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Mapping of Mosquito Breeding Areas with Risk Levels using Decision Rules for Guntur Urban, Andhra Pradesh Based on Land use Parameters

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Abstract: Dengue is one of the prevalent diseases present even in this technology-driven society, diseases that are rampant in earlier as prevalent diseases are compromised can address through the latest research. Dengue is mainly caused due to Aedes Ageypti mosquito mostly breeds around the houses of the residents precisely with improper storage of water and ill-conditioned places that enhance the ability of the mosquito to maintain high breeding rate and prevail the disease. This study utilizes the land use/cover (LULC) application to develop the decision rules using Boolean overlay operations that can generate the risk maps using on the factors Dense Vegetation, Sparse Vegetation, Water bodies and urban area cover [19]. These risk factors are generated using polygon overlay and further categorized into high-risk, moderate, and low risk depending upon the vulnerability of the region. The study is conducted in the Guntur Urban of state Andhra Pradesh, wherein the LULC scenarios are investigated by using Google earth imagery [1] for Guntur urban, Andhra Pradesh.

Keywords: Dengue, Overlay, Decision rules, LULC, risk, Boolean, and GIS

I. INTRODUCTION

In recent years the outbreak of the dengue has spiked throughout the world, people with low immunity are easily prone to this disease and even leading to death. Various remedial measures are being taken up by policymakers to control the disease outbreak. To complement the efforts of related departments, maps are one of the crucial tools that identify various risk locations [17] in the study area and helps concerned health workers to plan strategies to reduce the disease.

Static risk maps are created with mosquito behavior associated with static parameters such as

1.Water bodies
2.Semi urban croplands
3.Dense Urban Vegetation
4.Urban open lands/Sparse Vegetation

The above static parameters are suitable for mosquito habitats and conditions promoting mosquito breeding [18]. The prime importance in dengue mapping is the association between dengue incidence and distance from housing to breeding sites that have been documented from different points of the world where different vectors play a role in dengue transmission. These parameters are quantified by (Hoek et al.,) suggesting the use of a nominal distance of 750 m as a cutoff point for delivering a risk map of dengue in Sri Lanka.

As per Hoek et al., we considered a 1 km buffer region around four parameters, such as water bodies, dense urban vegetation, sparse vegetation/urban open lands, and semi-urban croplands

II. METHODS

A.Study Area

Guntur urban is the most populated area in Andhra Pradesh. Some part of the capital area is covered under Guntur urban. The total geographical area of Guntur urban is 88.5 km2, and population density is 5239 persons for km2. The average temperature in the region varies from warm to hot. During April & May this region witnesses scorching temperatures, but this scenario changes when monsoon enters in June. The months from November to February are a winter season with a relaxing climate. These months are mostly arid with minimal rain. July is the dampest month of all. The 28.5oc is the average annual temperature with rainfall measuring about 905 mm. Usually, in the rainy season; cyclones and storms are frequent starting from early June. Storms/Floods are unpredictable that occurs in any month of the year, whereas the incidence is higher from May to November.

