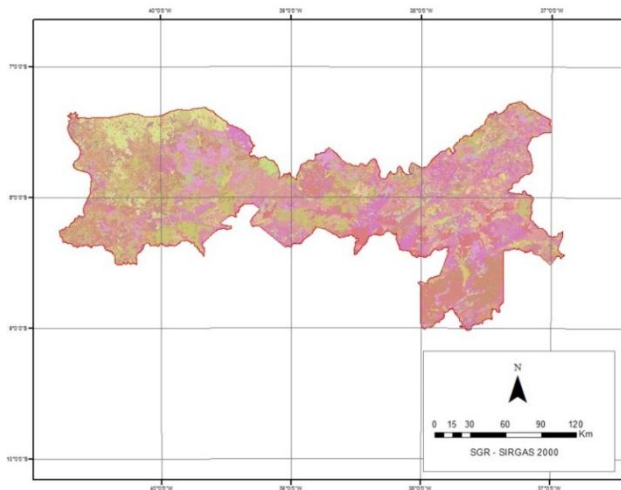
**Figure 8** - Cross-checking map using the soil-type, land-use and land-cover maps for the Agreste mesoregion of Pernambuco state, Brazil.



**Figure 9** - Cross-checking map using the soil-type, land-use and land-cover maps for the São Francisco mesoregion of Pernambuco state, Brazil.



**Figure 10** - Cross-checking map using the soil-type, land-use and land-cover maps for the Sertão mesoregion of Pernambuco state, Brazil.



In the Agreste mesoregion the most important class was pasturelands under Alfisols covering 316.214 ha; followed by Caatinga ecosystem (rangeland) with high shrub density (Dense Caatinga) under Ustorthent with 183,739 ha and croplands with under Entisols 178.862 (Table 1). In the São Francisco mesoregion, the most representative classes were dense Caatinga covering (241.941) ha and Caatinga ecosystem with low shrub density (open Caatinga) with 240.699 ha both land cover under Ustorthent soils. But also, the open Caatinga ecosystem under Ustalfs 219.362 ha (Table 2).

The Sertão mesoregion had as the most representative classes the dense Caatinga ecosystem under Ustorthent with 497.841 and open Caatinga under Ustorthent (291.984 ha) and Alfisols (211.105 ha).

**Table 1** - Areas (hectares) and percentage of land-cover classified according to soil type in the Agreste Mesoregion of Pernambuco state – Brazil.

	Agriculture	Water	Urban Area	Open Caatinga	Dense Caatinga	Sugar cane	Capoeira	Forest	Montane Forest	Pastureland	Bare Soil	%
Ultisol	64567	756	3924	30753	101102	8535	30104	24393	20848	169331	7131	<b>19.0</b>
Inceptisol	45	0	126	71	154	0	0	888	0	476	42	<b>0.1</b>
Aqualf	872	42	33	250	2134	300	692	607	20	1746	1093	<b>0.3</b>
Oxisol	11571	230	2542	5887	5240	10271	4956	27241	1517	68127	1867	<b>5.7</b>
Alfisol	10059	581	1399	18471	24919	5665	3927	7907	0	44191	4369	<b>5.0</b>
Ustorthent	45213	984	1390	48325	183739	341	2934	6029	13550	57447	4240	<b>15.0</b>
Psamment	11078	595	401	10446	27251	379	34	325	3051	18359	1095	<b>3.0</b>
Entisol	178862	292	3170	45125	53233	1318	1095	2172	3632	116634	2518	<b>16.8</b>
Ustalfs	176509	1533	11962	127187	168531	2833	840	15155	558	316214	13563	<b>34.3</b>
Vertisol	3388	0	25	266	1371	0	662	1397	0	11802	136	<b>0.8</b>
Other	0	997	0	0	0	0	0	0	0	0	0	<b>0.0</b>
<b>Total (ha)</b>	<b>502164</b>	<b>6010</b>	<b>24971</b>	<b>286782</b>	<b>567675</b>	<b>29642</b>	<b>45241</b>	<b>86115</b>	<b>43177</b>	<b>804326</b>	<b>36054</b>	
<b>%</b>	<b>20.6</b>	<b>0.2</b>	<b>1.0</b>	<b>11.8</b>	<b>23.3</b>	<b>1.9</b>	<b>1.9</b>	<b>3.5</b>	<b>1.8</b>	<b>33.1</b>	<b>1.5</b>	<b>100</b>

**Table 2** - Areas (hectares) and percentage of land-cover classified according to soil type in the São Francisco Mesoregion Pernambuco state – Brazil.

