Landscape units as predictors of risk to public health, associated with the geospatial distribution of mosquitoes (Diptera: culicidae) in Ciudad Juarez, Chihuahua, Mexico.

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Abstract- This document presents the use of images of high spatial resolution integrated into the Geographic Information Systems in urban surroundings, as powerful tools in the prediction of zones associated with the vulnerability of arborviral diseases transmitted by mosquitoes. The landscape units associate physical factors that are superimposed to environmental, ecological and socio-demographic variables for the generation of risk maps. Preliminary results show that in the case of Ciudad Juarez, Chihuahua, the vulnerable zones correspond to the south and west areas, which are characterized by a rough topographic surface, by the presence of irregular human settlements, by a deficient infrastructure of public services and by a low quality housing.

Keywords: Mosquitoes, Geographic Information Systems, Landscape Units, Risk map

1. INTRODUCTION

The importance of mosquitoes (diptera:culicidae) as vectors of disease, lies in the fact that they caused the death of more than one million people annually, plus the economical loss associated to its control. In trying to produce a more efficient mechanism of vigilance, satellites of low spatial resolution have been used extensively to conduct studies of regional and continental distribution of vectors such as ticks and diverse groups of dipterous (Thomson and Connor, 2000). Some of the variables which are possible to detect are; temperature, location of water bodies, soil moisture, vegetation coverage and urban characteristics (Ragoni de Moraes, et al, 2004). Multiple works have been completed to try to associate socio-demographical or environmental factors with the abundance of mosquitoes, which are transmitters of arborviral diseases. (Beck, et al, 1997; Anno, 2000; Keating, et al, 2003). Some of the works have shown limitations due to the use of data gathering platforms of very low spatial resolution (Dale and Morris, 1996; Moloney, et al, 1998). With the discovering of high resolution satellite images, such as IKONOS and QuickBird, and its incorporation to Systems of Geographical Information (SIG), the possibility of defining risk zones associated to mosquitoes in urban zones, is increased. The objective of this work is to determine high risk zones vulnerable to the transmission of arborviral disease, by association of landscape units and ecological, environmental and socio-demographic factors.

2. METODOLOGY

2.1. Study site

Cd. Juárez is a Mexican border city located to the northwest of the Juárez municipality of the State of Chihuahua, which represents 1.4 % of the entire surface of the state. Located 22" 31 44 ' north latitude and 106 26 ' 29 " east longitude and a height of 1116 msnm.; it is delimited by the elevations of the Sierra de Juárez to the west, Sierra del Presidio to the east, Sierra de Samalayuca to the south and the United States of North America to the north, with the Rio Bravo as the geographical border. Its climate is very dry (BWk) with an annual average temperature of 18.0°C, reaching the highest temperatures in June, July and August, when extreme highs of 41.0 ° C are registered. The average precipitation is 264.5 mm per year, with torrential rains in the months of July to September (INEGI, 2001). The population of Ciudad Juárez is between 1 ’ 187275 and 1 ’ 330000 inhabitants (INEGI, 2001; SEGOB, 2001) and, as any border metropolis, its deficient urban planning has originated irregular settlements in zones where access to public services, such as sewage, drinking water and trash collection is very difficult. (SEGOB, 2001).

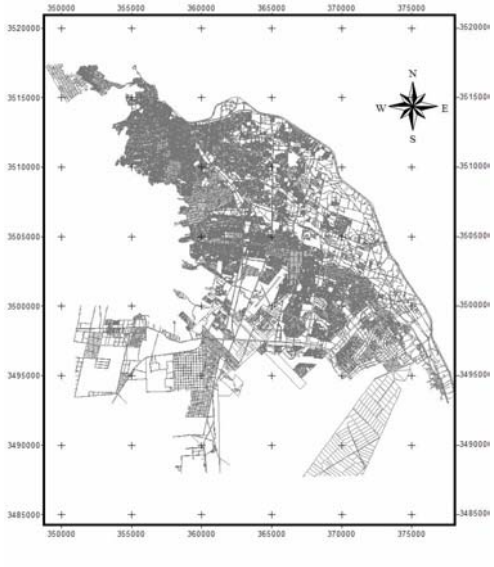

Figure 1. Geographical location of the zone subjec to the study.