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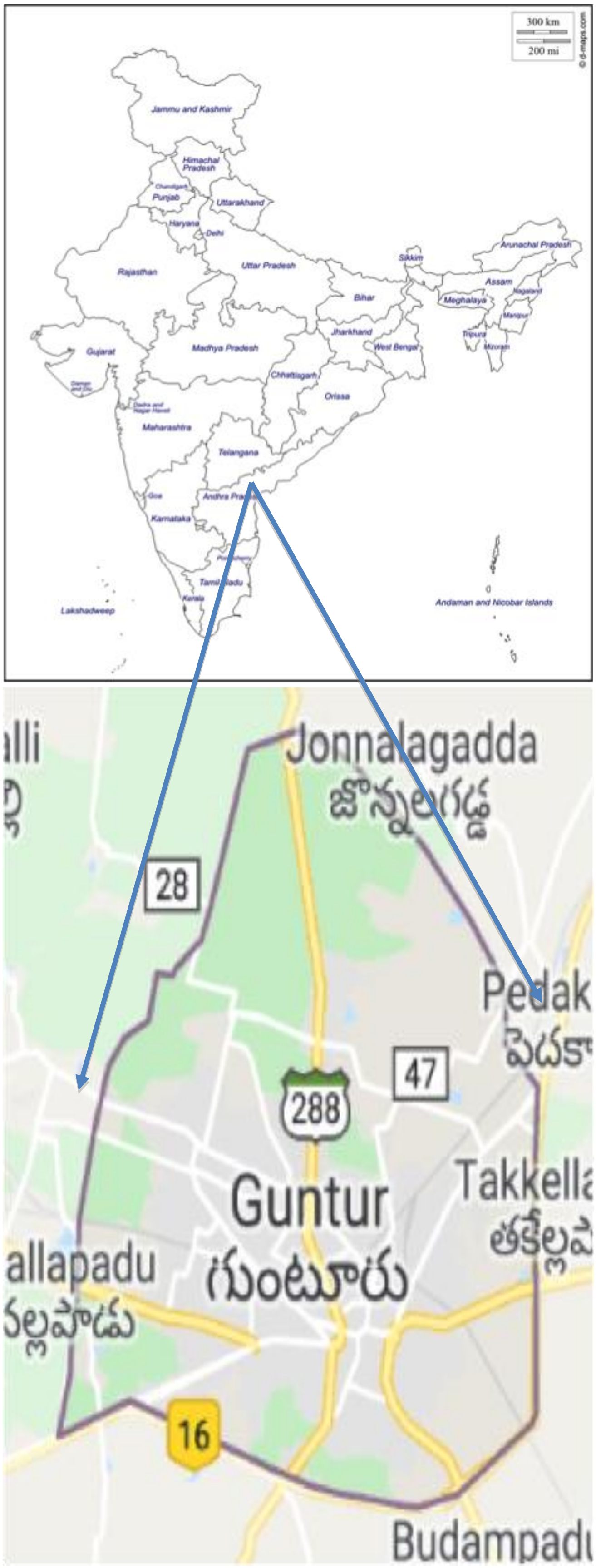


Fig 1: Map of study area.

2.(a)

2.(b)

Fig: 2(a) shows the Google map of Guntur Urban 2(b) shows the GE satellite image of Guntur Urban

After the Geo-referencing of Google Earth image, supervised image classification [7] was done.

B. Data Acquisition

For this study, Google Earth data [15] as on 23rd May 2015 was used for image classification, as shown in fig 2. The spatial resolution of the image is 1.40 meters. QGIS 2.18 Software was used for classification.

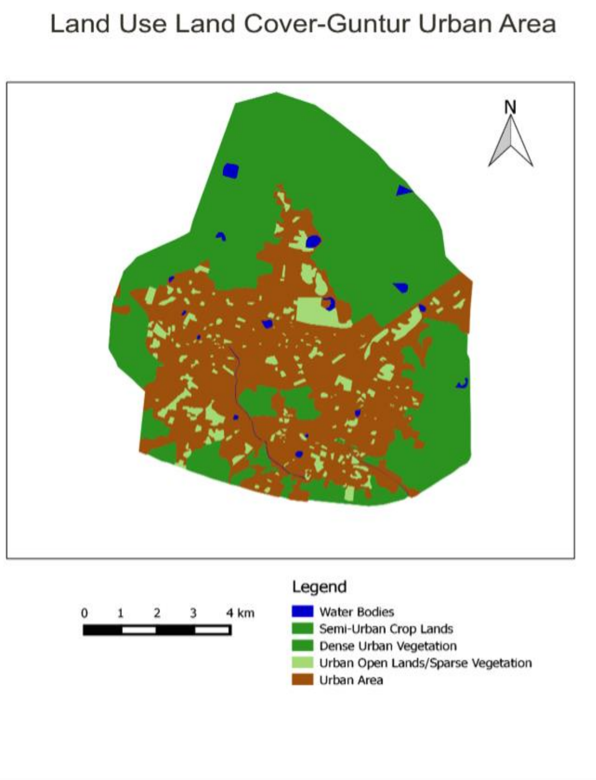


Fig 4 : Shows the Land Use Land Cover –Guntur Urban Area [2]

Wherein, the researcher tame the system to identify features that are available in the obtained data by recognizing image elements that represent its style of representation or location's cover determinants [2] that it correlates. The identified determinants then used in the process of classification after every tiny cell is fit into the land cover class based on resemblance.

