GEOTECHNOLOGIES APPLIED TO DISEASE RISK ANALYSIS RELATED TO THE ENVIRONMENT IN THE UPPER PARAGUAI WATERSHED, FROM 2007 TO 2011

Aline de Fatima Ferreira MATOS[1]
Stephanie Sommerfeld de LARA[1]
Ronaldo José NEVES[1]
Sandra Mara Alves da Silva NEVES[1]
Rosilainy Surubi FERNANDES[2]

Abstract

Diseases transmitted by vectors are an important cause of morbidity and mortality in Brazil and in the World, being frequently limited by environmental variables. The objective of this study is to apply geotechnologies to evaluate the infection risk by vector diseases in the municipalities of the Upper Paraguai Watershed in the period 2007 to 2011. Information on notifications from Dengue, Schistosomiasis, American cutaneous leishmaniasis, Visceral leishmaniasis and Malaria, were used. A medium detection coefficient was formulated for each disease during the years under study and the Index on Priority of Attention to classify the risk of illness from the local population. It was found out that Dengue presented high to very high Indices on Priority of Attention, followed by American cutaneous leishmaniasis, Visceral leishmaniasis, Malaria and Schistosomiasis. For the environmental variables 56 municipalities were identified with more than 50% of its areas devoid of vegetation cover and 31 with deforested areas above 80%. The highest temperatures registered occurred in the municipalities of the Upper Paraguai Watershed in Mato Grosso state. One must consider that there are many factors which influence the dynamics of diseases transmitted by vectors, but the impacts generated by human action on the environment enable a higher risk to infection within the population.

Keywords: Environmental changes. Diseases related to environment. Geo-processing. Index on Priority of Attention. Pantanal Biome.

[1] Universidade do Estado de Mato Grosso – UNEMAT/ Laboratório de Geotecnologias. Av. Santos Dumont, s/n. Bairro: Santos Dumont. Bloco I, Sl 09 – Cidade Universitária. CEP: 78200-000 Cáceres/MT, Brasil. E-mails: {alineferreira36, stephanie_sommerfeld}@hotmail.com, {rjneves, ssneves}@unemat.br

[2] Instituto Oswaldo Cruz/FIOCRUZ - Laboratório de Transmissores de Hematozoários. Av. Brasil, 4365 – Manguinhos. CEP: 21040-900 Rio de Janeiro/RJ, Brasil. E-mail: rosilainysf@gmail.com

Resumo

Geotecnologias aplicadas à análise de risco de doenças relacionadas ao ambiente nos municípios da Bacia do Alto Paraguai, no período de 2007 a 2011

As doenças transmitidas por vetores são importante causa de morbidade e mortalidade no Brasil e no mundo, estando frequentemente limitadas por variáveis ambientais. Objetivou-se por meio da aplicação das geotecnologias avaliar neste estudo o risco de infecção por doenças vetoriais nos municípios da Bacia do Alto Paraguai, no período de 2007 a 2011. Foram utilizadas as informações de notificações da Dengue, Esquistossomose, Leishmaniose tegumentar americana, Leishmaniose visceral e Malária. Formulou-se o coeficiente médio de detecção para cada doença nos anos de estudo e utilizou-se o índice de prioridade de atenção para classificar o risco de adoecimento da população residente. Constatou-se que a Dengue apresentou índices alto e muito alto de prioridade de atenção, seguido da Leishmaniose tegumentar americana, Leishmaniose visceral, Malária e Esquistossomose. Para as variáveis ambientais foram identificados 56 municípios com mais de 50% de suas extensões desprovidas de cobertura vegetal e 31 com áreas desmatadas maiores que 80%. As maiores temperaturas registradas ocorreram nos municípios da Bacia do Alto Paraguai em Mato Grosso. Deve-se considerar que são muitos os fatores que influenciam a dinâmica das doenças transmitidas por vetores, porém os impactos gerados pela ação humana no ambiente possibilitam um maior risco de infecção na população.

Palavras-chave: Alterações ambientais. Doenças relacionadas ao ambiente. Geoprocessamento. Índice de prioridade de atenção. Bioma Pantanal.

INTRODUCTION

The geotechnologies in the area of Health have a recent development in Brazil, notably at the end of the 1980's with the application of spatial analysis tools which allow to know, monitor and evaluate the health situation, when using spatial indicators in a determined time and space (BRASIL, 2007a, p. 6).

The indicators are helpful to facilitate the interpretation of problems and to make decisions effective and efficient. So indicators enable to convert data into useful information used by managers to improve, manage and implement policies in a certain area (MACIEL FILHO et al., 1999, p. 61).

The diseases transmitted by vectors constitute until today an important cause for mortality and morbidity in Brazil and worldwide (TAUIL, 2002, p. 59). The disease Dengue which occurs predominantly in tropical and subtropical environments caused 500,000 cases in Brazil during 2007 and of these 14% were restricted to the Central-West region. Malaria is concentrated in the so-called Legal Amazonia, with 90% of it occurring in this region, with 470,000 average yearly cases in Brazil in the years 2004 to 2008. The American Cutaneous and Visceral Leishmaniasis, which enlarged its incidence and geographical distribution, caused 25,000 average yearly cases in Brazil in the period 2004 to 2008, being 15% of them in the Central-West region. As for Schistosomiasis, aggravated due to environmental and climatic changes, such as floods and droughts and social-economic factors related to water access and quality, there were in average 36,000 yearly cases in Brazil and 0.5% of it occurred in the Central-West region (OPAS, 2009, p. 18-9).

