Spatial analysis of schistosomiasis human cases in the horticultural community of Zona da Mata of Pernambuco state, Brazil

Análise espacial dos casos humanos de esquistossomose em uma comunidade horticultora da Zona da Mata de Pernambuco, Brasil

Abstract

The objective of this study was to describe the spatial distribution of schistosomiasis in horticultural community of Natuba, district of Vitória de Santo Antão, Pernambuco state. It was conducted a parasitological survey, examined the fecal material of 310 community residents. The cases positive for *Schistosoma mansoni* were geocoded and included in the computerized template of the community, generating maps of spatial distribution with kernel estimators. The results showed a high prevalence of schistosomiasis, with 28.4% of the parasites. Other parasites were found in 25.8% of the population. The use of GIS tools to map and understand the possible distribution of cases of schistosomiasis in the space occupied by the community highlighting and listing locations of lower elevation (able to flooding), with a higher frequency of human cases. Studies like this provide information to the local health services, may intervene and bring about change for individuals living in areas with low housing conditions to minimize their exposure to risk of contracting schistosomiasis.

Keywords: Schistosomiasis. Spatial analysis. Epidemiology. Public Health.

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Resumo

O objetivo deste trabalho foi descrever a distribuição espacial da esquistossomose na comunidade horticultora de Natuba, Vitória de Santo Antão, Pernambuco. Foi conduzido um inquérito parasitológico onde se examinou o material fecal de 310 moradores da comunidade. Os casos positivos para *Schistosoma mansoni* foram georreferenciados e incluídos no croqui da localidade, gerando os mapas de distribuição espacial com estimadores de kernel. Os resultados apresentaram uma alta prevalência para esquistossomose, com 28,4% da população parasitada. Outros parasitos foram encontrados em 25,8% da população. O uso das ferramentas de geoprocessamento permitiu mapear e compreender a distribuição dos casos de esquistossomose no espaço ocupado pela comunidade, destacando e relacionando locais de menor altitude (passíveis de alagamento), com uma maior frequência de casos humanos. Estudos como este fornecem informações para que os serviços de saúde local possam intervir e promover mudanças para que indivíduos residentes em áreas com baixas condições habitacionais minimizem sua exposição ao risco de contrair a esquistossomose.

Palavras-chaves: Esquistossomose. Análise espacial. Epidemiologia. Saúde Pública.

Introduction

Brazil, a developing country, has public health problems due to the lack of policies oriented toward health promotion and education and due to the low investments in basic and environment sanitation, leading to not very healthy spaces for less privileged populations. Certain infectious-parasitic diseases are still quite widespread and have high prevalence rates in this socio-environmental setting[1-6]. Endemic diseases such as schistosomiasis mansoni are chronic in individuals infested at sites where the health status is a manifestation of unhealthy environments[7]. The space-time approach considers that sites have historical, social and political inheritances, and thus persisting endemic diseases may be represented by risky cultural practices molded throughout a long process of absence of health care[8].

By trying to understand the relationship between environment and health, the studies that approach the theme have successfully used geoprocessing tools to analyze hazards spatially, trying to assess the impact of adverse environmental conditions on the integrity of individuals in time and space[9]. Geoprocessing is a set of techniques to collect, show and treat spatial information, used along with Geographical Information System (GIS) and Global Positioning System (GPS) tools to develop appropriate models for the surveillance, forecast and prevention of risks for diseases[10]. Using maps has shown to be the best form of representation, as it gives the researcher an immediate and direct vision of the distribution of an event in space. Moreover, by using GIS, it is easier to check any spatial associations between health events and different aspects of the natural and built environment[11].

The World Health Organization (WHO) underscores the importance of identifying foci of transmission of diseases in environments of high prevalence and/or incidence of parasite infections, generating information to substantiate and support the implementation of health education programs capable of minimizing risks[1,12,13].

The search and identification of potential foci of parasite infections are extremely important to public health, given they can provide prophylactic and educational information to fight the forms of transmission and development of these conditions, mainly in regions where schistosomiasis is historically endemic, such as the Zona da Mata of Pernambuco, where several control strategies been thought of, although no advance has been sustainable enough for its control[14-17].

The present study aimed to describe the occurrence of parasite infections in the community of Natuba in Vitória de Santo Antão, Pernambuco, relating age group and work activity. Trying to evaluate the expression of schistosomiasis at the site through spatial analysis (spatial distribution, Kernel estimator and analysis of altimetry) was particularly pursued, given the location has had a scenario prone to the introduction and maintenance of the biological cycle of the *Schistosoma mansoni* for decades.

