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APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEM AND REMOTE SENSING FOR MOSQUITO INTERVENTION- A CASE STUDY OF GREATER HYDERABAD CITY, INDIA

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ABSTRACT

Application of remote sensing technology and dreadful diseases but also creates severe Geographical Information System (GIS) is a potential tool to explore all the minute details. The objective of this study is to identify the potential mosquito larval habitats by using satellite images of IRS-LISS-IV digital data which will reveal the information on false colour composition. Analyses of this image through their pixel values captured at different substances are evaluated by ground truthing. The pixel values shows 79% of mosquito larval sites are positive.

KEYWORDS: Remote Sensing, Geographical information, Mosquito intervention, Musi River.

1.1 INTRODUCTION

In recent years, vector-borne diseases (VBD) have emerged as a serious public health problem in most of the countries including India. Health Information System (HIS) is one of the best preventive methods to control the vector borne diseases. Govindraj *et al.*, 2011. Most of the Developed countries are applying this system to form their own policy levels to mitigate the mosquito problem. In India, applying GIS in health sector has just begun. Mosquito not only transmit annoyance and become cause of concern for human beings. Mosquito have got highly diversified breeding habitats and poses a challenging task for mosquito control programme. Potential larval habitats of the mosquito can be identified by using remote sensing and geographic information system (GIS) analysis. The present study area is the River Musi and Miralam tank of Hyderabad city in Andhra Pradesh. On satellite image previous studies have shown benefits of using remote sensing and GIS application in identification of vector habitats through landsat mapping (Hayes *et al*., 1985; Linthicum *et al*., 1987; Masuoka *et al*., 2003; Townshend *et al*., 2000). However, these studies have focused on identifying and mapping vector habitats, or assessing environmental factors related to vector habitat quality, but could not have targeted mosquito larvae. It is difficult to identify all the larval breeding grounds on conventional grounds, but geospatial mapping with the help of remote sensing is a potential tool to identify the mosquito larval breeding habitats just a finger tip away. This study is intended to assess potential larval habitats through pixel values by using IRS LISS-IV imagery in the Hyderabad city.

Though, sometimes some physical beerier may interfere with the clarity of satellite image and some mosquito prefers to lay eggs at vegetative habitats. For example to larval habitats of *Culex tarsalis* are often associated with vegetation growing at pond edges. More specifically, the edges of small water bodies where vegetation and other debris are concentrated are identified as larval microhabitat, Rogers *et al.*, (2002). Large water bodies (usually larger than 4 ha) are usually exposed to wind and generate wave action similarly running water such as a river or stream, are not suitable for mosquito breeding**.** Open waters like ponds and lakes are unsuitable for larva and vulnerable to predation (1988) due to prey and predator relationship. The pixel (area) can have its effect those around it, particularly through scattering**,** Barnes *et al*., (1979). However, in the preset study AVHRR (Advanced Very High Resolution Radiometer) data set has focused on identifying and creating maps of mosquito larval grounds (15). In the present study area mosquito menace has been undergoing significant increase in large number of mosquito biting density. In this study we have categorized distinct water classes were in turn used to identify suitable larval habitat sites through pixel values. This initial habitat classification was done by using knowledge-based GIS techniques requiring spatial data. Accuracy assessment was carried out by using field data and high-resolution image of IRS-LISS-IV.

The present study area covers the geographical area of 17 km length of the Musi River in Hyderabad. Remote sensing covers vast area, including un-surveyed and inaccessible areas and thus helps in understanding the breeding and spreading patterns of mosquito larvae spatially, Rekha Saxena *et al.*, (2009). Survey of Indias toposheets and thematic maps, base maps, roads network and water logged area are quite useful for this study (Thomson *et al.*, 1996). Multidated satellite imageries of LISS III were used in January 1998 M.Govindraj *et al.*, (2011) and by taking this as reference, LISS IV imager of August 2011 was used in the present study to identify mosquito larval breeding grounds. This study is useful in developing a health information system by studying landscape ecology and vector biology. Arc GIS and remote sensing technology is used for the identification of high risk areas for the control of vector borne diseases which provide excellent means for visualizing and analyzing data revealing trends and inter-relationship for better analyzing of images for mosquito larvae. In this paper the relationship between mosquito larva and image has been discussed.

2.1 MATERIALS AND METHODS

Field Study Area: Field study was considered with the satellite image undertaken to identify mosquito larval habitats of the River Musi from Uppal to Miralam water tank a stretch of 17km. Mosquito larvae were collected along river and pond edges by using a standard dipper at 105 positions at the same time and fiend images were captured with manual camera. For each site, four dipping were taken apart every 5 m with a total distance of 17 km from Uppal to Miralam water tank. Sampling coordinates were recorded using a geographic positioning system and transformed into a GIS data layer. The public feedback has been taken in the area surrounding the Musi River and found that the area is full of mosquito menace. Even the survey at the hospitals states that there is more number of malaria and dengue cases reported from Hyderabad Municipal Corporation area.

