EGYPTIAN ACADEMIC JOURNAL OF

BIOLOGICAL SCIENCES

ENTOMOLOGY

A

ISSN
1687-8809

WWW.EAJBS.EG.NET

Vol. 17 No. 4 (2024)

Citation: *Egypt. Acad. J. Biolog. Sci. (A. Entomology) Vol. 17(4) pp.27-37 (2024)*
DOI: **10.21608/EAJBSA.2024.390168**

Egypt. Acad. J. Biolog. Sci., 17(4):27-37 (2024)

Egyptian Academic Journal of Biological Sciences
A. Entomology

ISSN 1687- 8809
http://eajbsa.journals.ekb.eg/

Enhance Feature Selection for Spatiotemporal Modelling of blow flies Habitat using Google Earth Engine

Eman Zaher[1], Marwa Moustafa[2], Amira Sobhey[2]*, Mona Yones[2], Rawda Badawy[3] and Shireen Ma'moun[3]

[1]Department of Zoology, Faculty of Science, Zagazig University, Zagazig, Egypt.
[2]National Authority for remote sensing and space sciences, Cairo Egypt.
[3]Entomology Department, Faculty of Science, Ain Shams University, Cairo Egypt.
***E-mail:** marwa.gis@gmail.com - monayones@yahoo.com

ARTICLE INFO

Article History
Received:1/10/2024
Accepted:3/11/2024
Available:7/11/2024

Keywords:
Google Earth Engine (GEE), Feature Selection, Blow flies, Chrysomya.

ABSTRACT

Forensic Blow flies are of vital importance in the decomposition process. Their medical and veterinary importance came from their feeding habitat as they feed on faeces and cadavers. Also, they are vectors of viruses, bacteria and helminths. Recently, they were reported to cause myiasis in human and livestock. Google Earth Engine (GEE) is a cloud-based platform facilitating large-scale geospatial analysis through a web interface. It provides access to extensive satellite imagery and geospatial datasets, enabling computationally intensive studies. Feature selection serves as the cornerstone of successful habitat modelling. By carefully selecting relevant environmental variables, we can enhance predictive, reduce model complexity, and improve the understanding of species ecological requirements. Effective feature selection is crucial for addressing the challenge of high-dimensional datasets, especially in complex ecological modelling. While traditional methods have shown promise, identifying the optimal combination of feature selection techniques and predictive models remains an open research area. This study proposes a novel approach to model Blow flies' distribution by leveraging the vast spatiotemporal data capabilities of Google Earth Engine (GEE) aimed to enhance habitat suitability accuracy and contribute to a deeper understanding of Blow flies ecology. Modelling Blow flies distribution will be extremely relevant in conserving wild and human life. Additionally, the represented data might serve forensic science.

INTRODUCTION

Blow flies (Diptera: Calliphoridae) are a distinct group of flies characterized by their gleaming metallic blue, green, bronze and black colors. They are common flies that have the ability to breed on live or dead tissues of animal or vegetable materials. The adult Blow flies consume a variety of foods, including sugary materials, and are drawn to meat, while most of the larvae are scavengers feeding on dung, excrement, or carrions. The breeding of these flies on wounded animals, human excrement, manure, and carrions makes them crucial flies in medicine, veterinary medicine, and forensic science (Abd El-Gawad, 2019; Babu, 2022 and Rodrigues-Filho, 2023).

The subfamily Chrysomyinae includes numerous species which are known as "carrion flies" because they are among the first to arrive at dead bodies. During forensic investigations, Genus *Chrysomya* with other insect and arthropod species are frequently utilized as evidence for determining the suggested time from death which is expressed as postmortem interval (PMI), which require accurate identification. Succession studies of the development and ecological data of these species, thorough understanding the morphologies, habitats, geographical distributions, and expanding statistics of these necrophagous insect species, are of great value (Kordshouli, 2021; Amer, 2019; Salimi et al., 2018 and Sawaby, 2018).

Myiasis is common around the world, but particularly in tropical areas. It affects both domesticated and wild animals, as well as people but under circumstances. Myiasis in humans and animals is caused by several significant genera of the family Calliphoridae such *Chrysomya* species, can infest their hosts as facultative or obligate species causing severe damage to many living tissues and may be fatal according to the affected organs (Alahmed, 2020; Babu, 2022; Jayasundara, 2023). The distribution of Blow flies was well identified in Africa, the Middle East, and Southern Europe (Holdaway, 1933). Recently they are rapidly dispersed due to availability of more suitable climate (Gosselin, 2008).

