GEOSPATIAL ENTOMOLOGY: A Plausible Niche in Entomological Society of Nigeria (ESN)

By

Anumba Joseph Uche

National Arbovirus and Vectors Research Centre, Enugu- Nigeria

Profile- http://linkedin.com/in/anumbajoe | Email-anumbajoe@gmail.com | Phone No- 08032173955

BACKGROUND

The Entomological Society of Nigeria (ESN) since its inception in October 1965 continues to metamorphize and evolve to be a reputable society with the broad objective of "furthering the study of insects in Nigeria". The objectives of the society are among others to promote the study of entomology in all its aspects and to build mutually beneficial relations among all those involved in entomology at all levels. Indeed, the society has operated exclusively for scientific and educational purposes for the benefit of members and the society at large. In line with the mission of ESN to promote entomology in all its sub-disciplines for the advancement of science and the benefit of society, it is pertinent that its members advance with global trends and standards in their various fields of specialization. Globally, it is undisputable that the rate of technological advancement is occurring faster than we can imagine over time. This is palpable in entomology research as new technological tools and resources are used/ integrated in methodologies to answer questions and proffer better solutions to problems in various fields of entomology (e.g. medical and veterinary, agricultural, storage, ecology, forensic, apiculture and sericulture entomology). One of such technological tools is Geographical Information Systems and Remote Sensing (GIS/RS).

Generally, GIS is giving researchers a whole new perspective of spatially related entities on the earth surface. It provides an excellent means for visualizing and analyzing spatial data, revealing trends, dependencies and inter-relationships. GIS/RS tools and software enables users to attach landscape attributes to digital maps, which are then overlaid onto aerial photos and satellite images. With GIS and image processing, the viewer can see trends and patterns that aren't visible from the ground. This technology has been tested, proven and applied across various disciplines.

This paper attempts to illuminate the relevance of GIS/RS in entomology while citing various fields of entomology that have integrated this tool in conventional entomological methodologies to better understand the spatio-temporal and ecological dynamics of insects relative to geographic locations. It goes further to explore the plausibility of an interdisciplinary field; geospatial entomology that leverages on "the science of where" to further and discover deeper insights, make better decision to proffer solutions and recommendations to challenges or problems emanating in various fields of entomological research.

What really is GIS and Remote Sensing?

Geographical Information System commonly known as GIS is a collection of various science and technology tools used to manage geographic relationships across space and integrate numerous types of information to learn about an area, manage a project, choose an ideal site for something and/or choose a delivery route among many other things. It allows users to analyze spatially referenced data and make decisions about topics from a wide variety of fields including business, economics and government applications. In other words, they are computer-based tools used to store, visualize, analyze, and interpret geographic data. Geographic data (also called spatial or geospatial data) identifies the geographic location of features. These data include anything that can be associated with a location on the globe, or more simply anything that can be mapped. For example, roads, country boundaries, and address are all types of spatial data. These data are usually collected by people using a range of hardware devices (such as GPS) and specialized software (such as ArcGIS and QGIS) to explore a variety of topics in order to answer specific data-related questions geared toward providing insight and/or solutions to existing problems.

Remote Sensing on the other hand is simply the science or technology of obtaining information about a place or object under investigation on the earth surface without physically being there or touching it. Technically, it is a technology for sampling electromagnetic radiation to acquire and interpret non-immediate geospatial data from which to extract information about features and objects on the Earth's land surfaces, oceans, and atmosphere. Because the distances of the sensors, the data is consistent, routine and global. Data can be produced for regional, national and local scales; thus, providing information in areas where there are no ground-based measurements. The 3 most common remote sensing methods is by airplane, satellite and drone.

According to Dangermond (2017), GIS is about uncovering meaning and insights from within data. It is rapidly evolving and providing a whole new framework and process for understanding entities. With its simplification and deployment on the web and in cloud computing as well as integration with real-time information (the Internet of Things), GIS promises to become a platform relevant to almost every form of human endeavor—a nervous system for the planet. This system is now not only possible, but in many spheres it's quite inevitable. This GIS nervous system is providing a framework for advancing scientific understanding, integrating and analyzing all types of spatial knowledge (such as biology, sociology, geology, climatology, public health as well as entomology among other disciplines). In other words, GIS/RS provides a platform for understanding what's going on at all scales—locally, regionally, and globally. It presents a way to comprehend the complexity of our world as well as to address and communicate the issues we face using the common language of mapping.