Data and Software used: For the study of larvae, the following two images were used**,** 1.IRS-LISS-III.2005, November and 2. IRS-LISS-IV.2012, 21 August. For the analysis of the pixel values GIS software and ERDAS (Earth Resource Development Analysis System) were used IRS LISS-IV satellite image timings on Aug 2012 was morning 8:40 am to 10:20 am at 16o, 54 latitude north and 77o,21 latitude east in Hyderabad.

Satellite data: Software and was used to establish the GIS for the study area. Thematic maps were generated using ArcGIS 9.2 software. Remote Sensing and GIS was used to develop spatial and temporal data in the form of geographic coverage and descriptive information associated with the mapped features. Image classification and vector analysis was used to refine the identification of Pixel value, by using *ERIDAS.*

Remote sensing: Remote Sensing data is commonly used in diverse discipline such as Agriculture, Forestry, geology and Environment planning. In this study Remote Sensing is used to monitor environmental condition that influences the pattern of mosquito larval density (Ceccato *et al.*, 2005; Hassan and Onsi, 2004). Remote Sensing can be analogue (photography) or digital (multispectral scanning, thermograph, radar). The elements of a digital image or basic unit in an image are called resolution cells or pixels (after the creation of the image). The use of remote-sensing data requires some knowledge about the technical capabilities of the various sensor systems. The technical capabilities of the sensor systems can be listed according to the size of the smallest object that can be detected in an image. One meter spatial resolution in each pixel image represents an area of one square meter. The smaller an area represented by one pixel, the higher the resolution of the image.The satellite data of IRS-LISS- IV image (acquired 21 August 2012) with ground resolution of 5 × 5 m multispectral image was processed using ERDAS (Earth Resource Development Analysis System).

3.1 RESULT AND DISCUSSION

Position numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Pixel values	114	95	95	93	95	95	94	95	95	95	100	95	101	95	95	94	95	93	95	95	94
Position number	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Pixel values	95	95	95	95	100	95	95	95	113	95	96	95	97	95	95	95	95	95	99	95	95
Position number	43	444	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
Pixel values	100	94	95	95	98	95	95	99	95	95	99	95	98	95	95	95	97	95	95	95	102
Position number	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Pixel values	95	95	95	95	95	94	95	101	95	95	95	95	95	99	95	99	99	95	99	95	95
Position number	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Pixel values	95	95	104	95	95	95	95	95	95	95	95	95	95	95	101	95	100	95	114	95	99

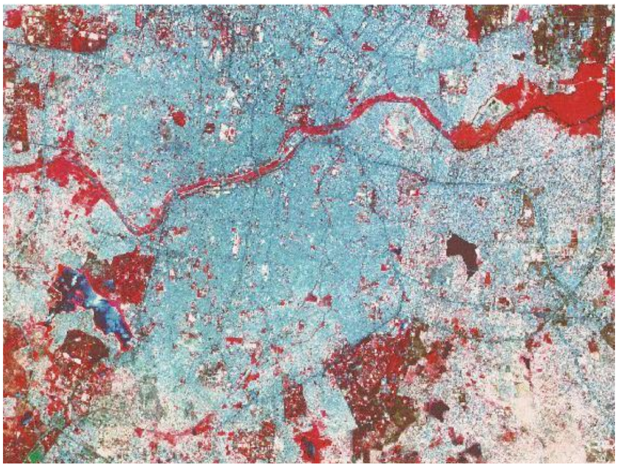


Figure.1 Raw data LISS: IV image.

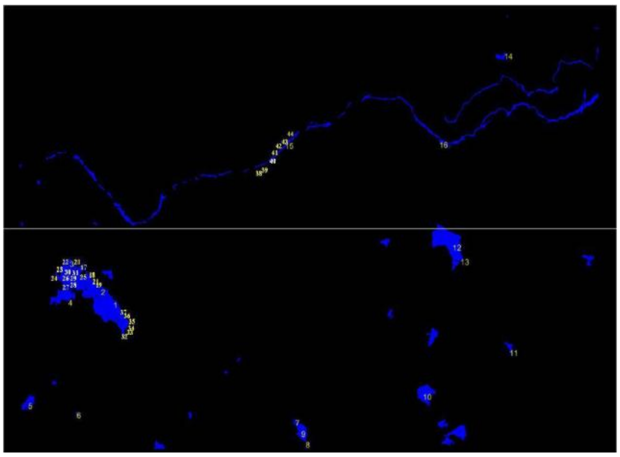
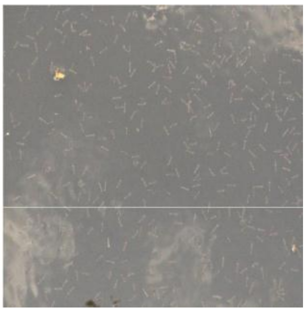


Figure. 2 GIS Analysis.

Position no 57



Position no 66

Position no 72

Position no 83

Figure. 3 Mannual images of mosquito breeding sites.