Google Earth Engine (GEE) has transformed geospatial analysis by offering unmatched access to extensive amounts of satellite images and geospatial data, together with the processing capacity required to handle this data effectively (Simoes, 2021). This platform, which operates on the cloud, has made high-performance computing accessible to a wider range of users. It allows academics to carry out intricate and computationally intensive analyses that were previously not possible. GEE has reduced the technical obstacles for a wide range of users, including those in fields like ecology, remote sensing, and climate research, by providing an easy-to-use interface and a diverse collection of algorithms. Consequently, the platform has expedited scientific discovery and innovation, enabling the creation of new methods to tackle global concerns. Feature selection (FS) is a critical preprocessing step in data mining, aiming to identify the most relevant features for predictive models. Traditionally, FS methods are categorized into filter, wrapper, embedded, and ensemble approaches (Bolón-Canedo, 2019). While filter methods rely on statistical measures, wrapper methods assess feature subsets iteratively. Embedded methods integrate FS within the learning process, and ensemble methods combine multiple FS techniques. Due to the (Nondeterministic polynomial time) NP-hard nature of optimal feature subset selection, metaheuristic algorithms, such as the Grey Wolf Optimizer (GWO), have gained prominence. GWO simulates the social hierarchy of wolves, enabling efficient exploration and exploitation of the search space. Its hierarchical structure and balance between exploration and exploitation contribute to its effectiveness in solving complex optimization problems (Mirjalili, 2014).

This study develops a species distribution model (SDM) for Blow flies utilizing the Google Earth Engine (GEE) platform to investigate the influence of environmental, biotic, and anthropogenic factors on habitat suitability. By incorporating a temporal dimension, the study aims to capture dynamic changes in habitat appropriateness. comprehensive GEE datasets encompassing environmental, biotic, and anthropogenic variables, including land use/land cover and population density, is employed. Then the feature subset is subsequently used to build a Random Forest (RF) model for predicting Blow flies habitat suitability.

The remainder of this paper is structured as follows: Section 2 outlines the methodology and materials employed in this study. The experimental setup and subsequent findings are presented in Section 3. Finally, Section 4 provides a comprehensive discussion of the results.

MATERIALS AND METHODS

1-Proposed Approach: This section provides a comprehensive detail of the proposed approach to selecting features for species distribution model (SDM) for Blow flies using GEE. The proposed SDM framework, as shown in Fig. 1. Is consists of five essential steps. Initially, crucial data and information are gathered. Following that, different factors that affect the distribution of species are examined. Next, the feature set is then subjected to adoptive Grey Wolf optimizer (GWO), which optimizes the subset for proposed SDM. Next, the modelling and mapping of habitat appropriateness is accomplished by employing Random Forest Classifier (RF). Finally, proposed SDM model is evaluated through comprehensive evaluation metrics. The subsequent sections provide an in-depth analysis of each stage.

2-Study Area and Field Survey: The specimens are collected from different localities through sweeping by Arial net and using bait traps, killed during freezing or using ethyl acetate. Then they pinned, labelled and examined for accurate identification by using different keys as in (Al-Shareef, 2016; El-Hawagry, 2019 and Setyaningrum, 2014). The environmental parameters are documented and acquired from the Egyptian meteorological service. Additional data is obtained from primary literary sources, while further data is gathered from specimens stored in the three primary Egyptian collections: The Ain Shams University Collection (ASUC) is located in the Entomology Department of the Faculty of Science. The Ministry of Agriculture Collection (MAC) is also a plant protection collection. The Cairo University Collection (CUC) is located in the Entomology Department of the Faculty of Science.