Applications of GIS and Remote Sensing in the Fields of Entomology

GIS /RS technologies are enhancing our ability to study and understand the large-scale spatial structure and dynamics of insect populations, as influenced by heterogeneous environments. These technologies have great potential in entomology and offer many new opportunities and methods for studying and managing insect pests. However,

these tools can only be fully exploited when used in conjunction with traditional monitoring and research techniques (e.g. insect/vector trapping and surveillance) that provide knowledge of an insect's biology and ecology. Monitoring and managing invasive species is one of many potential agriculture entomological applications of remote sensing and GIS technologies. From a brief survey of the Internet and a preliminary survey of printed literature, it appears that GIS and RS has been used by many people in fields such as integrated pest management, ecology, and medical entomology. However, the advent of Geographic Information Systems (GIS) and remote sensing has made the analysis of complex spatial patterns an attainable reality for entomologists and ecologists.

Within the general area of applied insect entomology, perhaps one of the major uses of GIS is the one that relates insect outbreaks to environmental features of the landscape. Outbreaks of grasshoppers and locusts are typical examples of large–scale spatial dynamics that are affected by local conditions that fluctuate with time. Factors affecting the numerical fluctuations in grasshopper and locust populations are usually variables that have both spatial and temporal characteristics and thus can be mapped and incorporated into a GIS (Kemp et al., 2002; Torrusio et al., 2002).

Integrated pest management (IPM) is an important component of sustainable agriculture, enabling the production of farm products with minimum pesticide residues and preserving the environment and the natural equilibrium among organisms in the agro-ecosystem. In order to carry out IPM, it is necessary to have enough information about the biology and ecology of a given pest, particularly concerning their spatial distribution and factors that affect the spatial distribution of given species, all of which is enabled by GIS techniques. GIS has allowed for the rapid development of technologies that offer new opportunities and potentially more effective methods for detecting and monitoring insect pests, as well as understanding their spatial dynamics. (Ivana Dminić et al., 2010).

Practically, map overlays for areas using pesticide as a biological control agent help keep different management methods separate and working as efficiently as possible. Reported outbreaks of certain pests or diseases of crops can also be analyzed by spatial distribution. This allows for the outbreak areas to be isolated, studied, and managed more efficiently and inexpensively. General population and biotic interaction data are also used to help form effective strategies specific to the biology of different pests and biological control predators.

In crop / agricultural entomology

In crop / agricultural entomology, understanding the effect of cropping patterns on population dynamics, dispersal and habitat selection of insect pests have been continues to pose a challenge (Carrière et al., 2006). At the global and regional scale, information of potential changes in the geographical distribution and relative abundance of agricultural pests is very useful to regulatory agencies (Sutherst et al., 2007). Some pest managers have investigated pest distribution and made location maps for several important pests using GIS technologies. For instance, some authors (Lefko et al., 1998; Bishop et al., 2002; Becklar et al., 2004; Burgio et al., 2006; Toepfer et al., 2007) investigated spatial and temporal distribution of various beetles (Elateridae, Silphidae and Chrysomelidae). Based on the results of the various studies, the problems related to temporal and spatial distribution of those pests were largely resolved. The investigated pests had different patterns related to their feeding habits, economic impact, population dynamics and ways of spreading. Therefore, they were investigated by the use of different methods, which were chosen according to pest biology and ecology and purpose of the investigations. A common thread for all investigations was that the data were processed by the use of GIS which helped in estimating the time and intensity of the appearance of the targeted pests on agricultural crops and the opportunities that were available for mitigating damage.

Furthermore, in insect (pest) sampling methods, GIS/RS technologies are enabling us to process environmental data in a more powerful way. Depending on the biology and abundance of the pest, it is necessary to decide

elevation and their impact on spatial and temporal distribution of insects are better investigated by integrating GIS/RS in such study. On a broader scale, these decision-making tools can be used in the context of agriculture in assessment of crop area extent, management of water resources, identification of pest attacks and diseases, yield assessment studies, land suitability assessment for agriculture disaster management and precision agriculture.

Medical Entomology

In medical entomology, GIS technology has been applied in malaria research (Abiodun et al, 2015). Known malaria vector mosquitos have their species data input into GIS which is subsequently overlaid with multiple climate variables which can be obtained as remotely sensed data. This provides a projection for the distribution of these important vector species. These are then cross referenced with reports of malaria infection in order to produce maps of the spread of malaria. This can also indicate which mosquito species is most likely to be the primary vector in a given region allowing for more specific control measures.