Methods

A cross-sectional analytical study was performed between October 2008 and March 2009 at the vegetable farming community of Natuba, district of the municipality of Vitória de Santo Antão-PE, located in the Zona da Mata of the state of Pernambuco, 45.1 kilometers from Recife, with a population of 896 inhabitants[8]. The referred community is crossed by the Natuba River, downstream to the South portion of the community, part of the Tapacurá water basin. River waters are used to irrigate and support daily household activities, such as washing clothes and leisure for the community. The climate is hot and humid, with an annual average temperature of 24.6ºC. The main route of access is the BR-232, a road of great economic importance for the state of Pernambuco. The vegetables grown by the community are sold at road sides and are also distributed to the markets of neighboring cities, making it one of the largest vegetable producing poles of the State of Pernambuco. The population of this region is in daily contact with the waters of this spring that harbors the snail vectors of this disease, due to work and daily activities. Therefore, most individuals are exposed to the risks of acquiring schistosomiasis and continuing its cycle.

The coproscopy survey was done by sampling, covering the entire community. EpiInfo 3.5.1 was used to calculate the minimum sample necessary to obtain results with statistical significance, with a 35% estimated prevalence and a maximum error of 5% for schistosomiasis in the community, based on a previous study[15]. A minimum number of 284 patients was established for a 95% level of confidence. Aimed at guaranteeing the reliability of results and minimizing the risk of bias due to sample loss, coproscopy was performed in 310 community dwellers.

The material for coproscopy was stored in a thermal box at 8ºC and transported to the Parasitology laboratory of the Associação Caruaruense de Ensino Superior – ASCES/FAAPE for processing. Parasitology feces tests were performed using two techniques, Hoffmann, Pons & Janner[19] and Kato-Katz[20], for each patient. Patients with any kind of parasite were duly referred for treatment. All households with cases of schistosomiasis were used for georeferencing for thematic and analytical maps.

A malacological survey was performed, electing the ridges of vegetable gardens as the site of highest exposure of farmers, given pools of *Biomphalaria straminea* were found. Graspers were used at the collecting stations marked at the ridges of the vegetable gardens, where all visible snails were captured. Collecting stations were georeferred by the Global Positioning System (GPS).

In order to identify the height of the flooded points, an altimetry resource of the GPS platform Garmin, eTrex model was used. All flood limits were marked, based on the visual recognition of field surveyors and on the report of community dwellers. In order to make the location sketch, a method described by The National Health Foundation

(FUNASA)[21] was used, according to the Geographical Indication guide. Group technicians systematically went through the community making the digital design of the locality. Data were transferred from the GPS to the computer and processed by GPS TrackMaker PRO software to correct polygons on the computerized template and to adjust for the virtual spectrum generated by trails. The river network map was purchased at the Pernambuco Technology Institute (ITEP). After treatment, points, lines and polygons were imported to the ArcGIS version 10(ESRI) software, where spatial analysis was performed. Descriptive data were analyzed by the EpiInfo 3.5.1 statistical package, using a p-value of 0.05 with a 95% confidence interval.

The Kernel estimator, a non-parametric technique that promotes statistical suavization generating chromatic gradients with "hot spots", was adopted for spatial analysis and identification of patterns of distribution and density of cases, given it concentrates the density of cases in a certain area. The gradient level is controlled by choosing a parameter known as band width (in the present study, 200 meters for positive cases), which indicates the area to be considered in the calculation and should reflect the geographical scale of the assumption of interest, and the previous knowledge on the event studied. The Kernel Polynomial 5 Interpolation with barriers technique, capable of generating chromatic intensity gradients was used for the interpolation between the dependent variable (case) and the geographical variable (elevation).

The study was registered at the Ethics in Research Committee of Associação Caruaruense de Ensino Superior (CEP/ASCES), approved by letter ACP nº155/08 CEP/ASCES. Volunteer participation of dwellers of the farming region included in the study was confirmed by the signature of the Consent Form.

Results

Of the 310 individuals analyzed, 190 (61.3%) had at least one parasite, *S.mansoni* having been the most frequent species, with a 28.4% frequency in the population studied (Table 1). The mean parasite load for *S. mansoni* in these individuals was 60.2 eggs per gram of feces (opg), ranging between 24 and 408 opg.