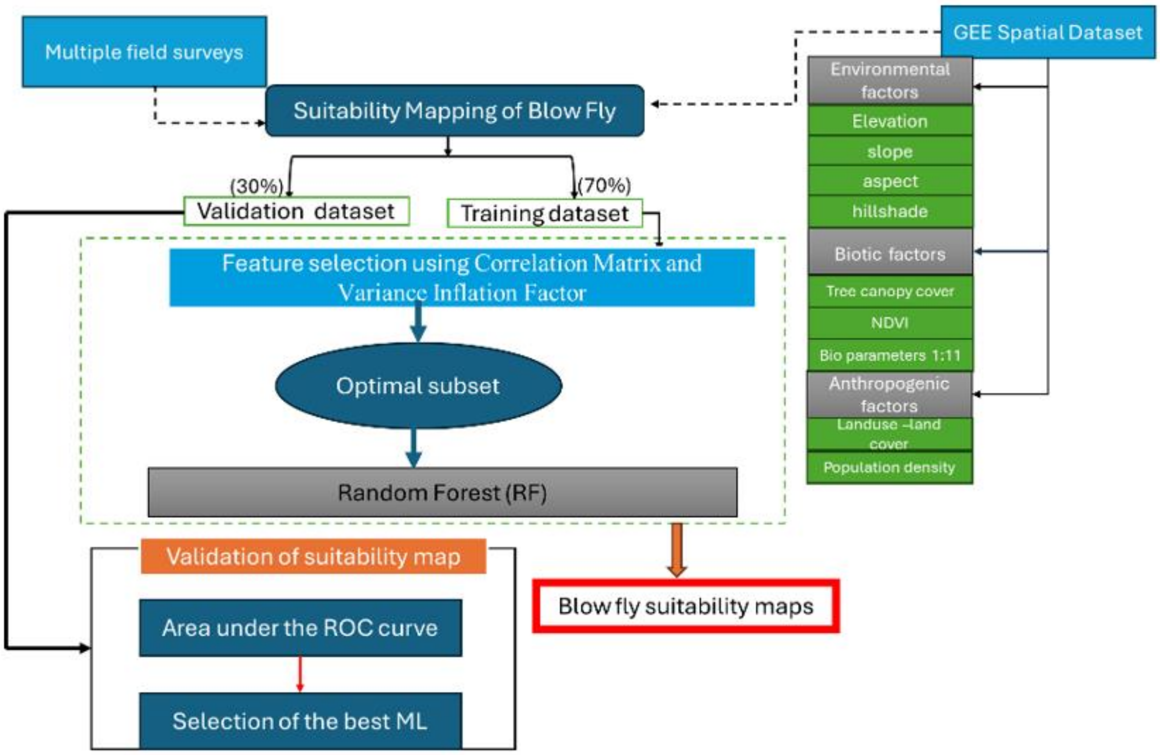

Fig. 1. The proposed Blow flies suitability.

3-GEE Datasets Variables: Google Earth Engine offers direct access to a multi-petabyte data catalog, which expands by approximately 6,000 new scenes daily from ongoing satellite missions. This section discusses the utilized datasets from the GEE data catalog in the proposed SDM model for Blow flies Habitat (Tamiminia, 2020).

World Clim V1 Bioclim: This dataset offers 19 bioclimatic variables derived from monthly temperature and precipitation data, spanning the period from 1960 to 1991, with a spatial resolution of 927.67 meters (Vijayakumar, Saravanakumar, Arulanandam, & Ilakkiya, 2024).

NASA SRTM Digital Elevation 30m: This dataset provides digital elevation data from the Shuttle Radar Topography Mission (SRTM), primarily collected around the year 2000. The data is available at a resolution of approximately 30 meters (1 arc-second). The subsequent code computes elevation, slope, aspect, and hill shade layers from the SRTM data.

Global Forest Cover Change (GFCC) Tree Cover Multi-Year Global 30m: The Vegetation Continuous Fields (VCF) dataset, derived from Landsat, estimates the proportion of vertically projected vegetation cover where vegetation height exceeds 5 meters. This dataset is available for four time periods centered around the years 2000, 2005, 2010, and 2015, with a resolution of 30 meters. Median values from these four time periods are utilized (Zurqani, 2024).

Gridded Population of the World Version 4 (GPWv4), Revision 11: This dataset models the global distribution of human population for the years 2000, 2005, 2010, 2015, and 2020 on 30 arc-second (approximately 1km) grid cells. Population distribution is allocated to cells based on proportional allocation from census and administrative units. The input data, sourced from the 2010 census round (conducted between 2005 and 2014), are extrapolated to generate population estimates for each modeled year.

The NDVI products in Google Earth Engine (GEE) offer a comprehensive suite of tools for analyzing vegetation health and land cover changes globally. Derived from various satellite missions such as MODIS, Landsat, and Sentinel-2, these products provide continuous NDVI measurements, allowing users to assess vegetation conditions over time. Each product varies in spatial and temporal resolution. GEE's NDVI products are widely used in environmental research, agricultural management, and climate studies, offering robust, easily accessible data for tracking vegetation dynamics and ecosystem changes. The NDVI values range from -1 to 1, where higher values indicate healthier and denser vegetation (Ganjirad & Bagheri, 2024).