The Diseases vectors are frequently limited by environmental variables, such as temperature, humidity, land use patterns and vegetation (BARCELLOS et al., 2009,

p. 294). Social transformations occurred since the 70's, characterized by accelerated urbanization, migration, environmental changes and communication facilities between continents, countries and regions, among other factors, contributed for the delineation of the present epidemiologic profile of the transmissible diseases in the World (BRASIL, 2010a, p. 38).

In the Upper Paraguai Watershed (BAP), encompassing the World's largest floodplain, there was an intensification of disordered land use/occupation, which promoted a significant de-characterization of the vegetation, favoring the occurrence of vector diseases (BRASIL, 2006a, p. 29).

In this context, the objective of this work is to evaluate the infection risks of vector diseases in the municipalities from BAP, in the period 2007-2011, using geotechnologies.

METHODOLOGY

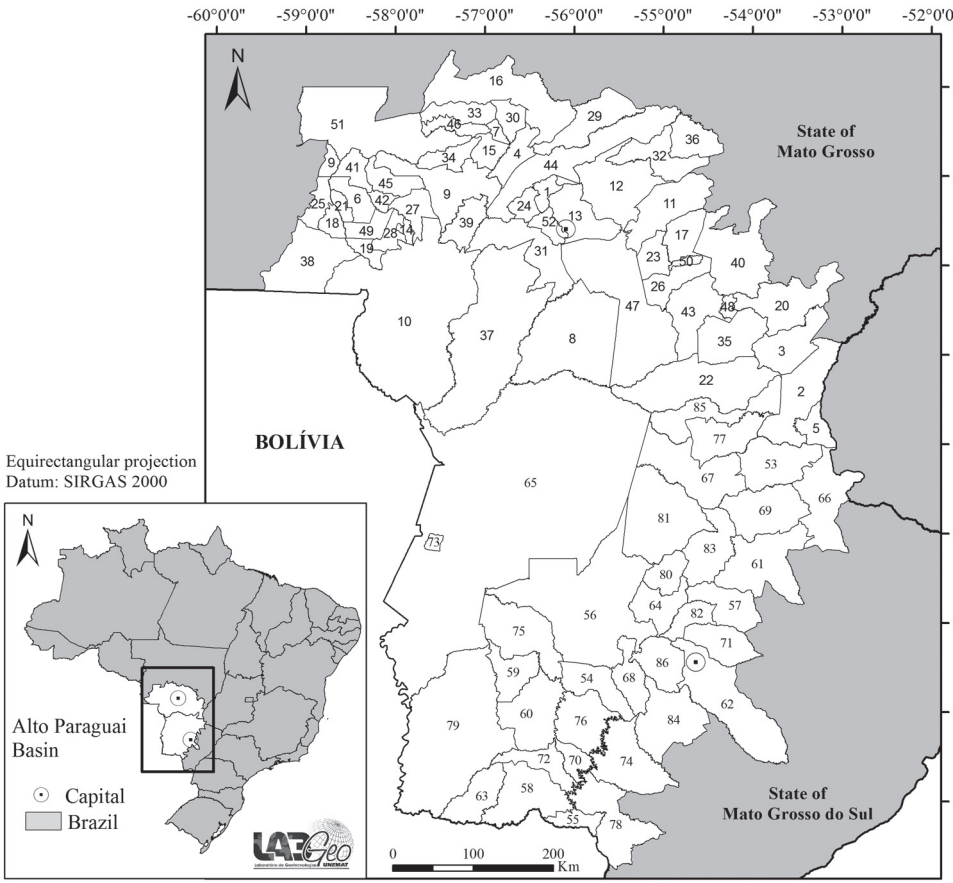
Study Area

The BAP is localized in the center of South America, occupying areas from Brazil, Bolivia and Paraguay. In Brazilian territory BAP has an extension of 361,666 km^2 in the Central West region, limited by geographical coordinates S 13º35'17,39" and S 22°46'18,00", W 52°45'40,39" and W 59°32'21,33", bordering with Bolivia and Paraguay (SILVA; ABDON, 1998, p. 1704-6).

Located in Western Brazil, BAP occupies part of both states Mato Grosso and Mato Grosso do Sul, including 86 municipalities, of which 52 are located in Mato Grosso and 34 in Mato Grosso do Sul (Figure 1). The total BAP population in 2010 was 3,198,870 inhabitants (IBGE, 2015).

At the municipalities within BAP one observed that 52 of them presented a Municipal Human Development Index (HDIM), classified as medium developed, 33 as high and only 1 municipality with low HDIM, referring to year 2010. At the variable Education, 84 BAP municipalities presented values rated as very low, low and medium development and for Longevity all municipalities under study obtained a high and very high HDIM (PNUD, 2015). At the borders of BAP the following biomes occur: Amazonia with 31,015.7 km^2, corresponding to 8.57% of the territory; Cerrado with 49.67% of it and Pantanal with 151,072.2 km^2 (41.76%), contained totally in the area of BAP (SILVA et al., 2011, p. 40).

The predominant climate in the area under study is Tropical, with annual average temperatures varying between 22.5ºC and 26.5ºC (BRASIL, 2006a, p. 29).



