Original Article

DECISION-MAKING METHODOLOGY IN THE OUTBREAK OF VECTORS TRANSMITTING TROPICAL DISEASES, USING HETEROGENEOUS GEOSPATIAL INFORMATION

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Abstract

The analysis and processing of data is important in different areas, and we must pay more attention when it comes to the health of people, in the development of the protocol to prevent the outbreak of vectors transmitting tropical diseases with an emphasis on the mosquito " AedesAegypti ", being able to control its reproduction is of vital importance, and is one of the objectives of the protocol, understanding the reproduction times corresponds to the times where we must take necessary actions to be able to cut its reproduction cycle, within the mechanisms Technological we indicate the use of meteorological information to be able to analyze and predict the favorable conditions so that the mosquito can reproduce, added to the valuable information provided by earth observation satellites, in their access to satellite images, which will provide us with Current images of the area of interest, for rapid detection of bodies of water that will be the future nests of the mosquitoes, the heterogeneous processing is characterized by the analysis of the meteorological data in the CPU and the processing of the satellite images in the GPU both running in parallel processes in the same computer, with which we optimize the use of resources available in applications dedicated to health care.

Keywords: Vector, Bio meteorological, Bodies of Water, Temperature, Humidity.

1 Introduction

This document constitutes Springer's guidelines for the preparation of proceedings papers. These may be stand-alone proceedings or part of a series. Here is a list of some of our main proceedings series:

Many transmission diseases through vectors are the cause of many infected parrons, one of the strategies is to be able to prevent them, instead of seeking treatment, this is how the management and control of the population of these vectors arises, in this line we find works where they use artificial intelligence techniques, in order to forecast about the Ae. Aegypti with the use of observational data as well as environmental variables, comparing

data from multiple output random forest models and latest generation closest neighbor models, taking advantage of clusters before the model which simplifies the task of aggregating sequence of counting mosquitoes with similar temporal patterns [1], we also find works where the temporal modeling of the oviposition activation of the Aedes aegypti mosquito will be analyzed, in the spread of viral diseases such as Dengue, Chicungunya and Zika based on a series of data that were extracted from satellite images of the earth, with the implementation of techniques such as Machine Learning which are capable of non-linear relationships between variables, with the use of artificial neural networks used to build a predictive model on oviposition activities, from where results were obtained with optimal yields compare two with linear models [2]. In this line we also find works where dangerous disease vectors were analyzed, which have focused on female mosquitoes which bite humans or animals in order to collect blood in order to obtain proteins for the reproduction of eggs, these mosquitoes have been recorded and then processed in order to obtain characteristics using classifying support vector machines, from which we obtained results with a precision of 75.55%. [3].

In works that analyze dengue vector monitoring methods and evaluations of public policies for dengue control, which have been considered as main concerns in tropical countries, based on monitoring methods based on in oviposition surveys on the egg counting process, storing information which will be analyzed for which an egg count automation method is proposed through a survey of the remote population of Aedes aegypti that was based on a scanning platform optical through a man-machine interface together with a software for counting mosquito eggs, this information will be transmitted through the internet in this way to be analyzed remotely for which prototypes installed in 2 different cities are installed [4]. We found works where the processing of satellite images and a support vector machine are analyzed in order to detect the aedes aegypti mosquito, which is a carrier of dengue virus for which there is no safe medicine for treatment, as a result it has been proposed a way to detect whether the mosquito corresponds to the Aedes Aegypti species, using the vector support machine with the Matlab tool, for which a training has been carried out using images of Aedes Aegypti and non-aedes aegypti taken from various views taking into account Considering its unique characteristics, in the image processing, characteristics have been extracted which have been classified into aedes aegypti or not aedes aegypti with the use of the confusion matrix to show the precision about detection [5] [6].

The use of satellite images is of vital importance in the analysis of land cover. Its use is becoming widespread as satellite technology is known. The presented protocol is based on the use of images, which provide satellite observation of the earth. Which are available in their respective catalogs, which provide satellite images of the area of interest as up-to-date as possible, in an average of 10 days before. For being working with the maximum mosquito reproduction time, the opportunity to have the image in the shortest possible time is of vital importance. After having presented an event that puts the population at risk.When we talk in terms of health, the risk increases, even more when we try to control disease outbreaks. The "AedesAegypti" Mosquito, responsible for the spread of tropical diseases such as denge, Zika and Chikungunya, that put our population at risk [7]- [8].