RESULTS

The accuracy comparison provides insights into the varied effects of different GEE datasets, which include environmental, biotic, and human-related factors. We carried out comprehensive experiments to assess the effectiveness of the proposed feature selection method. The RF method from the scikit-learn Python library was utilized in this study to develop a species distribution model (SDM) for Blow flies using GEE. The effectiveness of the RF classifier depends on two crucial parameters. The first, max features, represents the maximum number of features permitted in a decision tree and was configured to the square root of the total input features. The second, n estimators, which determines the number of decision trees in the forest, was set to 100. This study examines the impact of environmental, biotic, and anthropogenic variables species distribution model (SDM) for Blow flies.

Table 1 and Figure 2, provides a detailed comparison of four machine learning algorithms: Decision Tree (DT), Random Forest (RF), Support Vector Machine (SVM), and Boosted Gradient Tree, based on Overall Accuracy (OA), Kappa, Precision, Recall, and F1-Score. Among these, the Random Forest (RF) excels, achieving the highest scores across all metrics, including an OA of 0.97 and a Kappa of 0.94, indicating its superior ability to accurately classify data and maintain consistency between predicted and actual outcomes. This is further supported by its Precision, Recall, and F1-Score, all at 0.97, showcasing its effectiveness in minimizing both false positives and false negatives. The Decision Tree and Boosted Gradient Tree algorithms also perform robustly, with nearly identical metrics (OA of 0.96 and 0.95, Kappa of 0.91, and F1-Scores of 0.95), indicating they are reliable alternatives with a solid balance of precision and recall. However, the SVM falls short in comparison, with a significantly lower OA of 0.86 and a Kappa of 0.73, reflecting weaker agreement between predictions and actual classifications. While its Precision and Recall are both 0.87, the lower F1-Score of 0.86 suggests that it struggles more with achieving an optimal balance between precision and recall. In summary, the Random Forest algorithm clearly outperforms the others, making it the most reliable and accurate choice for classification in this context, with Decision Tree and Boosted Gradient Tree as strong contenders, and SVM being the least effective.

Table 1. Performance comparison for the four machine learning models species distribution model (SDM) for Blow flies using all features.

Algorithms	OA	Kappa	Precision	Recall	F1_Score
Decision Tree	0.96	0.91	0.96	0.95	0.95
Random Forest	0.97	0.94	0.97	0.97	0.97
Support vector machine	0.86	0.73	0.87	0.87	0.86
Boosted gradient tree	0.95	0.91	0.96	0.95	0.95