Municipalities of MT

1 Acorizal
2 Alto Araguaia
3 Alto Garças
4 Alto Paraguai
5 Alto Taquari
6 Araputanga
7 Arenápolis
8 Barão de Melgaço
9 Barra do Bugres
10 Cáceres
11 Campo Verde
12 Chapada dos Guimarães
13 Cuiabá
14 Curvelândia
15 Denise
16 Diamantino
17 Dom Aquino
18 Figueirópolis D'Oeste
19 Glória D'Oeste
20 Guiratinga
21 Indiavaí
22 Itiquira
23 Jaciara
24 Jangada
25 Jauru
26 Juscimeira
27 Lambari D'Oeste
28 Mirassol D'Oeste
29 Nobres
30 Nortelândia
31 Nossa Senhora do Livramento
32 Nova Brasilândia
33 Nova Marilândia
34 Nova Olímpia
35 Pedra Preta
36 Planalto da Serra
37 Poconé
38 Porto Esperidião
39 Porto Estrela
40 Poxoréo
41 Reserva do Cabaçal
42 Rio Branco
43 Rondonópolis
44 Rosário Oeste
45 Salto do Céu
46 Santo Afonso
47 Santo Antônio do Leverger
48 São José do Povo
49 São José dos Quatro Marcos
50 São Pedro da Cipa
51 Tangará da Serra
52 Várzea Grande

Municipalities of MS

53 Alcinópolis
54 Anastácio
55 Antônio João
56 Aquidauana
57 Bandeirantes
58 Bela Vista
59 Bodoquena
60 Bonito
61 Camapuã
62 Campo Grande
63 Caracol
64 Corguinho
65 Corumbá
66 Costa Rica
67 Coxim
68 Dois Irmãos do Buriti
69 Figueirão
70 Guia Lopes da Laguna
71 Jaraguari
72 Jardim
73 Ladário
74 Maracaju
75 Miranda
76 Nioaque
77 Pedro Gomes
78 Ponta Porã
79 Porto Murtinho
80 Rio Negro
81 Rio Verde de Mato Grosso
82 Rochedo
83 São Gabriel do Oeste
84 Sidrolândia
85 Sonora
86 Terenos

Figure 1 - Municipalities within BAP
Source: Labgeo Unemat, 2015.

Methodological procedures

This is an epidemiologic study, with an ecological delineation, executed from variable environmental and health data from the BAP municipalities.

The vector data (Shape files) of Vegetation and Water bodies were obtained in the site of the Brazilian Ministry of the Environment (MMA) generated by the Project for Conservation and Sustainable Use of Biologic Diversity (PROBIO). From these data the calculation from the municipal area covered with vegetation and water bodies was made, represented cartographically with legends classified as: Very High, High, Medium and Low. The Shape file from the municipalities was obtained from the Brazilian Institute for Geography and Statistics (IBGE) and from the biomes at the site from MMA.

Temperature data from the municipalities for the period 2007-2011 were acquired at the site of the National Institute for Meteorology (INMET). The arithmetic average of the compensated annual temperature series was performed.

At the Information System of Disease Notification (SINAN) the download was made of confirmed cases from the diseases Dengue, Schistosomiasis, American cutaneous Leishmaniasis, Visceral leishmaniasis and Malaria from resident population in the municipalities of BAP, in the period 2007 to 2011 (BRASIL, 2015).

The amount of population from each municipality contained in the BAP was obtained in the census of 2010, available on the IBGE site (IBGE, 2015).

From the raw data, the average coefficients for the detection of diseases selected for investigation were elaborated, which consisted in the sum of the reported cases from a determined disease in the period 2007-2011, with the calculation of the arithmetic mean for the period under study. From the result obtained, the calculation was made from the ratio of the resident population of the municipality in 2010, by the constant of 100,000 inhabitants.

For the analysis of the average coefficients for the detection of diseases at BAP, namely: at Pantanal, Cerrado and Amazonia, it was necessary to execute an intersection of the cartographic base from the biomes and municipalities, due to a spatial non-correspondence of the borders from the biomes and the political-administrative borders of the municipalities. The option considered was to include in the biomes only those municipal units whose territorial extensions are equivalent or larger than 51%.

The results of the coefficients of the biomes were distributed in quartiles according to the following legend: very high, high, medium and low.

For the analysis of the average detection coefficients of diseases by municipality, the equation of the Index on Priority of Attention was applied (SANTOS et al., 2013, p. 8579) to all diseases studied, based on the calculus of the average (μ) and the standard deviation (σ) from the temporal series 2007-2011 for each municipality. The resulting values (X) were used to establish the thresholds of the Priority of Attention Levels, represented in the map by colors: green when $X < \mu - \sigma$, yellow when $\mu - \sigma < X < \mu$, orange for $\mu < X < \mu + \sigma$ and red if $X > \mu + \sigma$, corresponding in the legend of cartographic representation to the classes very high, high, medium and low.

All cartographic representations of the study were elaborated using the software ArcGIS, version 9.2 (ESRI, 2007).

RESULTS AND DISCUSSION

The largest extensions of vegetation cover at BAP, predominate in municipalities of the portion from the Pantanal Biome. Among the 86 municipalities analyzed at BAP, 56 presented over 50% of its extension without vegetation cover and 31 with more than 80% of its territory with deforested areas (Figure 2). Harris et al. (2006, p. 50) and Harris et al. (2005, p. 161) verified that 44% of the original BAP vegetation was completely eliminated until 2004, which is associated mainly to livestock activities.