Products of this process being a thematic map, the comprehensive information pertain to statistics in related to land use are incorporated [3] in a GIS map.

C. Overlay

The traditional approach to overlay is one of comparing polygons on Coverage (common intersection part after overlaying the maps) to polygons on another average (a combination of the overlaid maps). The predominance of polygon overlay produced among GIS systems today derives from the practical considerations for the early GIS work carried on under the Canadian government during the development of CGIS. Thus, we can infer that many varied approaches are carrying out the polygon overlay operations, each answering user-specific needs. Creating user-specific solutions enables us to undertake a vast area of application properties. The first task of the health planner is to determine what areas should be zoned against urban land uses. After researching the other requirements, planners create maps detailing the quality of selected parameters like water bodies, dense urban vegetation, and sparse urban vegetation and semi-urban croplands. In the preceding examples, all the variables in each cover are weighted equally and could formally be called exclusionary variables; those are the aggravators that are resisting the throughput of an unique type of activity within places that they spread.

Although this method of overlay comparison is ubiquitous, it is somewhat limiting to users because of the Boolean logic and the nominal level of the data applied to the variables. In many applications of the overlay, we find that the discrete reaction produced by Boolean logic and contrived. We could modify our analysis by assigning higher importance to areas on the map that exhibit conditions of the parameters. This approach, which we call as a Boolean based overlay, has the freedom to assign weights to respective variables to account for the varied effects may influence our decision.

In this research, all the determinants assigned equal weights because all the determinants have got equal importance. As far as mosquito-breeding sites are concerned, those are concluded as favorable locations for mosquitoes, and those intersections of all four features give high risk, three features give elevated risk, and two features give moderate risk. Since all features got the equal weight, the rank 4, 3, and 2 carry high, elevated, and moderate risk that can explain the suitability for mosquito breeding.

Algorithm:

Risk Identification through decision rules

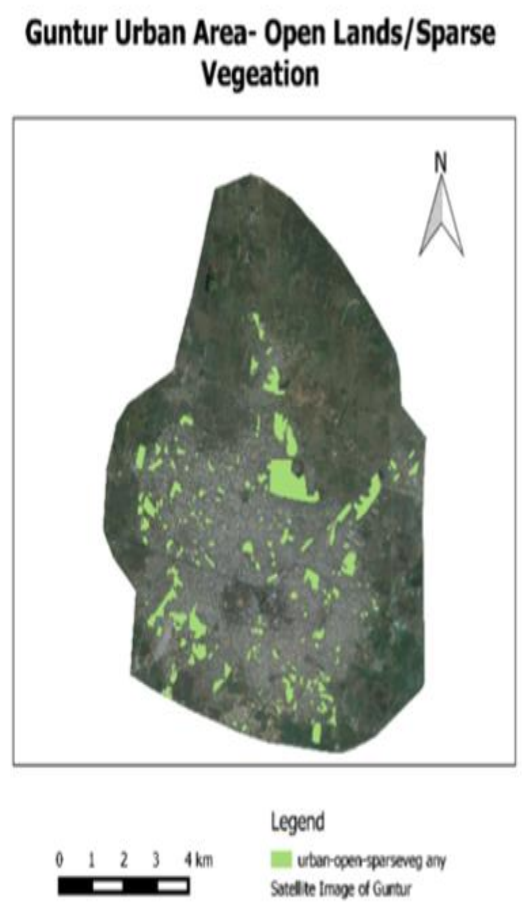
```
Begin
Input a, b, c, d
// where a, b, c, and d are risk parameters
//All risk parameters are equally weighed i.e.1
// If Land Use parameter is present weight=1 else
weight=0
//Where X=Risk Level
X ← a+b+c+d
If(X==4) then
Write "High Risk"
Else if(X==3) then
Write "Elevated Risk"
Else if(X==2) then
Write "Moderate Risk"
Else if(X==1) then
Write "Low risk"
Else Write "No risk"
End
```

Decision rules formed based on the risk parameters illustrated by the land use parameters. In this research, all the land use parameters have given equal weights i.e., one as this study has taken the grid size of one Square Km. Based on the algorithm, if a grid found four land use parameters in the taken size. It would be 1+1+1+1 = 4, which is probable high area for mosquitos to breed their eggs; if the decision rule gives an output 3, that would be elevated risk for human, then two risk parameters in a sample size shows moderate risk for human, and the value on 1 shows low risk, finally, if no land use parameter found in the selected grid – no risk for human pertain to mosquito breeding.

