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Report on the role of Global Positioning System (GPS) and Geographic Information System (GIS) on Integrated Pest Management (IPM)

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ABSTRACT

Global positioning system (GPS) is a satellite-based navigation system. It is designed to assist the movement of insects and other animals and accessible to anyone with a GPS receiver. Various map display formats like Bitmap Images (BIs), Vector Maps (VMs) and Points of Interest (POI's) are popular imaging technologies. This paper explores the significance of GPS and GSI technologies over the integrated pest management system.

Key Words - GPS, Bitmap images, Vector maps, Insects, GSI, POI.

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INTRODUCTION

The present review is designed in a way to study the various aspects of the benefits and limitation of application of GIS and GIS in the Integrated Pest Management. It shall also help us to understand the various angles of the application and prediction of insect pest dispersal over the agro-horticultural areas. GIS technology is an important tool to manage, analyze and visualize the threat on biodiversity by defragmentation of habitat, anthropogenic disturbances and global climate change and promote conservation practices. The authentic wildlife data of ArcIMS software helps to understand the conservational activities.

Entomology is a branch of Life Sciences that deals with insects. It belongs to phylum arthropoda and class insecta recorded maximum species of arthropods. They are widespread on the earth and a vast range of pests belong to this class. These insects are indispensible part of the ecosystems.

Aims and objective of this review work were:-

(a) collection of recent work on the topic.

(b) compare the recent results of the topic with the effectiveness on the integrated pest management.

(c) to provide the application of recent methods in GPS and GSI technologies.

Global positioning systems (GPS) and Geographic information systems (GIS) are popular technologies used in agriculture or site-specific farming (www.gps.gov/applications/agriculture/). These tools are computer based and therefore, used to store, organize, access, manipulation, analysis, correlation and expresses spatial information (Liebhold, 1993 & Green, 1999). These technologies help scientists and farmers to collect real-time data and on that basis the accurate position of insect pests. It helps to predict the mode of infestation and degree of damage by the insect pests in the agricultural fields. It also provides a large number of data that helps farmers to plan their farming and informs them about the status of ecological factors. These tools are used in the study of spatial distribution of insect pests that helping in practical implication of the integrated pest management of orchard and vineyard plants. The electromagnetic

radiation of soil and plant materials is one of the key sources for the non-contact measurement remote sensing technique (Sciarretta & Trematerra, 2014). The Global positioning system (GPS), Global information system (GIS) and Remote sensing technology (RST) for mapping vectors of communicable disease like malaria (*Plasmodium* sps.), filarial (*Wouchereria* sps.), Dengue etc (Palaniyandi *et al.* 2016).

To make a Global Information System (GIS), the data collection tool GPS is most applied tool. The feature of GPS that provides accurate position to inspect, maintain and update data. In the field of entomology, it is used for mapping, surveying and navigating the pests and other insects. It strengthens the GIS database to come out with fruitful outcomes by differential correlation. In area-wide integrated pest management, Global Positioning System (GPS), Global Information System (GIS) and Variable Rate Technology (VRT) are assisted by remote sensing technology (Huang *et al.* 2008). For the mapping of geographical distribution of pests, Global Information System (GIS) is very effective (Acharya *et al.* 2015).

METHODOLOGY

This review work comprises of studies which were done till May 2021 by using digital browsing platforms like Google Scholar, Academic edu, Medline, Embass, Zotero and also by manual search of the materials available in the library of University Department of Zoology, Ranchi University, Ranchi. The review of literatures was made systematically as per the guidelines of Meta-analysis (Prisma).

Search criteria: The search of key words was made with the help of open source reference management software called Zotero.