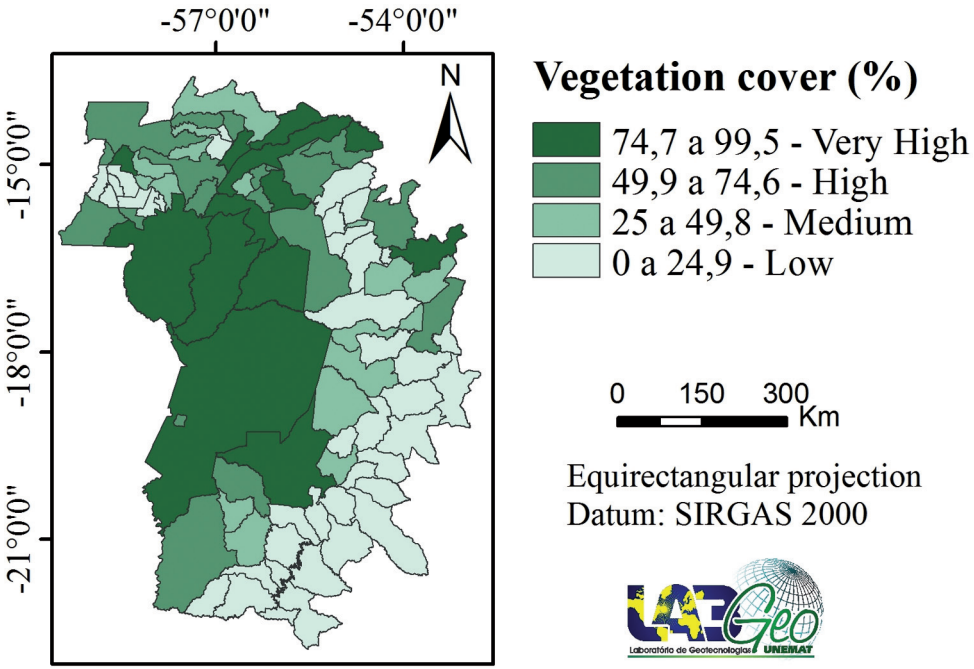


Figure 2 - Vegetation cover of BAP municipalities, in the period 2007-2011

Source: Labgeo Unemat, 2015.

Vector transmitted diseases are associated to deforestation, because they are limited exclusively by environmental variables, such as temperature, humidity, land use patterns and vegetation (BARCELLOS et al., 2009, p. 294). Thus the changes in the natural environment with the vector presence have favored the increase of endemics.

The municipalities of Cáceres, Poconé and Ladário stand out at BAP because they present the highest percentages of water bodies (Figure 3), which agrees with Guimarães (2007, p. 1), this favors the permanence of mollusks and flying insects.

The BAP municipalities of Mato Grosso state were those which presented the highest average temperatures in the period 2007-2011, varying between 18.5°C and 25.1°C, while at the Mato Grosso do Sul municipalities average temperatures oscillated between 12.3°C and 18.7°C during the same time (Figure 4).

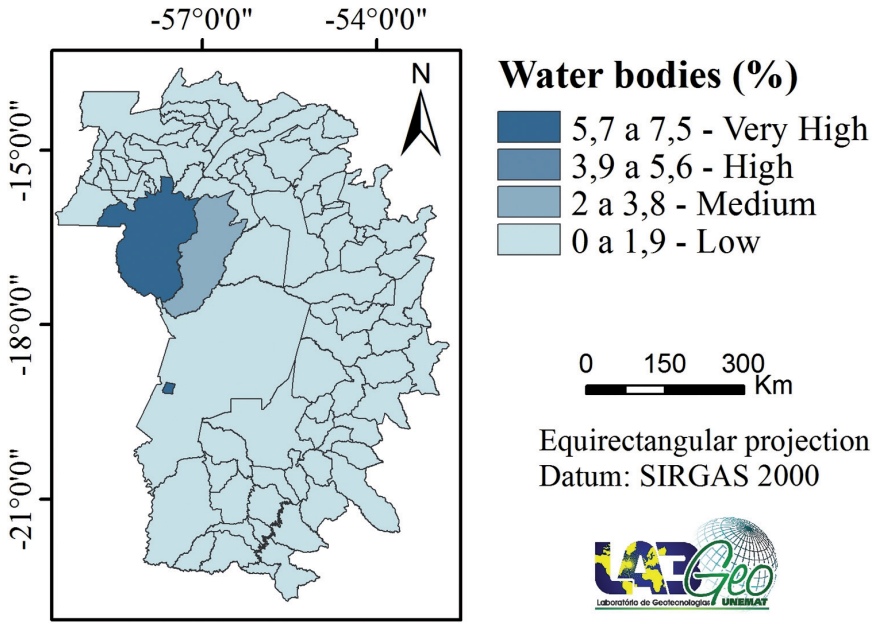


Figure 3 - Water bodies of BAP municipalities in the period 2007 – 2011

Source: Labgeo Unemat, 2015.