Polyparasitism was observed in 25.8% of the population studied, 58.7% of which with two parasites, 25% with three parasites and 16% with four parasites. Among age groups, the age group between 10-19 and

Table 1 - Prevalence of parasites in the researched population, Natuba, Vitória de Santo Antão, PE, Brazil.
Tabela 1 *- Prevalência das parasitoses na população estudada, Natuba, Vitória de Santo Antão, PE.*

Parasites	n	%
Schistosoma mansoni	88	28.4
Entamoeba coli	61	19.7
Ancilostomídeos	56	18.0
Entamoeba histolytica/dispar	42	13.5
Giardia lamblia	37	11.9
Ascaris lumbricoides	10	3.2
Endolimax nana	10	3.2
Hymenolepis nana	6	1.9
Trichuris trichiura	4	1.3
Enterobius vermicularis	2	0.6
Others	4	1.2

Table 2 - Infection percent of *S. mansoni* by age group, Natuba, Vitória de Santo Antão – PE, Brazil.
Tabela 2 - *Percentual de infecção pelo* S.mansoni *por faixa etária, Natuba, Vitória de Santo Antão, PE.*

Age group	Positivity (%)*
0 to 9	4.2 (n=1)
10 to 19	34.2 (n=25)
20 to 29	37.1 (n=26)
30 to 39	28.3 (n=17)
40 to 49	25.0 (n=10)
> 50	20.9 (n=9)

* P-value < 0.0321; χ^2 =12.2; gl = 5

20-29 years was affected most, with 29.6% of individuals infected by *S. mansoni* (Table 2). No significant differences were observed between the proportion of men and women infected.

Forty-three samples of snails of the *Biomphalaria straminea* species were collected during the malacological survey on the ridges of vegetable gardens. After the specimens were exposed to an artificial light source (60 w bulb) for 2 hours, the elimination of *S. mansoni* cercariae was not observed. Other species of snails at capture sites such as *Melanoides tuberculatus* and *Pomacea sp.* were also detected.

The computerized template of the location (Figure 1) shows the distribution of vegetable gardens and of *Biomphalaria* pools. Figure 2 shows the concentration of positive cases for *S. mansoni* in the community. Figure 3 has an interpolation map of cases with the elevation, which is related to the flood area highlighted at the location.

Discussion

In Natuba, the site built by the community for economic support is represented by a vast extension of vegetable gardens with irrigation ridges, a system that represents 75% of the local area. Vegetable gardens are irrigated with water extracted from the river by suction pumps and sprinkling hoses carry and spread the vector snails throughout the plantation. As the gardens are irrigated constantly, their side ridges are always soaked in water, forming excellent artificial pools where snails find food (lettuce waste) and reproduce themselves abundantly.

In 1998, Barbosa CS & Barbosa FS[15] had already registered that sanitary sewages from most homes drained into the Natuba River, leading to the contamination of the water environment, favoring the establishment and maintenance of the cycle of parasites like *S. mansoni*. The present study observed that the same sanitation and environment conditions remain and modulate the current local epidemiological landscape.

The flooding of the ridges where vegetables are cultivated creates the necessary and ideal conditions for the survival of *B. straminea*. Although this snail is considered a bad biological host for *S. mansoni,* as the exposure of farmers is intense and systematic, and due to their work activity, it guarantees the high prevalence and maintains the intensity of the infection in the community.

The non-shedding of cercariae in the lab from snails collected may be explained by the low susceptibility of this vector species[22].

A previous study performed at this location[15] registered 35.1% of the population infected by *S. mansoni*. On that occasion, all cases received specific medication for treatment. The population of Natuba can be considered stable, as it has owned the land for decades. And the fact that the present study diagnosed a prevalence of 28.4% means that the epidemiological