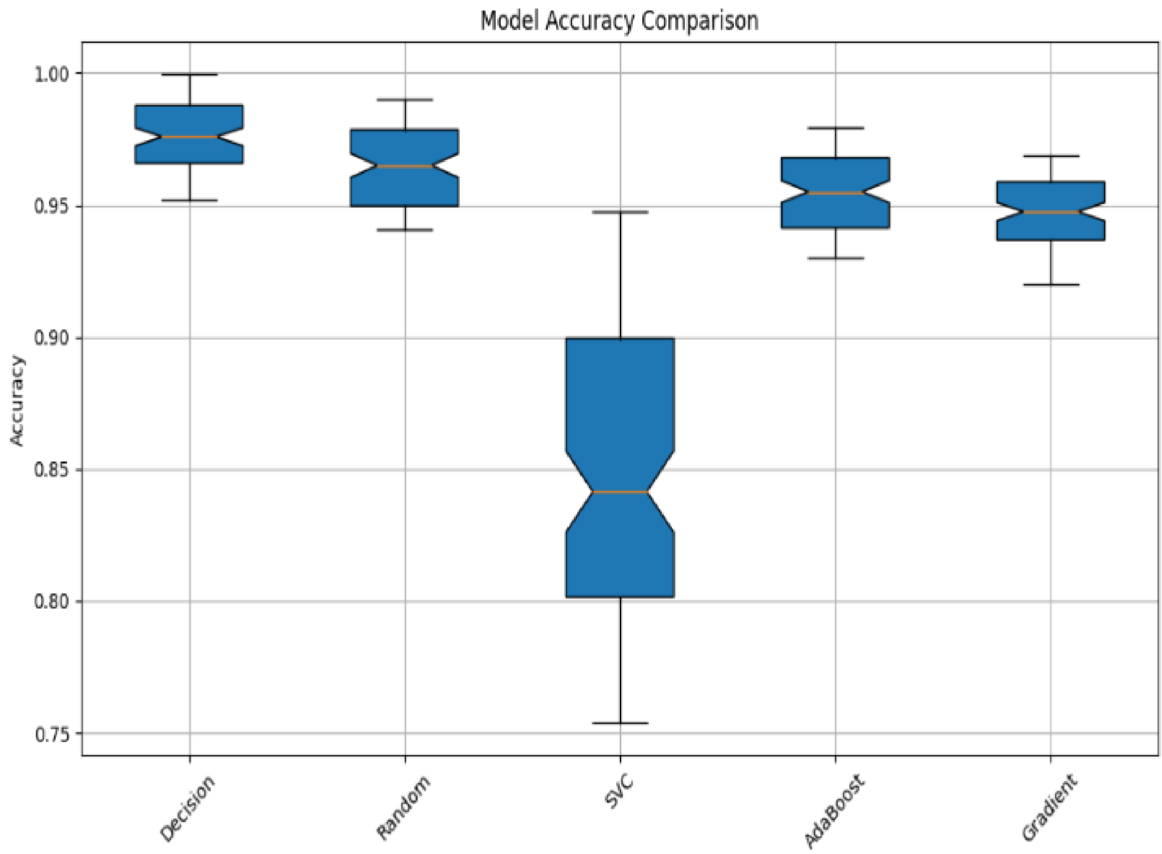

Fig. 2. A comparison between five machine learning approach for species distribution model (SDM) for Blow flies.

The selection of features is crucial in developing a species distribution model (SDM) for Blow flies. High-dimensional data can introduce complexity and confusion within the model, potentially reducing its overall performance. To measure the significance of 26 independent variables, correlation matrix and Variance Inflation Factor (VIF) as shown in Figure 3(a) and (b) respectively and Table 2.

The Variables Correlation Matrix highlights significant correlations among several "bio" features, particularly "bio10," "bio11," and "bibioo12," suggesting potential multicollinearity that could impact model performance. Additionally, features like NDVI, tree canopy cover, and population density show varying degrees of correlation with terrain features such as hillshade, aspect, elevation, and slope. NDVI and tree canopy cover exhibit moderate correlations with some terrain features, while population density has weaker correlations, indicating a more independent relationship. The terrain features themselves, including hillshade, aspect, elevation, and slope, generally show low to moderate correlations with one another, which may still contribute useful information to the model. To mitigate multicollinearity and enhance model reliability, consider reducing or combining highly correlated features, especially within the "bio" variables

The VIF heatmap highlights potential multicollinearity issues among the features in dataset. Notably, features like "bio1" and "bio7" have very high VIF values, indicating they are highly collinear with other features, which could destabilize the model. Most off-diagonal correlations are close to zero, suggesting low pairwise correlations, though a few features show stronger correlations. To improve model stability, consider removing or transforming the features with high VIF values, such as "bio1" and "bio7," and explore feature engineering strategies to reduce redundancy. Addressing these issues will enhance the reliability and interpretability of model coefficients. Following the model in (Rodrigues-Filho *et al.*, 2023), the most influential variables in the model's construction were bio1 (67.7%) and bio7 (21.4%), demonstrating how the predicted probability of presence varies with changes in bioclimatic factors. Additionally, bio1 and bio7 showed the highest gain in the model.