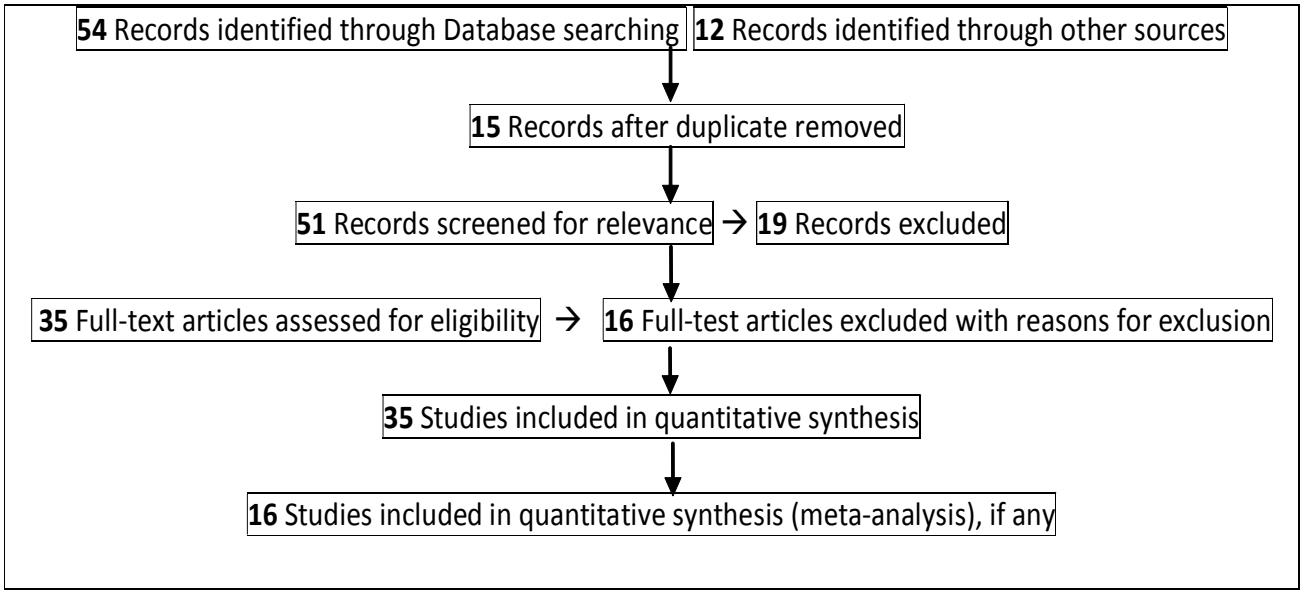
Key words used during the search: Insects and GIS; Insects and GPS; IPM and GIS/ GPS; Insect pests and GIS/ GPS; Impact of GIS and GPS on IPM etc.

Selection of studies: The collected references were further analyzed on the basis of their relevance and then inclusion and exclusion criteria were used to obtain the relevant papers.

Data extraction: The selected papers were used to extract objective of the studies, method and mythologies applied, key result area of the work, findings and recommendations by the authors.

Data synthesis: It was done under the specific headings as bumble bee humming sound, low frequency of sound waves, effect on brain and effect on vital organs of the body. The quality of papers were assessed for their Methodological Quality Rating Scale (MQRS)(Miller and Wilbounce, 2002).

The PRISMA 2009 checklist (Moher *et al.*, 2009). is followed for the unbiased meta-data analysis.



RESULT AND DISCUSSION

Different papers on the title were studied and the valuable information were collected separated and developed a discussion.

Integrated Pest Management (IPM) and Global Information System (GIS)/ Global Positioning System (GPS):

Integrated pest management (IPM) is considered as best model for a sustainable agricultural. It promotes higher yield of crops, fruits and vegetables with minimum use of pesticides and chemical fertilizers. Therefore, It not only protect environment against harmful chemicals rather also strengthen the ecological practices. It is a best method to manage the balance between the agricultural needs of society and the yield. IMP prefers the use of organic and biodegradable pesticides, green fertilizers, and balanced water supply. For the analysis of the effectiveness of IPM at a particular place and time, the knowledge of GIS and GPS is very significant. This technique enables us to extract information about the biological and ecology of insect pests, their spatial distribution and factors affecting them (Kemp *et al.* 1996 & Carrière *et al.* 2006). The success of IPM depends on the information of various ecological factors including climatic factors too (Table- 1) and their effects on insect pests. The geological distribution of pests is directed by climatic factors in and around the habitat. By the correlation between GIS and statistical analysis of data clearly denotes insect pest distribution and habitat selection. In this direction, a group of insects belonging to Acrididae family were studied through GIS (Bai *et al.* 2005). Insects of this family are invasive, economical, agricultural pests and polyphagous in habit (Bai *et al.* 2005; Johnson *et al.* 1988; Kemp *et al.* 2002 & Cohen *et al.* 2008). They spread through active migration, transport through soil, humus, compost, traffic. In Isreal, the controlling of *C. capitats* Wiedemann, a harmful invasive, economic, polyphagous habit and quarantine pest, was done by the help of GIS and Spatial Decision Support System (SDSS) (Moher *et al.* 2009).