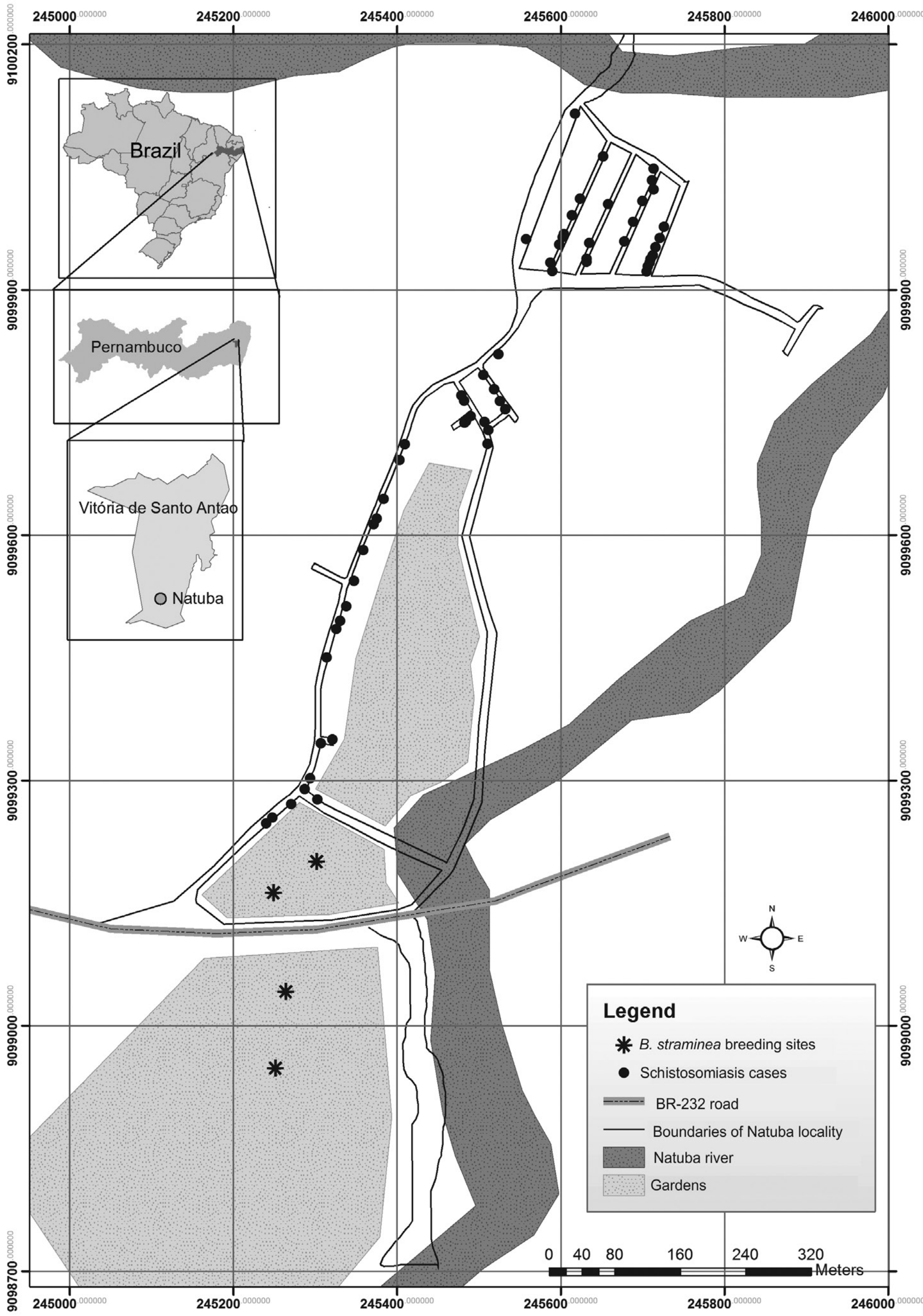

Figure 1 - Spatial distribuition Schistosomiasis cases at Natuba, Vitória de Santo Antão, Pernambuco, Brazil.
Figura 1 *- Mapa de distribuição espacial dos casos de esquistossomose em Natuba, Vitória de Santo Antão, Pernambuco, Brasil.*

pattern of contamination of the environment and infection also is stable, in face of the observation of the maintenance of the unhealthy environment and working conditions that promote the maintenance of cases of schistosomiasis and guarantee the chronicity of the disease in the community.

The occurrence of a higher number of cases of the disease in young adults may be related to their work, given that this age