The analysis and treatment of the information is considered in being able to process the data by means of an analysis and interpretation and prediction of the meteorological conditions that will allow presenting the conditions for the mosquito reproduction. Among these variables is temperature and humidity.

Monitoring of these parameters is important. Being able to locate the possible bodies of water that are exposed, it is important to find the possible mosquito nests. This data is processed in the computer, optimizing the use of computer resources, in a heterogeneous processing Based on GPGPU programming, the meteorological data is programmed to be processed in the CPU and the satellite images are processed in the GPU. Both are achieved through programming using the MATLAB computational tool because the CPU and GPU access can be accessed jointly and simultaneously [9]- [10].

2 Materials and Methods

For the development of the protocol. We use the available theoretical information to understand the concepts that govern the problems. In our case we try to control the mosquito's life cycle, we need to know how it

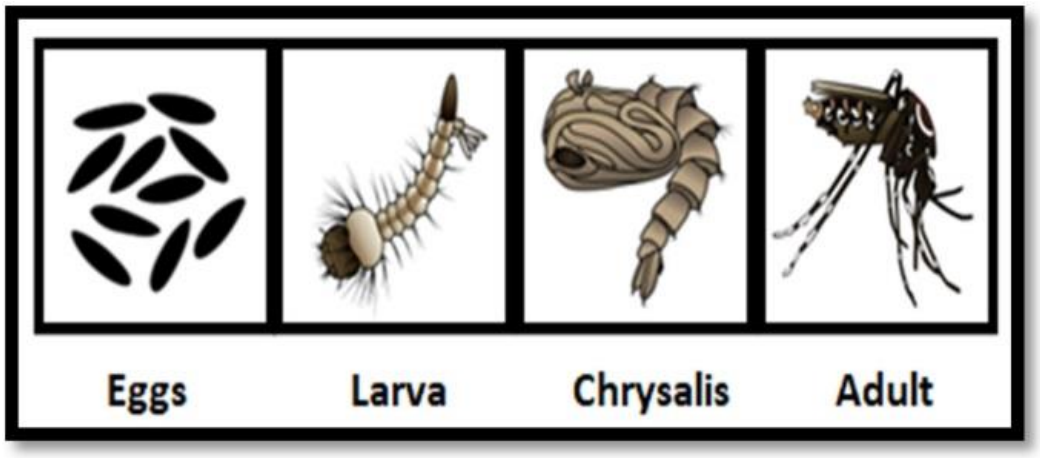
reproduces, how long it lives, under what conditions it reproduces, what its natural habitat is, in order to handle the characteristics of the protocol.

The protocol is based on proposing the use of available resources. As well as the institutions committed to disaster prevention, in the most common cases they are the Ministries, Municipalities, among others. Who will be in charge of being able to take preventive measures for mosquito control, these actions are fumigation and the elimination of water bodies. As a component of the institutions that provide technological information. There are services that provide meteorological data and international organizations that provide information that can be used.

2.1 Mosquito Biophysics

Understand the biophysics of the "AedesAegypti" mosquito. Who is a carrier of tropical diseases. It plays an important role in the development of the protocol, because, it is at the time of mosquito reproduction, where measures must be taken to prevent them from reproducing and not having to control them later.

Fig. 1. Mosquito breeding cycle.



The mosquito's reproduction and growth cycle lasts between 7 to 10 days from the egg until it becomes an adult mosquito:

- The female mosquito lays her eggs in any container that contains water.
- Water is the trigger of the incubation process, which can last between a few days to months.
- When the eggs become larvae in the water, the become chrysalis in the next 5 days.
- Chrysalis lives in water and takes two to three days to become adult mosquitoes and to be able to fly.
- As a characteristic theme of the mosquito, we can indicate that its habitat is found in accumulations of water, in natural and artificial containers very close to homes and often indoors.

Among the kinematic characteristics of the mosquito is its flight range that is on average 400 meters, this information is important for nest searches if any positive case is found.

Among the climatic characteristics that help the spread of the mosquito are considered the temperature that from 20 ° C and above 60% humidity.

2.2 Collaborating Institutions

Among the institutions, responsible for taking the first actions that contribute to eliminate the mosquito and prevent its spread. There are municipalities, regional governments and mainly the Ministry of Health, who will be responsible for controlling the mosquito; What is the vector that transmits the disease, among the actions carried out are the elimination of water accumulations and fumigation.