Ecological Factors affecting the Insect Diversity:

Both biotic and abiotic factors affect the diversity and dominance of insects in an ecosystem. Abiotic factors are climatic, agricultural and natural calamity factors while biotic factors consist of vegetations, disease causing and anthropogenic factors (Table-1). The role of GSP and GSI in the data collection of such ecological factors helps to correlate the degree of impact in the given ecosystem.

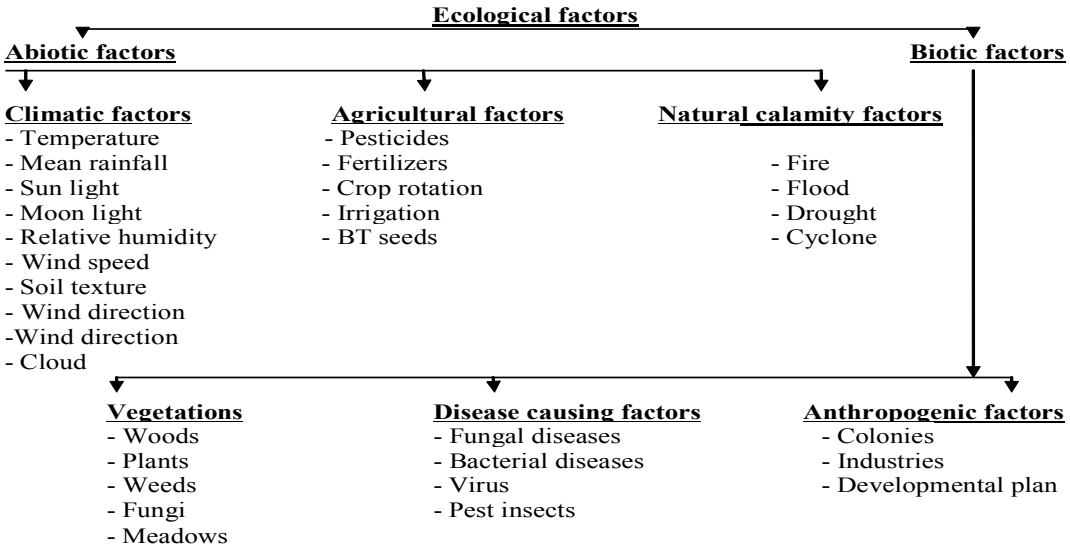


Table 1: Various ecological factors that affect pests and data are collected by GIS, GPS. Ecological factors include both abiotic and biotic factors.

Software used for the different stages of the case study in Entomology:

The field work of any project related to entomology like biodiversity, ecology, spatial modeling, phonological simulation etc., can be effectively accessed by the use of different kinds of software.

(a) Microsoft EXCEL is widely used software for statistical data analysis like input of data in tabular form and getting graphs, mathematical analysis.

(b) COREL DRAW of Corel Corporation is popular software that import and export files with graphic formats. It may manipulate the images and texts.

(c) FRAGSTATS (DOS-based spatial analysis program) is used to quantify landscape structure. Its PC version creates IDRISI raster-format files.

(d) VARIOWIN (Pannatier, 1996.) is used to compute Geostatistical analyses and variogram modeling in 2D. A variogram may give us a measure of how much two given samples of mining area will vary in the percentages of the taken ore.

(e) SURFER (Golden Software, Inc.) is a surface mapping system programme. It manages and displays 3D raster-based data. Geostatistics needs a good combination of different software and here VARIOWIN programme do the same.

Interface facilities of Geo-coding reference of objects:

ArcGIS is very effective interface facility of geo-coding reference of insects. It maps and share geographic information with Environmental Systems Research Institute. The database is used for various aspects of the research related to positioning of insects in different habitats. Table-2 enlists some of the best practices of GIS.

Table 2: Interface facilities of Geo-coding reference of objects.

Sl. No.	Interface facilities of Geo-coding reference of objects
1	ArcGIS Java script API
2	ArcGIS Flex/Flash API
3	ArcGIS Silverlight API
4	ArcIMS API
5	Arc objects API

CONCLUSION

A synchronous use of technologies may enhance the utility of Integrated Pest Management (IPM). Because, this control management needs knowledge about pest, host plants, environmental and ecological factors. Further, more works is required to develop accuracy of the results.

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