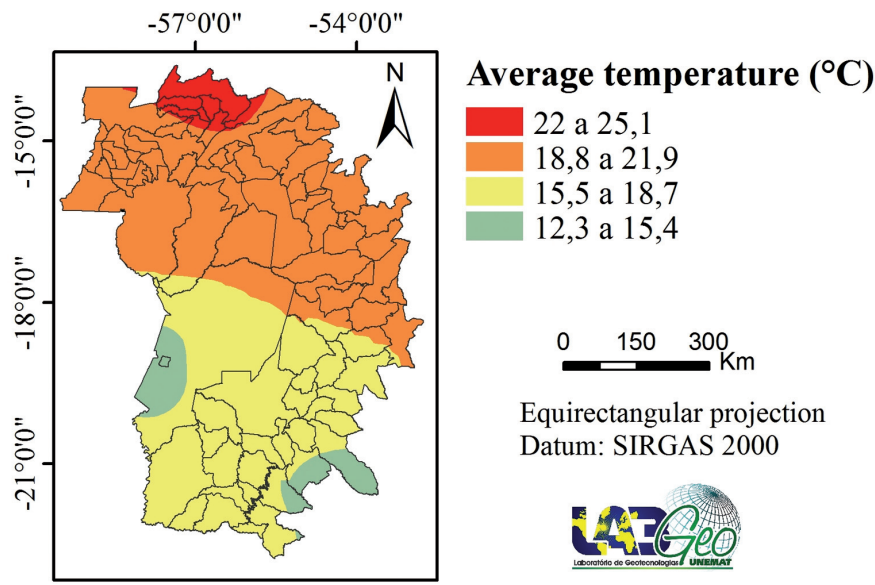


Figure 4 - Average temperature of BAP municipalities, in the period 2007-2011

Source: Labgeo Unemat, 2015

During the investigated period 106,685 cases of Dengue were registered in the 86 BAP municipalities, whose average detection coefficient was 667 cases for 100,000 inhabitants; 3,043 cases of American Cutaneous Leishmaniasis; 1,200 cases of Visceral Leishmaniasis represented by a coefficient of 7 cases for each 100,000 inhabitants; 111 cases of Malaria with approximately 1 case for each 100,000 inhabitants and 61 cases of Schistosomiasis, with a coefficient smaller than 1 case (0.38) for each 100,000 inhabitants of BAP.

Analyzing the average detection coefficient of infectious vector diseases, considering the biomes at BAP, referring to the period 2007 to 2011, it was found out that there is a high number of Dengue cases in the Pantanal; Visceral leishmaniasis and Malaria in the Cerrado area; Schistosomiasis and American cutaneous leishmaniasis in the Amazonia Biome (Figure 5).

Tauil (2006, p. 276) and Barcellos et al. (2009, p. 295) report that diseases transmitted by vectors are frequently associated to the tropical climate and to the impacts generated by human action on the environment, but multiple factors which influence the dynamics of the diseases transmitted must be considered, such as: environmental (vegetation and hydrology), demographic (migration and population density), biologic (life cycle of flying insects and infectious agents) as well as medical-social (immunologic status of the population; effectiveness of the local health systems and specific programs for disease control, etc.).

In the year 2011, the incidence of Dengue in the states Mato Grosso and Mato Grosso do Sul was of 202 and 347 cases for each 10 thousand inhabitants, respectively (BRASIL, 2014). In this study, Dengue in the Pantanal biome presented an average detection coefficient of 804 cases for each 100,000 inhabitants. The situation in the other two biomes (Cerrado and Amazonia) was not less relevant with coefficients of 650 cases for each 100,000 inhabitants in the period 2007 to 2011 (Figure 5A)

The biomes of BAP present a low endemic behavior for Schistosomiasis, because the average detection coefficient of this disease in the period under study 2007-2011 was of approximately 1 case for 100,000 inhabitants, with a higher occurrence in the larger municipalities within the Amazonia Biome of BAP (Figure 5B). Santos et al. (2007, p.6944) declared that over 12% of this biome suffered some changes by Man, and according to the Brazilian Ministry of Health (BRASIL, 2010a, p.40) the Schistosomiasis is generally associated to environmental changes caused by Man, to population displacements originated from endemic areas and to the insufficient infrastructure of water and sewage nets or on the availability from other forms of access to these services.

In the Amazonia biome of BAP there is the highest average detection coefficient of American Cutaneous Leishmaniasis, with 56 cases for 100,000 resident inhabitants in this area (Figure 5 C). It is known that American cutaneous leishmaniasis is distributed sparsely in the Brazilian states: in some areas there is an intense concentration of cases, while in others there are only few isolated cases.

According to the Ministry of Health (BRASIL, 2010b, p. 18) Mato Grosso state has an intense concentration of cases, because it presents one of the highest detection coefficients of American cutaneous leishmaniasis in the year 2004. This information corroborates with that one found in this study that the biome Amazonia in the BAP had an intense concentration of this disease.