2.3 Bio Meteorological in Format

The proposed methodology indicates that we must have temperature and humidity as meteorological characteristics. We turn to several sources to obtain the information. These can be weather stations close to the evaluation areas or through access to global environmental monitoring systems. One of the best practices is to be able to obtain and work with historical and current information to analyze what could be of great help for the protocol.

Satelital Image

Satellite images present information with a level of detail that varies from a resolution of 0.5 meters, with a land cover of 14.5 kilometers or more. This feature makes it possible, that requires a large calculation capacity for analysis and image processing. In addition, specialized software is required. This increases the degree of image analysis by end users.

Classically, when working with satellite images. It seeks to have the highest resolution, but is directly proportional to its computational cost. When performing the analysis, you can discriminate the objects in the image in greater detail; caused by the high resolution of the image. For certain types of processes and jobs a level of image production with certain characteristics is required, which is commonly called processing levels. These special features are: ortho-rectification, fusion of the different bands of the satellite, natural color, panchromatic, among others.

The protocol works with the images provided by the space agency. These images are, at best, catalog images, but as current images are required. For this, an acquisition of the area of interest is made.

Getting the images. The analysis is carried out in the different combinations of the bands, such as: real color image, false composite color, real false color and infrared color.

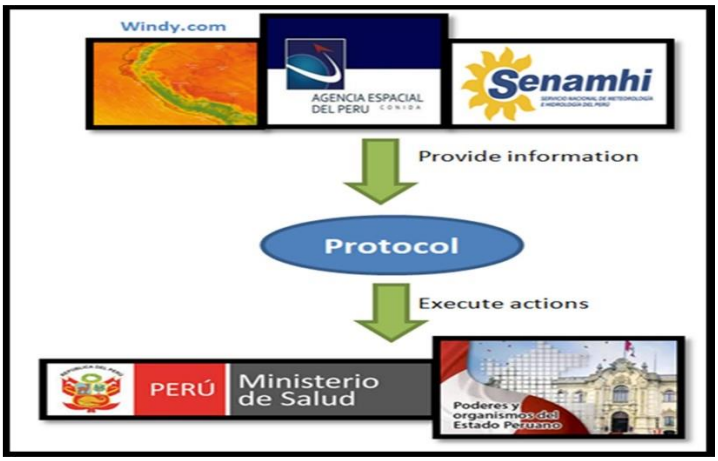
When analyzing a satellite image. You can see certain characteristics of land cover, depends on the use of color bands. With the different color combinations, you can analyze the color change in areas that correspond to vegetation, bodies of water, and soils among others. In our case we will focus on analyzing the bodies of water.

Fig. 2. Example of satellite image..

3 Results

The results presented in the present investigation. They are characterized by being able to apply the protocol. In our case we are in a Peruvian case, by way of analysis Peru has its own satellite for the acquisition of images in the shortest possible time [11]- [24].

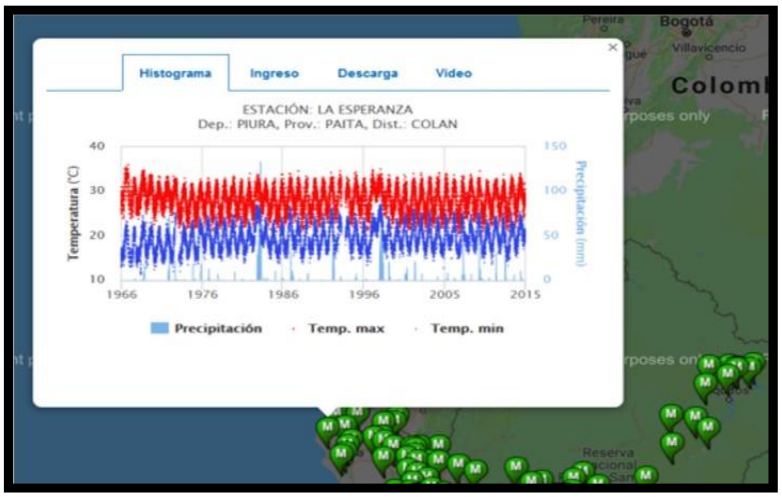
Fig. 3. Organizational Model of the Protocol.



In the design of the protocol we can indicate that the Space Agency of Peru will provide us with the satellite images. The meteorological information will be provided by the Peruvian Meteorological Service (Senamhi) and you can also access the meteorology provided by the Windy.com platform.

Among the institutions of the Peruvian state. The National Meteorological Service provides us with temperature and humidity information. This information is obtained from the meteorological stations, which are installed throughout the Peruvian territory. In the following figure we can verify the information you can provide us.