With genetic research being applied to insect ecology, populations and sub classifications of species and subspecies have become increasingly more precise over the years. The use of GIS can help explain some of the minute genetic differences discovered between separate populations of what the same species. Utilizing the collection data of studied specimens allows us to view the genetic changes over a spatial difference. This allows researchers to isolate populations by area and project where gene change is progressing. Linking areas to changes also help one understand the reasons behind the process of natural selection in these areas. Areas with different populations may have different climatic data, different habitat coloration, biological interactions, or other limitations that can cause genetic divergence. These can be gotten via remotely sensed data and imagery.

Furthermore, integrated hybrid techniques of remote sensing, GPS, and GIS are used to map the spatial variation of the vector biodiversity, vector abundance, and the active infection state of vector borne disease transmission, and surveillance towards the epidemic control and management (Palaniyandi et al., 2016). The total potential breeding surfaces of malaria, filariasis and JE were measured in square kilo meters (sq.km), the habitats positive for dengue and chikungunya vector mosquitos' breeding was calculated in percentage for mapping and the ward wise cumulative value of mosquitoes potential breeding was also estimated for mapping the areas vulnerable for mosquito problems and the extensive of vector mosquito borne disease transmissions.

The Geospatial Entomology Niche

Indeed, GIS /RS technology is a powerful and laudable tool whose strengths lie in its ability to create access, integrate, and publish large amounts of geographically relevant information. The above applications in entomology is but a few to mention. In the Nigerian context, there are pockets of entomological studies that have employed the use of global position system (GPS) devices to obtain geographic coordinates of study areas or points of interest; most often, this is limited to creating static maps that show such entities. This can be regarded as an underutilization of the GIS/RS technology because a lot more can be done. One of the reasons for such limitation could be attributed to the seeming technical complexities in the use of geospatial technologies (such as GPS, GIS and Remote sensing) by contemporary entomologists to advance their research. There is need to create avenues and opportunities for entomologists to acquire geospatial skills and apply this technology to advance their research across the respective fields of entomology from an interdisciplinary perspective.

A research institution under the Federal Ministry of Health; National Arbovirus and Vectors Research Centre, Enugu has been on the frontier of integrating GIS/RS technology in routine disease vector surveillance and control activities across its sentinel sites in Nigeria (Anumba and Chukwuekezie, 2014). They also provide thematic training and support to academicians, researchers and scientific officers across the country on entomological and geospatial techniques for their research.

this technology in the advancement of its research has created an interdisciplinary research group (GIS and Remote Sensing in Research) to encourage its students and academicians to leverage on and integrate geospatial technological tools to their research activities; they remain committed to training and equipping researchers with knowledge/ skills in the use of GIS, remote sensing and modelling in research. Another research group; the Vector Biology Research Group in the entomology unit of Zoology Department, University of Ilorin have anchored capacity building workshops for malaria vector control research in Nigeria Institutions; this has yielded positive outcomes among which is a collaborative project: Remote Sensing and GIS Mapping of Oviposition and Larval breeding sites of malaria vector species in selected communities in Enugu, Nigeria (Anumba et al., 2018). This can serve as a template for researchers and institutions because the concept is particularly relevant in the larval source management component in the integrated approach to reduce the abundance of malaria vectors in any geographical location which in turn reduces the burden caused by malaria transmission in the human population.

From the foregoing, it won't be out of place if the concept of Geospatial Entomology is explored by the Entomological Society of Nigeria (ESN) such that it becomes a domain among other fields of entomology with the aim of advancing insect science research methods from an interdisciplinary perspective thereby providing a multifaceted yet holistic understanding of insects relative to our environment over time.

References

Abiodun, M.A., Joel, O. B., Jane M. O., Hannes C.J.R., Ahmed, M. K., Philemon L. T., Mayowa O.A., Nsubuga

F. W., Paul M., and Ausi, S. (2015). Application of geographical information system and remote sensing in malaria research and control in South Africa: a review. Southern African Journal of Infectious Diseases, 30:4, 114-121.