D.Classified layers based on Land-Use features

5.a.

5.b.



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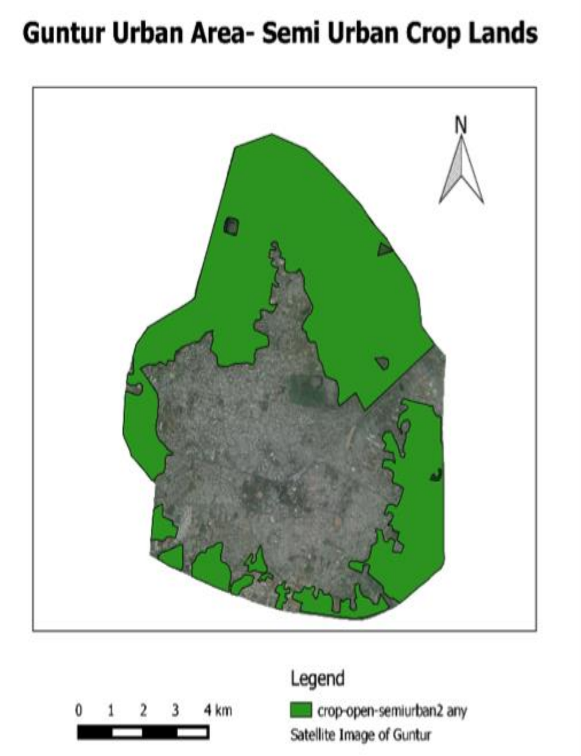

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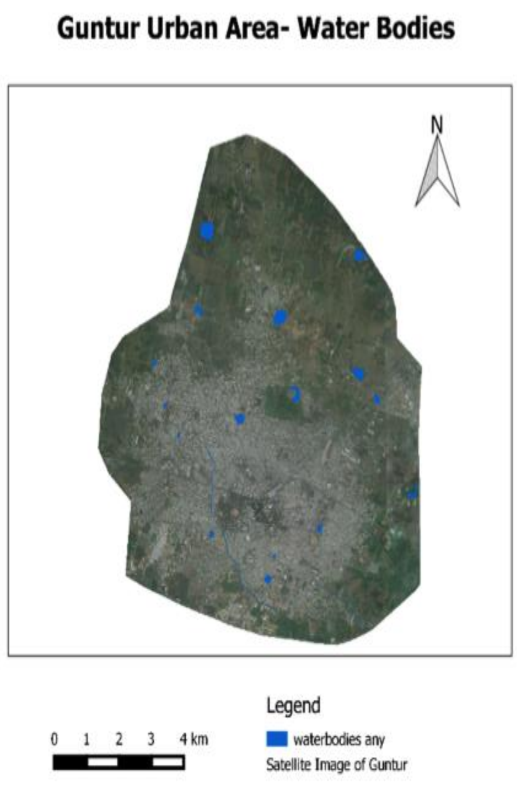
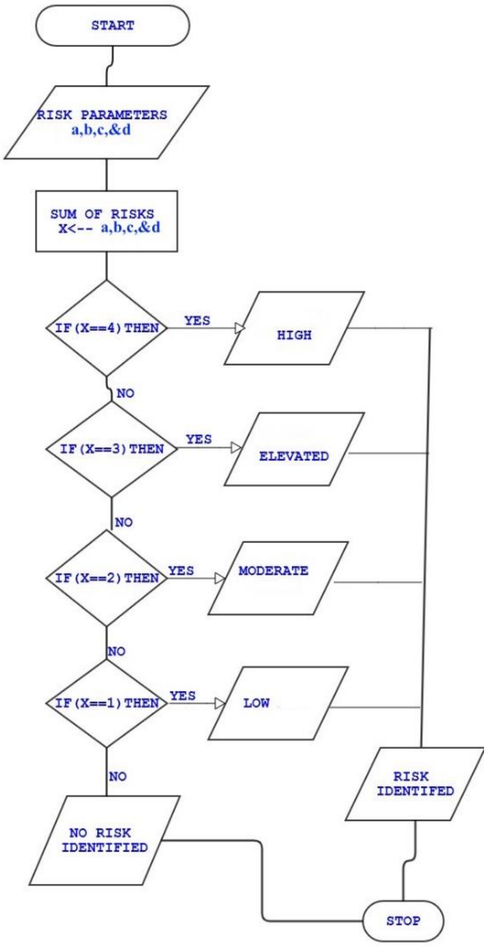