Fig. 4. Historical temperature information provided by the National Meteorological Service.



For the protocol, it is necessary to have updated information in order to analyze and predict. If the climatic conditions for mosquito propagation are occurring. That is why the implementation of our database was carried out with information corresponding to the temperature of the day, temperature at night and humidity. Based on the information provided by Windy.com services and those provided by the National Meteorological Service. This information is represented visually and in layers. Identifying the areas of interest. Climate variables are provided below [13] [14] [15].

Fig. 5. Updated humidity and temperature information from Windy.com.

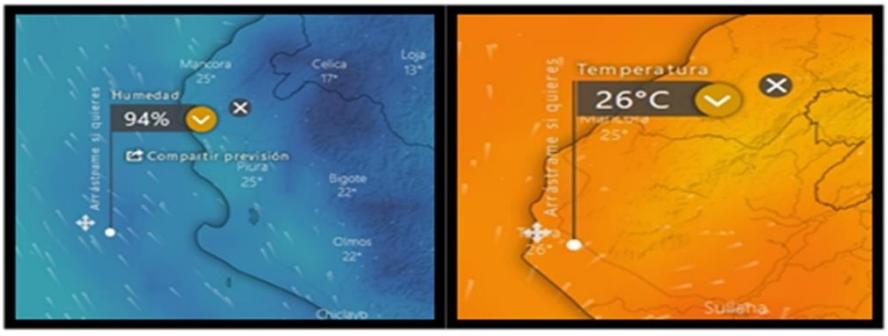


Fig. 6. Record of meteorological information.

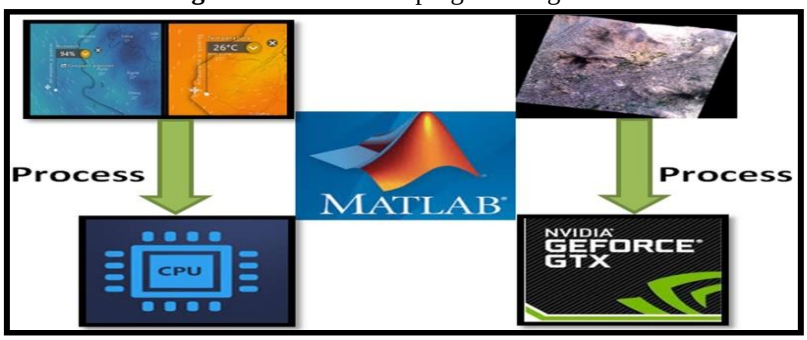
Año	Mes	Dia	Lugar	Temperatura dia (°C)	Temperatura noche (°C)	Humedad (%)
2019	Febrero	5	Piura	26	24	90
2019	Febrero	6	Piura	25	22	92
2019	Febrero	7	Piura	26	22	92
2019	Febrero	8	Piura	26	23	94
2019	Febrero	9	Piura	25	23	95
2019	Febrero	10	Piura	26	22	96

Among the results that were obtained at the time of executing the protocol are described below:

- The result of analyzing meteorological data, such as satellite images, is presented in the protocol description:
- Estimation of weather conditions in the region of interest, through temperature and humidity.
- Analysis of the first positive case, it is the first warning, because it is the activator of the protocol. This is why the conditions for their production of the vector are being presented.
- Search and request of satellite images of the affected area.
- Fast analysis of the satellite images, to detect the possible bodies of water, which are the natural habitat of the vectors.
- Search and registration of bio meteorology information.
- Location of areas with presence of bodies of water and dissemination to entities of the Peruvian State (MINSA).
- With the meteorological information and the satellite image we proceed to the analysis.

For this we use the MATLAB computational tool. Where the meteorological data is worked with the CPU and the processing of the satellite images with the GPU according to the following figure.

Fig. 7. CPU and GPU programming model.



We proceed to analyze, the different bands of the image, to obtain a greater register in the band of blue color. As an example we can indicate an urban area. Where it has been affected by an overflow of the river. That presents a high risk of formation of bodies of water. Consequently mosquitoes can reproduce.

Fig. 8. Area of interest, corresponding to an urban area with the presence of river overflow.

Fig. 9. Area of Histogram of the previous image, where you can see the color components: red, green and blue, each of them is represented by a trend line of the same color.