Image Classifications

The false colour composite image of a typical larval habitat was considered as a mosaic of several dark Pixels (water) and adjacent to red Pixel (vegetations) and AOI (Area Of Interest) was delineated by selecting Pixel of known Larval positive sites. Identification processes of very small water bodies, usually has smaller DN (Digital Number) values 2 to 3 which were not properly classified as open water, because they are mixed pixels in images. Small standing water bodies have a greater potential for larval development than large open water bodies, so identifying and classifying small water bodies is important and challenging through pixel values. The analysis of data by high spatial resolution satellite sensors has potential in land cover monitoring (water bodies). Therefore attention was given to the selection of an appropriate spotting of water bodies and vegetation classification. The use of a Geographic Information System (GIS) allows further spatial analysis of the data derived from remotely sensed images and analysis of the impact of land cover change on regional sustainable development. The satellite-derived data used in this study is Thematic Mapper (TM) data acquired by IRS-LISS-IV, 5x5m resolution on 21Augsust 2012 in Hyderabad. The results obtained for larval habitat through pixel values is shown in Table-1.

Data analysis

Initially water bodies were classified into spectrally distinct water and vegetation classes, which were in turn used to identify suitable larval habitat sites. This initial habitat classification was refined using knowledge-based GIS techniques requiring spatial data and field data in this area. Ground truthing assessment was carried out by using field data and high-resolution data (5 Mt Resolution) IRS-LISS-IV images. The classifier can identify likely habitat for ponds, Musi River from Miralam tank to Uppal for increase in potential larval habitats.The particular area in the water body where the larval density is more has been identified and the results given in the tables from 2009 to 2011 shows that the areas included in circle 5, 9 and 10 are having more number of larval density and cases of mosquito-borne diseases as these areas are near the water body (MUSI RIVER) and Miralam tank. Understanding the interactions between water, vegetation, mosquito breeding habitats and land use patterns, the environmental conditions and mosquito-borne disease and their occurrence is highly significant. Collection and analysis of the data from study area and topography of drainages and other water bodies at a faster pace, to match the speed of change in mosquito density and epidemiological situation is positively correlated.These are the state of art techniques in the field of environmental studies and spatial epidemiology for the study of vector ecology in disease transmission**,** Ceccato *et al.*, (2005). Surveillance and subsequent disease burden associated with the study of vectors are becoming more useful and dynamic through the integration of spatial, ecological and epidemiologic data, Rekha Saxena *et al.*, **(**2009). Geographic information system (GIS) is a powerful computer mapping and analysis systems for studying spatial patterns and processes which are applicable to numerous disciplines including the study of mosquito larval ecology, John *et al.,* (2006).

GIS may be used to map and analyses the spatial distribution of pixel or DN values related instantaneous field of-view (iFOV) on satellite image (Barnes and Cibula,1979.) and to assess the ecological factors that contribute to observed distribution of breeding grounds as show in Figures 1, 2.

A detailed understanding of what drives heterogeneities in the distribution of mosquitoes and mosquito-borne diseases can help to design most efficient control programs that maximize the use of limited resources. In this study it is attributable the disease burden and mosquito density. With the use and analysis of data obtained by contemporary technology based on GIS and RS, it is possible to get relevant data on the location of the mosquito larval sites to estimate the mosquito density, employ optimal techniques to create a rational, environmentally friendly strategy to control the nuisance mosquitoes and vector-borne diseases (Charoenpanyanet; Barnes and Cibula 1979). By using this method the larval formation in water bodies (Musi and miralam tank) has been studied at 105 sites, out of which 73 areas (as show in table-1) have been found to contain the larvae after ground truthing with manual images. The pixel values of these areas are verified and found that the values are same at all 73 points. The results thus provide very useful information to identify mosquito larval positive sites in water bodies. Mosquito larval points are randomly selected in this image. The ranges of possible values are from 0 to 255 in which value 95 states a positive result. Typically zero is taken as black and 255 are taken as white. Values in between this make up different shades of gray.

The present report provides brief overview of the use of Remote Sensing and Geographical Information System (GIS) to the environmental problems, mosquito surveillance programme and management of mosquito control interventions (Figure 3). It also shows how Geographic Information System combined with remote sensing have the potential to assist in water bodies for vector density and so as to minimize disease outbreak, Pedro Lopes *et al.,* (2005).

Though the most effective mosquito control interventions on large scale to preventing larval spread are by larviciding and adulticiding, but they are much expensive and also cause environmental pollution. By using remote sensing and GIS effectively and efficiently mosquito larval control can be target oriented in achieving the task at less cost. Hence in this study GIS and remote sensing is utilized to carry out efficient larval identification. The mosquito larvae seen in the water bodies at random points in the ground truthing are compared with the values of satellite images by GIS analysis. The pixel values at the maximum points are found to be same as that of image. Majority of the pixel values at the point 95 indicates that the mosquito larvae are existed along the study area. The characters found after image analyses and Ground truthing are statistically correlated and high significant.

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