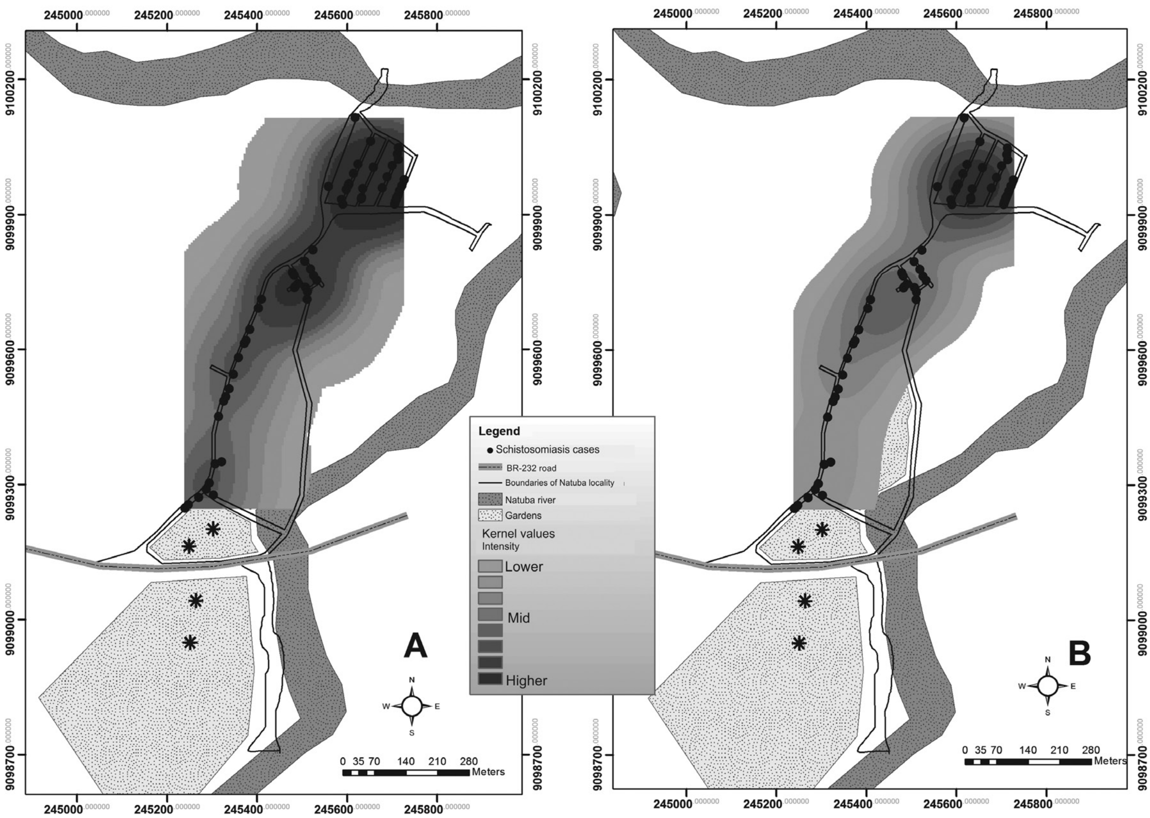

Figure 2 - Kernel estimator map, by location of human cases (A) and parasitary load (B), Natuba, Vitória de Santo Antão, Pernambuco, Brazil.
Figura 2 *- Mapa Estimador de Kernel segundo localização dos casos humanos (A) e carga parasitária (B), Natuba, Vitória de Santo Antão, Pernambuco, Brasil.*

group is more productive and, consequently more exposed, which can be corroborated by other studies[23,24]. On the other hand, schoolchildren (regardless of gender) were observed to be more exposed to activities related to using river water for leisure. The transmission model found in Natuba is similar to those identified in studies that approach eco-epidemiology, in which the understanding of the disease cannot be dissociated from the analysis of the space in which the individual is inserted[25]. The polyparasitism shown in the present study can be understood in a similar way to previous studies[26-28], in which there are the characteristics of living conditions and routine of individuals that live at sites with precarious sanitary conditions.

The theme map presented by Figure 2 shows that most individuals infested by the *S. mansoni* live in the north region of the location. In this region, there are important water collections that are potential natural pools for *Biomphalaria,* although they were not found there. The location of individuals infected near these rivers represents a favorable setting for the expansion of schistosomiasis to the site and to neighboring areas, putting in risk a part of the population living there and not comprised of farmers.

Figure 3 associates the distribution of cases with the geographical elevation variable, showing that the areas with lower elevations concentrate the highest number of cases because they are more susceptible to flooding by the overflow of the Natuba River during the rainy seasons, enabling contact of individuals with water and increasing the risk for schistosomiasis infection. This seasonal and occasional event probably represents a less