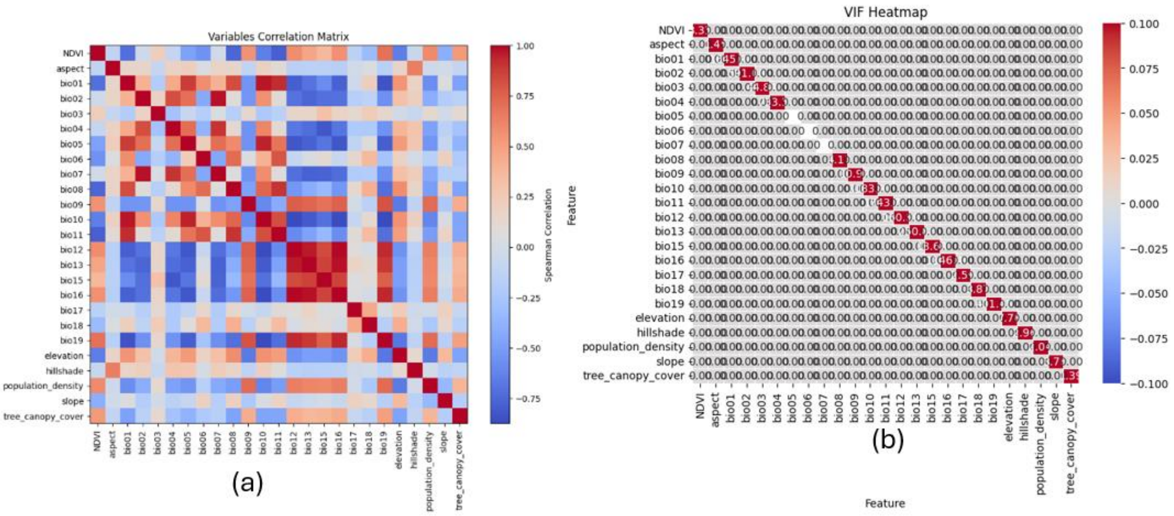

Fig. 3. Assessment of 26 Independent Variables: (a) Correlation Matrix and (b) Variance Inflation Factor (VIF).

Table 2. Performance comparison for species distribution model (SDM) for Blow flies using different feature setting.

	# Features	Accuracy (%)
Traditional Random Forest	26	0.97
Random Forest+ World Clim V1 Bioclim	19	0.7641
Random Forest + NASA SRTM	4	0.5128
Random Forest + Forest Cover Change+ Population + NDVI	3	0.46153
Proposed SDM model	15	0.964

Figure 4, presents the evaluation metrics for SDM using only features selected by AGWO. The model achieves high accuracy at 0.964, with precision, recall, and F1-scores all consistently at 0.863. The Cohen Kappa score is slightly lower at 0.726, indicating moderate agreement between predicted and actual classifications.

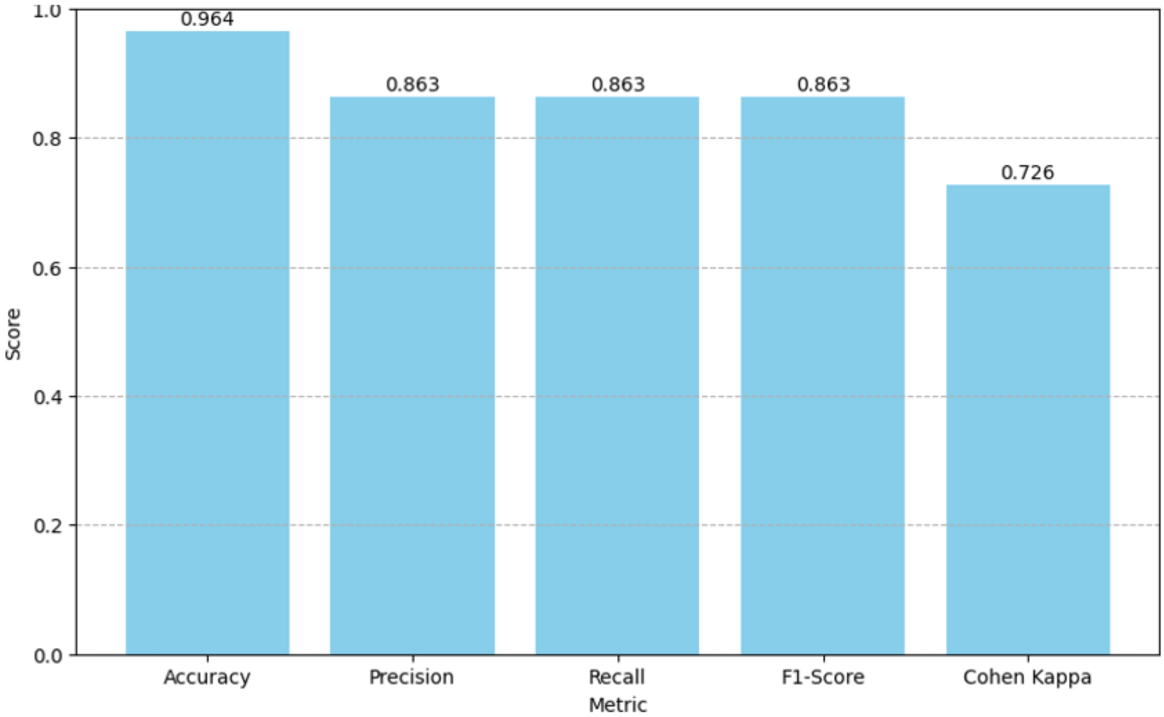

Fig. 4. Performance Metrics for proposed SDM Model.