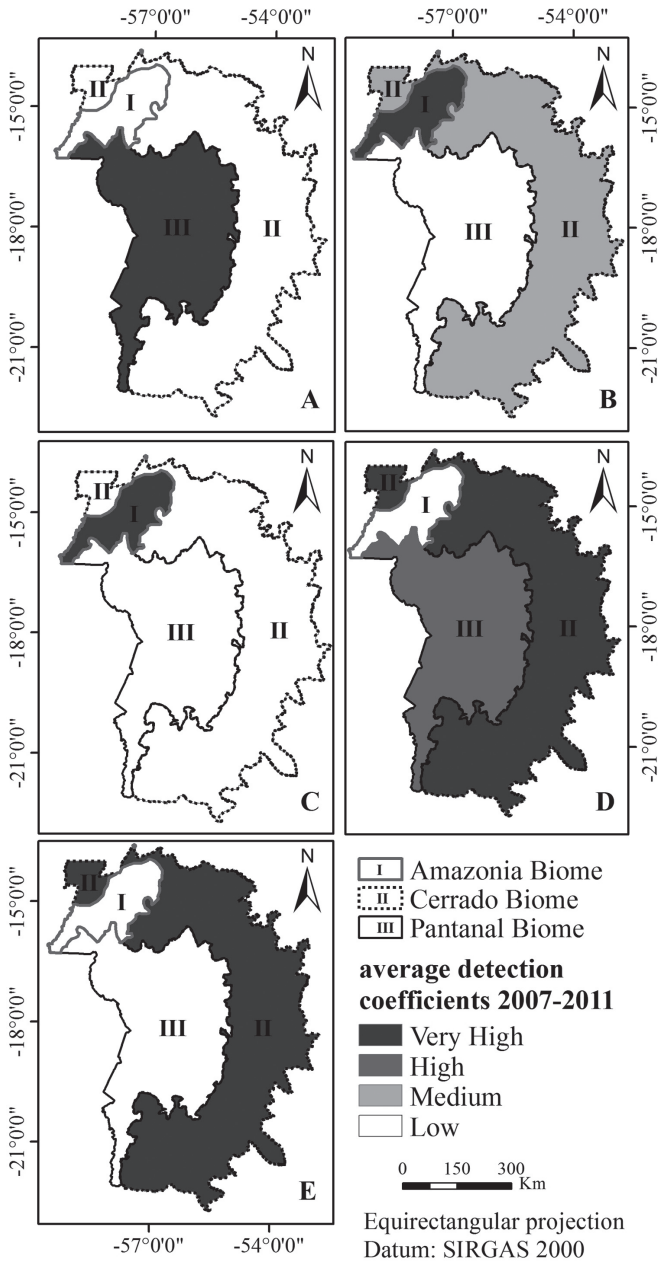


Figure 5 - Average detection coefficients in the period 2007-2011 in the BAP biomes for the diseases: A) Dengue, B) Schistosomiasis, C) American cutaneous leishmaniasis, D) Visceral leishmaniasis and E) Malaria

Source: Labgeo Unemat, 2015.

Several studies indicate that the transmission of Visceral leishmaniasis in Mato Grosso is increasing and that its dissemination accompanies the chaotic urban occupation process, together with the migratory flow among the municipalities of the Center-South region with North and Southeast Mato Grosso. The increase of the vector density, the living of man close to domestic water reservoirs, the accentuated deforestation and the constant mobilization of people constitute the main determinants of the epidemic levels from Visceral leishmaniasis (MESTRE; FONTES, 2007, p. 46; MISSAWA; LIMA, 2006, p. 337).

The Cerrado Biome aggregates municipalities with the lowest percentages of vegetation cover, where the coefficient of Visceral leishmaniasis was of 6 cases for each 100,000 inhabitants, in average for the years 2007 to 2011. The Pantanal biome, which has the municipalities with the highest vegetation cover percentages, obtained an average detection coefficient of 5 cases for each 100,000 inhabitants (Figure 5D). Studies performed in Mato Grosso on the presence of Leishmaniasis vectors, indicated the highest frequencies of *Lutzomyia cruzi* both in the Pantanal and Cerrado, indicating that the Cerrado is the preferential environment for this species (RIBEIRO; MISSAWA, 2002, p.34). Missawa e Lima (2006, p.338) verified a great occurrence of *Lutzomyia longipalpis* in forest areas as well as in transition sections and in the Cerrado. These species of genus *Lutzomyia* corresponds to the main vectors incriminated on the transmission of Leishmaniasis in the Americas (REY, 2008. p. 371).

According to the Ministry of Health (BRASIL, 2013, p. 10), the population of states Mato Grosso and Mato Grosso do Sul present a low Malaria risk, with values below 10 cases notified for each thousand inhabitants, compared with other Brazilian states in 2011. Analyzing in this study, the average detection coefficient of Malaria for the period 2007-2011 by biomes in BAP, it was found out that municipalities with areas within the Cerrado biome presented the highest values, characterized by approximately 1 case notified for each 100,000 inhabitants (Figure 5E).

The spatial distribution of Index on Priority of Attention on Infectious Vector Diseases studied by municipalities within the BAP area presented heterogeneous patterns (Figure 6), with municipal agglomerates, characteristic for infectious diseases.

In the BAP municipalities there were High and Very high Priority Indices for Dengue, which occurred in 29 municipalities (33.7%) in the years analyzed, followed by American cutaneous leishmaniasis in 27 municipalities (31.4%), Visceral leishmaniasis in 21 municipalities (24.4%), Malaria in 12 municipalities (13.9%) and Schistosomiasis in 12 municipalities (13.9%), all with high infection risk (Figure 6).

The Indices High and Very high for Dengue varied from 582 to 2,738 cases for each 100,000 inhabitants in the BAP municipalities, referring to the annual average from 2007 to 2011 (Figure 6A). One observes in this study (Figure 2) that the municipalities with the lowest vegetation percentage (except for Corumbá) also show very high Indices on Priority of Attention for Dengue, namely: Nova Brasilândia, Indiavaí, Pedro Gomes, Jardim, Maracaju, Rio Branco, Salto do Céu, Jauru, Rio Verde de Mato Grosso and Araputanga. Besides that, in the more populated municipalities, such as the capitals of Mato Grosso state (Cuiabá) and Mato Grosso do Sul (Campo Grande), these indices were higher this is strongly associated with the dynamics of the disease transmission, taking into account that the mosquito vector is anthropophilic (preference for contact and human blood) and endophylic (prefernce for the interior of houses for shelter, rest and food).