Fig. 5.a. Dense Urban Vegetation, Fig. 5.b. Open Sparse Vegetation, Fig. 5.c. Semi Urban Croplands, Fig. 5.d. Water Bodies.

E. Flowchart for the decision rules:



III. RESULTS

After employing the decision rules on the prepared layers of the determinant factors, risk is obtained for visualization.

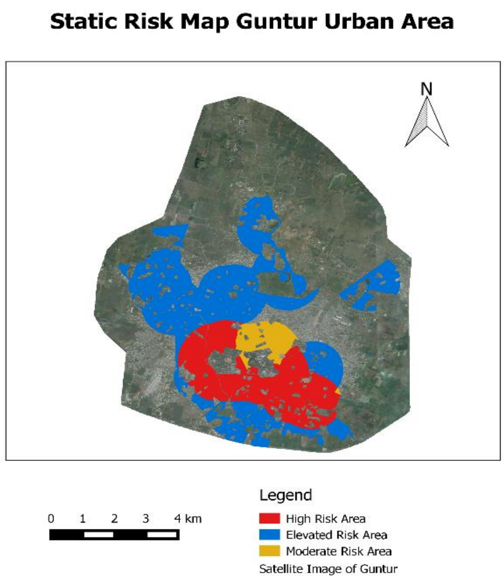


Fig 6: Shows the Static Risk Map of Guntur Urban Area

High Risk Zone:

Intersection of 1 km buffer regions of urban water bodies, dense urban vegetation, urban open lands, and sparse vegetation

Elevated risk Area:

Intersection of 1 km buffer regions of any three amongst four identified parameters

Moderate risk Area:

Intersection of 1 km buffer regions of any two amongst four identified parameters

7.a.)

SL.NO.	RISK	AREA (IN Sq. Km)	PERCENTAGE
1	High	10.251708679	11.59%
2	Elevated	16.899902797	19.11%
3	Moderate	2.390535	2.71%
Total risk area		29.5421463	33.41

Fig.7.b)

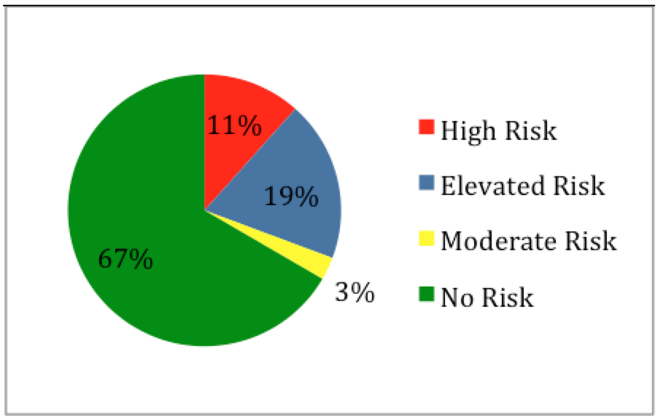


Fig 7.a) shows the Table of risk statistics in Sq. Km., Fig. 7.b) pie chart represents the percentage of risk area.

IV. CONCLUSION

The flight of the mosquito is confined to 200 - 300 meters [11] the research can substantiate the risk areas in the study area further targeting of vector control interventions requires a comprehensive idea of vector breeding habits [16], flight range and favorable conditions for laying eggs. Mapping risk-prone [10] areas can significantly complement the effectiveness of interventions; exclusion of regions where transmission occurs may cause targeted interventions to fail. Furthermore, the level of contiguity may also determine whether spatially targeted interventions are appropriate (Carter, Mendis, and Roberts 2000). In areas of high to moderate transmission [12] is identified through decision rules that can be useful for public health fraternity. Thereby take effective preventive measures, supply of medicines, conduct camps, and awareness programs, and it implicates the urban planners to think from the public health perspective [14].

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