It is believed that Ciudad Juárez, Chihihuahua, is vulnerable to arborviral diseases due to various reasons such as, a high immigration rate, high population, increase of artificial breeding grounds, eco-climatological conditions, a deficient urban infrastructure and the presence of species of mosquitoes considered as principal vectors of Dengue and the West Nile Encephalitis.

2.2. Base map

With the information obtained from various databases; Instituto Nacional de Estadística y Geografía (INEGI), Instituto Municipal de Planeación e Investigación de Juárez (IMIP) ,Centro de Información Geográfica de la Universidad Autónoma de Ciudad Juárez (CIG) a base map was completed. A unit of cartography of 1:50,000 was used, and considering different physical aspects (geology, physiography, climate, elevation), which permitted the boundary and later characterization of the Landscape Units. High resolution spatial satellite images (QuickBird 0,6 m) were classified and thematic maps were generated with the use of software eCognition to consider water bodies, shrub and arboreal vegetation as well as uncultivated lots as artificial breeding grounds. The AGEBS (Geographic Area of Basic Statistic) were classified according to variables associated to the urban development of the city using the data of the General Population and Housing Census of 2000. A risk index was completed considering the following parameters, which literature associates with the frequency of the vector as well as the frequency of arborviral diseases: population density (low, medium and high), housing density (low, medium, high), precarious condition of construction in housing (low, high), drainage system, potable water and paved system (yes, no).

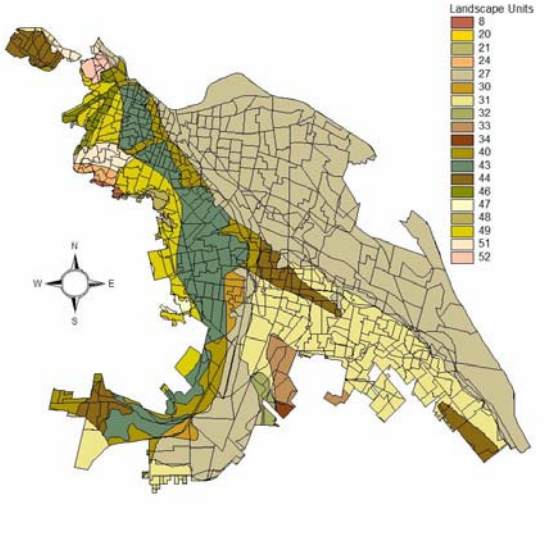

Figure 2. AGEBS included by landscape units.

2.3 Results and Discussion

Nineteen units of the landscape were obtained, as they appear in Table 1 and Figure 2, with variations from mountain to plains slightly dissected.

Table 1. Landscape units associated with the urban zone of Cd. Juárez, chih.

Key	Category	Origin
8	Mountain Slightly Dissected (100-250)	Lutita-Sandstone
20	Small hills and valleys strongly dissected (80-100)	Limestone
21	Small hills and valleys strongly dissected (80-100)	Limestone-Lutita
24	Small hills and valleys strongly dissected (80-100)	Lutita-Sandstone
27	Waived plain moderately dissected (5-10)	Alluvium
30	Waived plain moderately dissected (5-10)	Conglomerate
31	Waived plain moderately dissected (5-10)	Aeolian
32	Waived plain moderately dissected (5-10)	Lacustrine
33	Waived plain moderately dissected (2.5-5)	Aeolian
34	Waived plain moderately dissected (2.5-5)	Lacustrine
40	Hilled plain moderately dissected (15-20)	Alluvium
43	Hilled plain moderately dissected (15-20)	Conglomerate
44	Hilled plain moderately dissected (15-20)	Aeolian
46	Hilled plain moderately dissected (30-40)	Alluvium
47	Hilled plain moderately dissected (30-40)	Limestone
48	Hilled plain moderately dissected (30-40)	Limestone-lutita
49	Hilled plain strongly dissected (30-40)	Conglomerate
51	Hilled plain strongly dissected (30-40)	Lutita-sandstone
52	Hilled plain strongly dissected (30-40)	Tonalita

The classification of thematic maps with eCognition (Definiens Imaging GmbH Munich, Germany) allowed the determination of vegetation coverage, bodies of water and uncultivated lots which had artificial breeding grounds for each AGEB to be including in the determination of the risk index.