Some studies in other Brazilian states corroborate these findings, i.e. on the preference of *Aedes aegypti* for urban habitats, such as in Rio de Janeiro (SOARES, 2008, p. 66) and São Paulo (FERREIRA; CHIARAVALLOTI NETO, 2007, p.7). In Mato Grosso, Souza et al. (2010, p. 1007) and Fernandes et al. (2012, p. 82) confirmed the presence of this disease in the most populous neightborhoods from the cities Cáceres and Tangará da Serra.

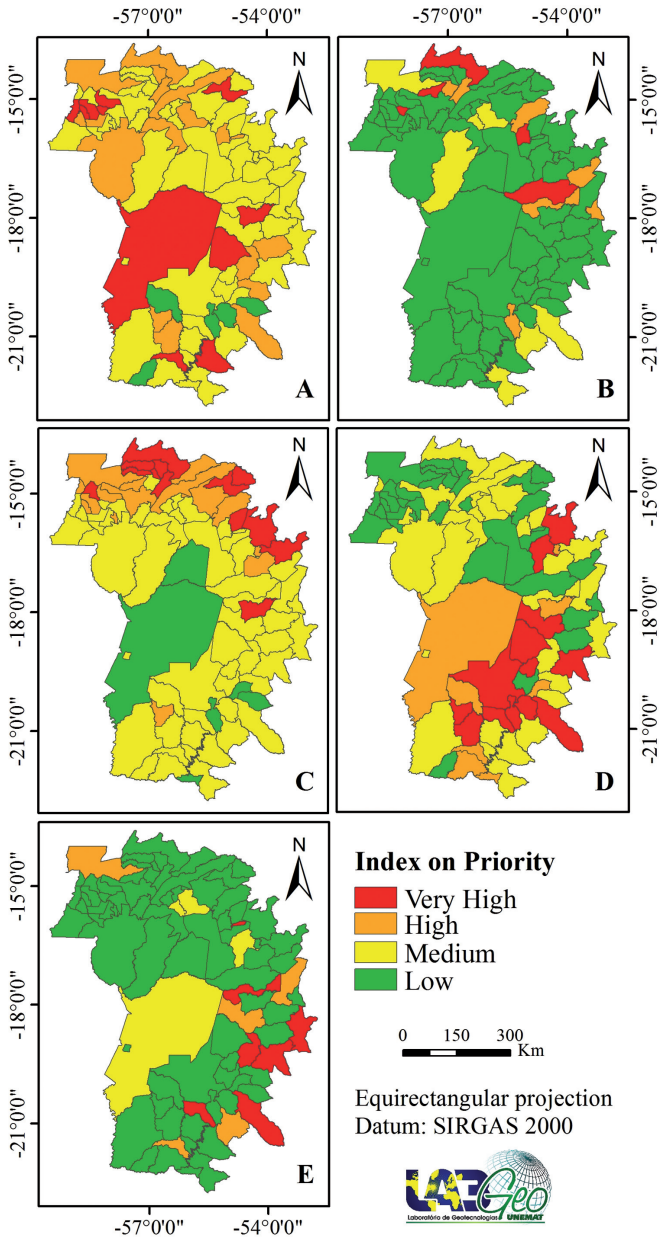


Figure 6 - Spatial distribution of the Index on Priority of Attention on Infectious Vector Diseases, period 2007 to 2011, in the BAP municipalities for the diseases: A) Dengue, B) Schistosomiasis, C) American cutaneous leishmaniasis, D) Visceral leishmaniasis and E) Malaria

Source: Labgeo Unemat, 2015.

The Schistosomiasis (Figure 6B) had its highest occurrence in the municipalities of Mato Grosso with High to Very high Indices on Priority of Attention varying between 1 and 17, cases per 100,000 inhabitants. The municipalities of Mato Grosso were the most frequent to present the very high attention to priority index for Schistosomiasis, which are: Jaciara, Rio Branco, Diamantino, Nova Olímpia and Itiquira. These municipalities however presented a low percentage of water bodies. This disease occurs in 80% of the cases in Northeast Brazil, and 0.5% of the cases in Central-West Brazil region (OPAS, 2009, p. 20).

The water quality is the main factor for the occurrence of this disease, because it can interfere in the presence of the vector, the conch of genus *Biomphalaria* (considered the most efficient intermediate host). The pollution caused by humans can result in the selection of the most resistant conches, and the residues of sewage dumped directly in the rivers favors the dynamics of transmission from the parasite *Schistosoma mansoni* in the conch, besides contributing to its proliferation in the environment, due to the increase of multiplication from the phytoplankton, which is the food of mollusks (VIDAL et al., 2011, p.372).

The High and Very high Indices on Priority of Attention for American cutaneous leishmaniasis vary between 49 and 244 cases for each 100,000 inhabitants (Figure 6C). As for Visceral leishmaniasis (Figure 6D), there are from 5 to 44 cases for each 100,000 inhabitants in the BAP municipalities for the period considered in this study. The World Health Organization (WHO) considers the Leishmaniasis an endemic infectious-parasitic disease of highest relevance, and a problem for public health (WHO, 1990, p. 9). The environmental conditions for the transmission of this disease are associated with the increase of temperature, reduction of rainfall and changes of vegetation cover (tropical forests) the social-economic conditions in these areas are related to the population insertion in them or of domiciles in risk areas (OPAS, 2009, p. 19).