Anumba J. U. (2014). The role of Information Communication Technologies and Geoinformatics In Vector Control in Nigeria. Retrieved from https://www.academia.edu/6118214/INTEGRATED_VECTOR_MANAGEMENT_SURVEILLANCE_and_CONTROL_IN_NIGERIA_Mapping_Of_Mosquito_Species_In_the_Six_Geopolitical_Zones

Anumba J. U., and Chukwuekezie, O.C. (2014). Integrated Vector Management [Surveillance & Control] In Nigeria: Mapping of Mosquito Species in the Six Geopolitical Zones. Retrieved from https://www.academia.edu/6118214/INTEGRATED_VECTOR_MANAGEMENT_SURVEILLANCE_and_CONTROL_IN_NIGERIA_Mapping_Of_Mosquito_Species_In_the_Six_Geopolitical_Zones

Anumba J. U., Obiezue, R.N.N., Onyido A.E., Adeogun, A.O and Oduola, A.O (2018). Remote sensing and GIS mapping of oviposition and larval breeding sites of malaria vector species in selected communities in Enugu, Nigeria. Manuscript in preparation.

Beckler, A. A., Wade F., B. and Chandler, L. D. (2004). Characterization of western corn rootworm (Coleoptera: Chrysomelidae) population dynamics in relation to landscape attributes. Agricultural Forest Entomology; 6(2):129-139

Bishop, A. A., Hoback, W. W., Albrecht, M. and Skinner, K. M. (2002). A comparison of an ecological model and GIS spatial analysis to describe niche

populations by geostatistics and GIS: Preliminary results in a rural farm of northern Italy. Spatial Data Methods for Environmental and Ecological Processes, 14-15 September, Foggia, Baia delle Zagare, Italy.

Carrière, Y., Ellsworth, P. C., Dutilleul, P., Ellers-Kirk, C., Barkley, V. and Antilla, L. (2006). A GIS-based approach for area wide pest management: The scales of Lygus hesperus movements to cotton from alfalfa, weeds and cotton. Entomologia Experimentalis et Applicata. 118(3):203-210

Dangermond, J. (2017). Understanding the Science of Where. ESRI Press Team. Retrieved from https://www.esri.com/arcgis-blog/products/product/uncategorized/understanding-the-science-of-where/

Harsha V. (2017, November 7). Applying the Science of Where through GIS. Retrieved from https://www.geospatialworld.net/blogs/the-science-of-where-gis/

Ivana D., Antonela K., Renata B., and Jasminka I. (2010). Geographic information systems (GIS) and entomological research: A review. Journal of Food, Agriculture & Environment. Vol.8 (2): 1193-1198

Kemp, W. P., McNeal, D., Cigliano, M. M. and Torrusio, S. (2002). Field-scale variations in plant and grasshopper communities: A GIS based Assessment. Transaction in GIS. 6(2):115-133.

Lefko, S. A., Pedigol, L. P., Batchelor, W. D. and Rice M. E. (1998). Spatial modelling of preferred wireworm (Coleoptera: Elateridae) habitat. Environmental Entomology. 27(2):184-190

Palaniyandi M. (2014) GIS based site selection for fixing UV light adult mosquito trap and gravity adult mosquito trap. Journal of Entomology and Zoology Studies for epidemic control in the urban settlements. Int. J of Scientific & Technology Research. (IJSTR). 3(8):156-160

Palaniyandi, M., Anand, P.H., Maniyosai, R., Mariappan, T. and Das, P.K. (2016). The integrated remote sensing and GIS for mapping of potential vector breeding habitats, and the Internet GIS surveillance for epidemic transmission control, and management. Journal of Entomology and Zoology Studies 4(2):310-318

Sutherst, R. W., Maywald, G. F. and Bourne, A. S. (2007). Including species interactions in risk assessment for global change. Global Change Biology. 13(9):1843-1859

Torrusio S., María M. Cigliano María L. and De Wysiecki (2002). Grasshopper (Orthoptera: Acrididae) community composition and temporal variation in the Pampas, Argentina. Journal of Orthoptera Research. Vol 11(2): 215-221

Toepfer, S., Ellsbury, M. M., Eschen, R. and Kuhlmann, U. (2007). Spatial clustering of Diabrotica virgifera virgifera and Agriotes ustulatus in small-scale maize fields without topographic relief drift. Entomologia Experimentalis et Applicata; 124:61-75.