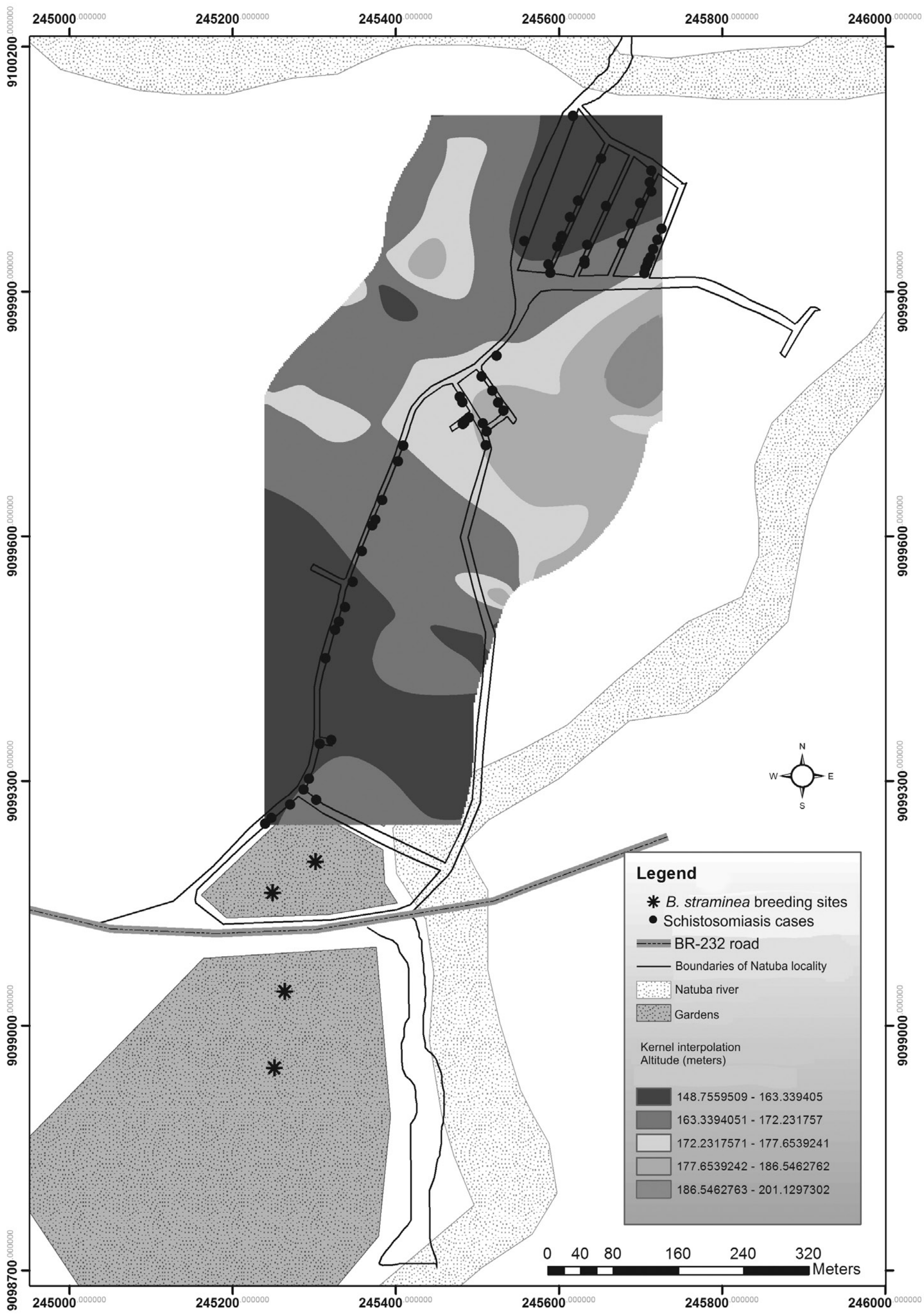

Figure 3 - Kernel interpolation map with altimetry attribute. Natuba, Vitória de Santo Antão, Pernambuco, Brazil.

Figura 3 *- Mapa de Interpolação de Kernel com o atributo de altimetria do terreno. Natuba, Vitória de Santo Antão, Pernambuco, Brazil.*

important impact on the transmission of the disease than the daily exposure of farmers in the pools of the vector snails detected in the gardens.

In general, using geotechnologies for building epidemiological settings is of great value for diseases such as schistosomiasis, that have a major environmental component in the understanding of their transmission[29,30].

The results of the present study indicate that the transmission of schistosomiasis at this site has remained throughout the years due to the geographical structure and work activities of the population, associated with the precarious sanitation conditions. Based on what was exposed, interventions for interrupting the transmission cycle should be based on improvements in sanitation and in the environment, such as basic sanitation and drainage of rain water, given the impossibility and inconvenience of promoting changes in the physical structure or in the work model of the community without affecting the local economy and disturbing the social order established there.

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