Referring to American cutaneous leishmaniasis, the contact of the humans with the vector, through their insertion in occurrence areas of the vector, is one of the main factors for the appearance of disease outbreaks. According to the Ministry of Health (BRASIL, 2007b, p. 13), the American cutaneous leishmaniasis occurs in three epidemiologic profiles: sylvan (transmission in areas of primary vegetation); occupational or leisure (transmission associated to disordered forest exploitation or deforestation for the construction of roads, timber extraction, gold-digging, livestock activities, etc.) rural (area where the vector adapted to the domicile).

The American cutaneous leishmaniasis presented very high values of the index on priority of attention in the following municipalities of Mato Grosso state (Figure 6C): Nova Marilândia, Santo Afonso, Nortelândia, Planalto da Serra, Nova Brasilândia, Reserva do Cabaçal, Poxoréu, Arenápolis, Alto Paraguai, Guiratinga, Dom Aquino among others. Most of these municipalities presented a vegetation cover below 50% in its respective territory. In some of the Mato Grosso state municipalities which presented high indices on priority were formerly gold-digging areas such as Diamantino and Poxoréu. In Mato Grosso do Sul state, only the municipalities Pedro Gomes and Bodoquena obtained high priority indices and both had less than 50% vegetation cover.

The physiographic pattern of Visceral leishmaniasis has expanded to urban peripheries which had previously an eminently rural character (BRASIL, 2006b, p.11-2). Achados de Mestre e Fontes (2007, p.42) report the beginning of a Visceral Leishmaniasis epidemic in 1998, in the Metropolitan region of Cuiabá, in 1998, encompassing 34 municipalities until 2005. In this study a transmission pattern of the disease was verified, with its expansion to the interior of Mato Grosso state, following the migratory flow and the disordered urban occupation process. Oliveira et al. (2006, p.446) identified 149 cases of the disease in Três Lagoas (Mato Grosso do Sul state)

during the period 2000 to 2003, confirming the changes of the vector localization and alerting on the need for a diagnosis and early treatment of the Visceral leishmaniasis.

Regarding this aspect, the following municipalities of Mato Grosso do Sul stand out with the highest index on priority of attention for this disease: Rio Verde de Mato Grosso, Anastácio, Coxim, Rio Negro, Aquidauana, Bonito, Dois Irmãos do Buriti, Terenos, Bodoquena, Campo Grande, Camapuã, among others. Most of these municipalities presented a vegetation cover below 50% of its territory. In Mato Grosso state, the municipalities of Poxoréu and Rondonópolis presented the highest indices on priority for Visceral Leishmaniasis (Figure 6D).

Malaria (Figure 6 E) was one of the diseases with the lowest incidence in BAP, varying between 1 and 6 cases for each 100,000 inhabitants which occurred principally in the municipalities of Mato Grosso do Sul state. According to data from the Ministry of Health (BRASIL, 2001, p.4), over 60% of the Brazilian territory has favorable conditions for the transmission of Malaria, wherein 99% occur in the so-called Legal Amazonia region, due to factors such as: strong variability of precipitation which causes an increase of potential places for the procreation of the vector, change of vegetation cover and land use as well as the living and work conditions in the risk areas (ALECRIM; GONÇALVES, 2004, p.156).

The history of Malaria is related with the implementation of governmental economic development programs which aimed to expand and occupy territories to increase the agriculture production, and due to that, it is associated to the construction of federal highway axis. According to Matsumoto et al. (1998, p. 799), who evaluated in the 90's the transmission of Malaria in the BAP municipalities, verified 3,544 cases of it in the Mato Grosso do Sul State and 685 of this total in these municipalities, in the period 1990 to 1996.

One emphasizes that most of these cases were imported and that this situation occurred due to the presence of a worker contingent coming from northern Brazil. A decade after the conclusion of this study, the presence of Malaria is still verified, mainly in those municipalities of Mato Grosso do Sul state with very high indices on priority of attention and vegetation cover below 50% of its territory, such as: Sonora, Camapuã, Anastácio, Costa Rica, Campo Grande, São Gabriel do Oeste, and in Mato Grosso state, the municipality of São Pedro da Cipa.

CONCLUSIONS

Based on the environmental data analyzed, it is concluded that of the 86 municipalities within BAP, 56 had over 50% of the respective territory without vegetation cover and 31 presented deforested areas above 80% and low percentages of water bodies in 83 municipalities.

The highest temperatures remained restricted to those municipalities situated on the northern portion of BAP, which have favorable conditions for vector diseases of epidemiologic importance for Brazil.

The high average Dengue detection coefficients occurred in the municipalities within BAP in the Pantanal biome; Visceral leishmaniasis and Malaria in the Cerrado; Schistosomiasis and American cutaneous leishmaniasis in the Amazonia biome, evidencing a higher illness in these areas.

In this study, it was verified that Dengue was the disease with the highest occurrence, because it occurred in more municipalities with high Indices on Priority of

Attention, followed by American cutaneous leishmaniasis and Visceral leishmaniasis. The Schistosomiasis and Malaria were diseases with low incidence in BAP, if compared to all diseases investigated.

It is important that the information presented reaches the municipal decision makers and the resident population, because these are vulnerable areas for the transmission of these diseases. The optimization of resources, prevention actions and disease control guarantee a better quality of life for the resident population in the municipalities studied.

It is necessary to increase studies in the biomes with areas in the BAP directed to the entomology of vectors, epidemiology and social-environmental conditions of the investigated diseases analyzed, using geotechnologies to improve understanding of peculiarities from the pathogen transmission dynamics for each environment.

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