Finally, we applied a repeated spatial block cross-validation technique over 8 iterations, where 100 x 100 km blocks were randomly partitioned into training (70%) and validation (30%) sets. In each iteration, pseudo-absences were generated, and the training sets were used to fit a random forest classifier with 500 trees (Evans, Murphy, Holden, Cushman, & Drew, 2011). To ensure a balanced dataset, which enhances performance in non-parametric classifiers like random forest (Evans *et al.*, 2011), We generated a matching number of pseudo-absences to correspond with the occurrence data obtained from (Field visits). An environmental profiling approach was applied in two steps to restrict the area designated for pseudo-absence generation (Senay, Worner, & Ikeda, 2013). First, k-means clustering based on Euclidean distance divided the study area's pixels into two clusters: one environmentally similar to a subset of 200 presence locations and the other dissimilar. Pseudo-absences were then randomly generated within the dissimilar cluster. Model accuracy was evaluated using AUC-PR, AUC-ROC, sensitivity, and specificity metrics on the validation data from the 8 iterations. The final habitat suitability map was produced by averaging presence probability outputs across all iterations, while the final predicted presence–absence map was created using a majority vote from the 10 binary model outputs. The final predicted suitable habitat, as shown in Figure 5, was consistent with previous studies on the same specie (Rodrigues-Filho et al., 2023). The mean AUC-PR (0.93 ± 0.05) and AUC-ROC (0.97 ± 0.06) from the 10 model iterations demonstrated good performance, aligning with results from similar studies (Rodrigues-Filho et al., 2023). The models also showed high sensitivity (0.92 ± 0.16) and specificity (0.88 ± 0.10) across the iterations.

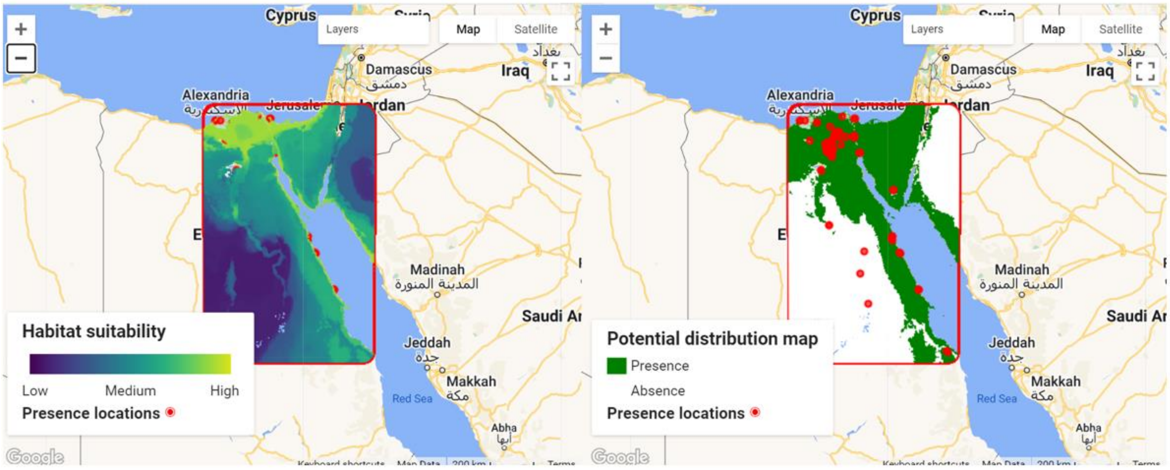

Fig. 5. The habitat suitability model (left), created by averaging eight random forest models, and the potential distribution map (right), generated using a majority vote from the eight random forest binary classifications. Red dots represent occurrence records of Forensic Blow flies (Diptera: Calliphoridae) observed during field survey.

DISCUSSION

Species distribution model show that northern areas of Egypt (governorates of Delta) and governorates of Nile Valley have environmental, biotic, and climatic suitability of Blow flies Habitat and thus have high habitat suitability, on another hand areas around red sea have medium suitability. The main explanatory factor for the climate suitability results, are changes in temperature. Blow flies are important in forensic contexts and as potential medical and veterinary agent. Their dispersion to new locations cannot be ignored, and their expansion should be carefully recorded.