Photo Splash

Dr Oyerinde and the contractor at the ESN National Secretariat Site at the University of Abuja

Dr Oyerinde showing the boundaries of the One-hectare plot for ESN National Secretariat in Abuja

Casting of foundation for the ongoing fencing of ESN plot for National Secretariat at the University of Abuja

Excavation of land for the ongoing fencing of the One-hectare plot for ESN National Secretariat in Abuja

Photo Splash

Casting of foundation for the ongoing fencing of ESN plot for National Secretariat at the University of Abuja

Participants at the 6th Api Expo Africa held at the International Conference, Abuja

ESN Abuja Branch members participating in the 6th ApiExpo Africa held 25-29th October, 2018 at the International Conference, Abuja

ESN Ile Branch Members taking a snapshot after the branch meeting

BEEKEEPING PANACEA TO NIGERIA'S ECONOMIC PROBLEMS

Bidemi Ojeleye
Centre for Bee Research & Development (CEBRAD), Ibadan

You will agree with me that the Nigeria economy is sick and everyone knows this. Over the years a lot of people have tried to fix it but so far things aren't getting any better. It's my bet that the problem won't even begin to be solved until we can put a finger on the causative button.

Fortunately, the beekeeping industry evolved thriving due to favorable ecosystem to salvage the dwindling economy. Providentially, even though the writing is on the wall, beekeeping has opted to look the other way to buoy the Nigeria economy. In the past two decades the negative factors affecting beekeepers have amplified geometrically. When the cost of petroleum products went through the ceiling, the downward spiral began.

However; managing a colony of bees should be a fairly simple thing; in that beekeeping fits into several sectorial scientific disciplines as a rural development enterprise and non-wood forest product. As an activity, beekeeping is mainly entomology and sometime partly forestry, horticulture, botany, veterinary/animal husbandry, nutrition and environmental science. There aren't any of these sectors that don't have anything to do with beekeeping as an enterprise. A very good example is the relationship between pollination activities of the bees and horticulture whereby the management of bees is considered to be animal production. Similarly, in the classification of bee products; while honey is classified as food; beeswax is listed amongst non-food waxes and oils. In view of these ambiguities and complexity, beekeeping has suffered a very serious set-back that is currently affecting its development as a major enterprise not only in Nigeria but across the globe.

The Honeybee Swarm

The relationship of people with bees dates back into the mists of time with the plundering of nests for their sweet honey treat. This is vividly shown in Mesolithic rock paintings and is underlined by historic accounts of honey hunting techniques in Asia and Africa.

Including bees in sacred texts or as part of creation myths in so many cultures and religions is an indicator of just how long bees have been important to people. Worldwide, people have historically exploited different species of bees for the honey they produce. The differing anatomical structure of these species has meant people to have developed sophisticated methods of hunting

The Honeybee Workers Clustering the Queen Bee

and various ingenious techniques.

From time immemorial; people have understood that bees provide a cornucopia of delicious, useful and medicinal products like honey and beeswax. However, some other hive products of lesser importance are also sought after, while other value-added bees' products are as important today as ever.

Beekeeping gives some of the world's poorest people the opportunity to enhance their income from the practical and frequently indigenous skill of beekeeping. It is better understood that the beekeeping techniques adopted are sustainable in order to preserve these precious pollinators and valuable producers survive to serve and enrich future generations as well as they have served us in the past.

As always asserted by this writer, beekeeping is not only a noble; economically rewarding vocation, practiced by peasant farmers and nobility alike, but it is also a very serious economic pursuit undertaken all over the world. It is therefore an important aspect of modern agriculture any developing economy would ignore at great risk to its general well-being.

The value of beekeeping is as sweet as honey itself.

A bee researcher experiencing the friendliness of the Honeybee

Apart from bee products i.e. honey, beeswax, pollen, propolis, royal jelly and bee venom; honeybees' pollination activities are of great value to food production. When ranking the values of beekeeping; adequate priority must be given to the pollination services of honeybees especially in our cash crops like cocoa, kola, coffee, citrus etc. In fact, many tropical farmers are oblivious of beneficial effects of bees to their crops. Economy of beekeeping will reveal the dividend potential of beekeeping depending on how it's viewed.

In her bid to explore the unending opportunities of bees, Nigeria hosted the African continent to ApiExpoAfrica2018 where Nigeria introduced the new apiculture model for economic development that the rest of the continent may draw inspiration from. The five-day international conference to find new potential partners and clients and to directly communicate to the representatives of the companies you are most interested in.

Musing down the memory lane of the ApiExpoAfrica2018, it got done that Nigeria beekeeping should be more involved in scientific research in the interest of developing value chain from the hive products as sources of industrial raw materials.