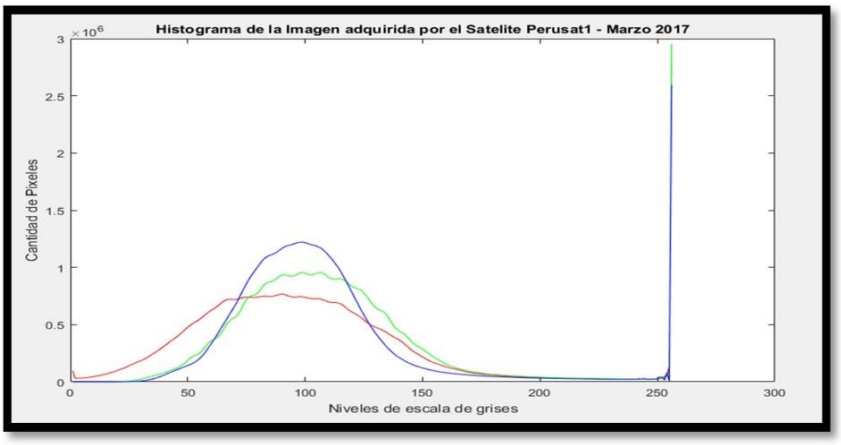
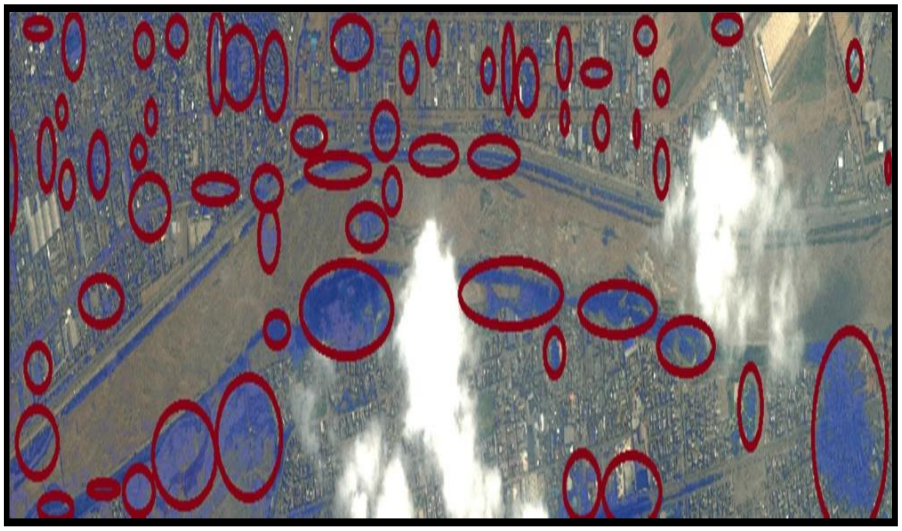


Fig. 10. Search for water bodies through image analysis by grouping in the blue band and representation in the real color composition.



4 Conclusions

Satellite images offer useful information. For the analysis of land cover.In a very special case; the search for bodies of water, as mentioned. It is a very important factor in the mosquito growth process. This analysis should be performed in the shortest possible time. Because you have 10 days, as the analysis time limit. This time corresponds to the mosquito breeding cycle.

Verification of weather conditions.For mosquitoes to reproduce. It's of vital importance. Because with this information, you can start with the dissemination of alerts to possible risks. Make recommendations to the population, to take certain phytosanitary measures. Taking the meteorological conditions that occur in the Peruvian territory and the presence of high humidity is conducive to the generation of these propagation sources.

As a fundamental axis in the protocol. It is the potential we have with the PERUSAT1 satellite, to have access to high resolution images. And with the added value of the temporality of the images, which is of vital importance in our protocol. For the short time of action and to be able to have the images.Due to the acquisition mechanism. You run the risk of having images with cloud cover. It is suggested to acquire the image and to be able to discriminate areas free of cloud cover. Due to the degree of emergency and to mitigate as much as possible. The meteorological data helps determine the climatic conditions for mosquito breeding.

In the data analysis method we have the GPGPU programming. Due to the parallel and heterogeneous processing, where the programming in the CPU and the programming in the GPU are combined.Each in a specific task. Achieving the best results and in the shortest possible time. The tests were performed on a laptop, with an i7 central processor and a GTX 1050ti graphics card from the NVIDIA brand. Using the MATLAB tool, this provides us with this type of programming in the same environment and can access the data simultaneously.

The protocol is a description of the possible use of available resources. Its refinement and optimization will be achieved as the benefits of the protocol and the articulation of information between the State entities are disseminated.

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