	Agriculture	Cropland under irrigation	Water	Urban Area	Open Caatinga	Dense Caatinga	Forest	Montane Forest	Pastureland	Bare Soil	%
Ultisol	194416	37302	1322	1739	240699	241940	0	0	171206	0	<b>37.8</b>
Inceptisol	8805	0	59	58	2574	2766	0	384	2969	0	<b>0.7</b>
Oxisol	12730	17270	155	1127	30414	24988	0	213	10132	0	<b>4.1</b>
Alfisol	17382	1553	142 1	1163	178178	142370	0	0	7751	0	<b>14.9</b>
Ustorthent	8255	135	32	59	29043	80342	0	256	8298	54	<b>5.4</b>
Psamment	31681	31839	153 8	4473	162920	58983	1	0	14256	374	<b>13.0</b>
Entisol	15652	45	53	120	29217	11271	0	0	3594	550	<b>2.6</b>
Ustalfs	34635	6468	127 3	701	219362	193119	2	0	45746	0	<b>21.3</b>
Vertisol	178	1290	119	47	1971	233	0	0	53	0	<b>0.2</b>
Other	0	0	133 8	0	0	0	0	0	0	0	<b>0.1</b>
<b>Total (ha)</b>	<b>323733</b>	<b>95902</b>	<b>7309</b>	<b>9487</b>	<b>894378</b>	<b>756013</b>	<b>3</b>	<b>853</b>	<b>264004</b>	<b>978</b>	
<b>%</b>	<b>13.8</b>	<b>4.1</b>	<b>0.3</b>	<b>0.4</b>	<b>38.0</b>	<b>32.1</b>	<b>0.0</b>	<b>0.0</b>	<b>11.2</b>	<b>0.0</b>	<b>100</b>

**Table 3** Areas (hectares) and percentage of land-cover classified according to soil type in the Sertão Mesoregion of Pernambuco state – Brazil.

	Agriculture	Cropland under irrigation	Water	Urban Area	Open Caatinga	Dense Caatinga	Forest	Montane Forest	Pastureland	Bare Soil	%
<b>Ultisol</b>	165519	0	2380	1807	195553	291984	4	2020	158409	575	<b>21.3</b>
<b>Inceptisol</b>	9051	0	659	85	6529	8970	0	1	3618	0	<b>0.8</b>
<b>Oxisol</b>	135969	0	570	446	188129	74308	0	2179 8	78177	96	<b>13.0</b>
<b>Alfisol</b>	88111	0	2061	1288	151021	154432	0	0	43366	1	<b>11.4</b>
<b>Ustorthent</b>	106238	0	1622	2651	212571	497841	89	8281	111679	565	<b>24.5</b>
<b>Psamment</b>	95596	7903	3108	1106	143795	144414	69	667	34650	1087	<b>11.2</b>
<b>Entisol</b>	33259	0	195	1118	43745	47997	0	0	20702	61	<b>3.8</b>
<b>Ustalfs</b>	66107	327	2671	1918	166056	211105	18	81	59235	10	<b>13.2</b>
<b>Vertisol</b>	420	0	68	92	1425	2497	0	0	12181	26	<b>0.4</b>
<b>Other</b>	0	0	15662	0	0	0	0	0	0	0	<b>0.4</b>
<b>Total (ha)</b>	700270	8231	28995	10512	1108825	1433548	180	3284 7	522016	2419	
<b>%</b>	<b>18.2</b>	<b>0.2</b>	<b>0.8</b>	<b>0.3</b>	<b>28.8</b>	<b>37.3</b>	<b>0.0</b>	<b>0.9</b>	<b>13.6</b>	<b>0.1</b>	<b>100</b>

## Conclusões

As result of this project, maps were developed in the scale of 1:100.000 using as reference the cross-checking soil map, and land use-cover map for the Agreste, São Francisco and Sertão mesoregions of Pernambuco state – Brazil. The main classes observed in these mesoregions were: Dense Caatinga under Ustorthent (497,841 ha) and Ustilsoils (291,984 ha). In the Agreste mesoregion was bare soil under Ustalfs (316,214 ha). Finally, The sertão mesoregion has as the most important class the Dense Caatinga under Ustorthent (497,841 ha) The results obtained in this study could be helpful as a tool to guide new modeling work in the semiarid region of Pernambuco State in Brazil.

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