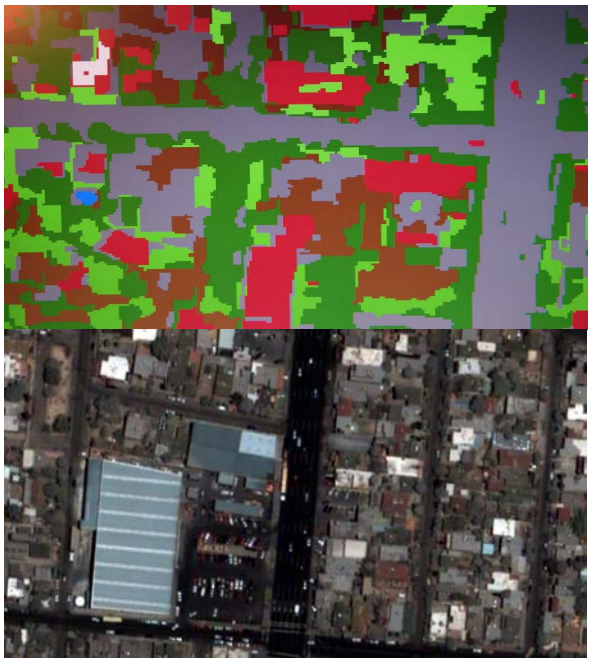

Figure 3. Quickbird image of a section of an urban area.

Finally map 4 shows the classification of the AGEBS according to the determining risk variables in three categories: low, medium and high.

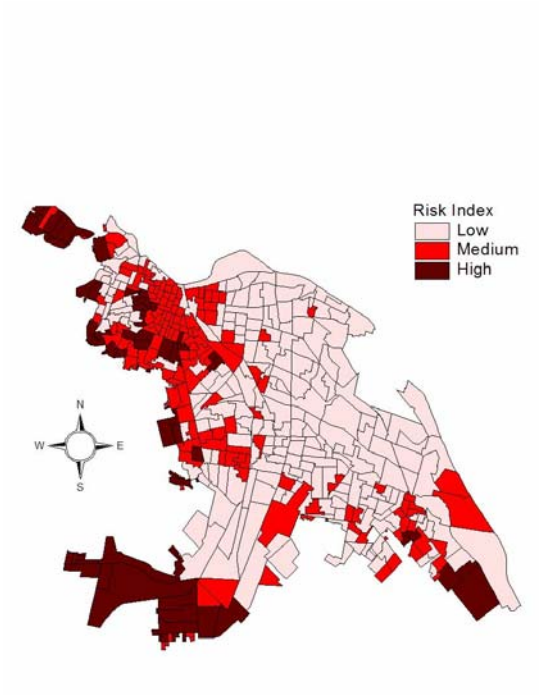

Figure 4. Risk zones associated to the vulnerability of arborviral diseases.

By the integration and space analysis of the different coverage, it is predicted that the risk zones are located in the south and west regions of the city, characterized by irregular human settlements, rough topography and a deficiency of public services. These are the areas where the preventive and vector control actions should be directed. Similar studies have been carried out in other cities in Latin American, Africa and Asia (Perez, et al, 2003; Botinelli, et al, 2002; Keating, et al, 2003; Nagao,et al, 2003). A second part of the study includes a corroboration of the selected areas of risk by an intensive field collection of adult and immature mosquitoes

3. CONCLUSION

The preliminary results allow us to conclude up to now, that the high spatial resolution images in a GIS are a powerful tool that allows a more efficient utilization of the few resources that the developing countries have. The goal is to carry out prevention programs, monitor and control mosquitoes of medical importance.

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