Early developmental stages of Blow flies depend on temperature to complete their vital processes. Higher temperatures increase the rate of development and reduce the time of development (Gallagher, Sandhu, & Kimsey, 2010). The development of Blow flies is related with humidity (Clark, Evans, & Wall, 2006) as both environmental biotic and abiotic factors directly affect the population dynamics of flora and fauna of forensics. In (Jadav & Sathe, 2014), found from the previous results, some species are resistant to environmental and ecological changes, still dominant as *Chrysomya albiceps* (Wiedmann, 1819), can tolerate wide range of temperature, humidity and foods, while other species considered a sensitive species, cannot spread effectively as *Chrysomya megacephala* (Fabricius, 1794).

The choice of variables include aspect, bio01, bio03, bio05, bio06, bio07, bio08, bio09, bio12, bio13, bio15, bio16, elevation, hill shade, and tree canopy cover. Result agreed with (Jadav and Sathe, 2014) who found that the genus *Lucilia* and *Chrysomya* were abundant at low altitude than higher altitudes of Western Ghats.

Bio1 was found to be the most useful variable in explaining the potential distribution of *C. albiceps* worldwide in the work of (Rodrigues-Filho, 2023), and also identified as an important variable in explaining the potential future distribution of *Chrysomya bezziana* (Rodrigues-Filho, 2023). In contrast, bio15 (Precipitation Seasonality - Coefficient of Variation) has been identified as the best explanatory variable for the potential distribution of species in the family Syrphidae in Europe (Miličić, 2018).

Conclusion:

It is obvious that the number of individuals and species of most Subfamily Chrysominae has increased in Egyptian fauna during the last 20 years, this may be related to the increase the rate of trade, fast food shops, chicken, meat and liver restaurants.

This study highlights the potential of Google Earth Engine (GEE) as a powerful tool for large-scale geospatial analysis, particularly in the realm of habitat suitability modelling. GEE platform can handle complex, high-dimensional datasets, thereby enhancing the accuracy of predictive models. By focusing on the ecological requirements of Blow flies, this approach not only advances our understanding of species distribution but also underscores the importance of effective feature selection in ecological modelling. The findings suggest that the combination of GEE's extensive spatiotemporal data and advanced feature selection techniques offers a promising direction for future research, particularly in refining habitat models and exploring the ecological dynamics of various species. As the field continues to evolve, the methodologies proposed in this study could serve as a foundation for further exploration and innovation in geospatial analysis and ecological modelling.

Declarations:

Ethical Approval: This research was approved by the Research Ethics Committee of Faculty of Science, Zagazig University, Zagazig, Egypt. (Approval code: ZU-IACUC/1/F/108/204).

Authors Contributions: RB, EZ, MM and AS; methodology, MM and AS; software, MM and AS; validation, MM and AS; formal analysis, ShM, MY, RB, EZ, MM and AS; investigation, RB and EZ; resources, MM and AS; data curation, RB, EZ, MM and AS; writing original draft preparation, ShM, MY, MM and AS; writing review and editing, RB, MY, ShM; visualization.

Conflicts Interests: The authors declare no conflict of interest.

Code and Data Availability: Data sharing is not applicable to this article, as no new data were created or analysed.

Source of Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements: National Authority for Remote Sensing Space Science and Entomology department Ain Shams University and Faculty of Science, Zagazig University provided the required lab space and equipment for this work, for which the authors would like to express their sincere gratitude.

REFERENCES

Abd El-Gawad, A., Badawy, R. M., Abd El-Bar, M. M., & Kenawy, M. A. (2019). Successive waves of dipteran flies attracted to warfarin-intoxicated rabbit carcasses in Cairo, Egypt. *The journal of basic and applied zoology*, *80*, 1-10.

Al-Shareef, L. (2016). Species Identification of Forensic Important Blow flies (Diptera, Calliphoridae) that occur in Jeddah, Kingdom of Saudi Arabia. *Global Journal of Nursing and Forensic Studies, 1*(3), 1-8.

Alahmed, A., Nasser, M., Sallam, M., Dawah, H., Kheir, S., & AlAshaal, S. (2020). Two new records of flies causing myiasis from Saudi Arabia with a survey of flies parasitizing goats and sheep in Jazan region. *Tropical Biomedicine,1;37*(2), 499-512. PMID: 33612819.

Amer, S.M., Hammad, M.K., Hasaballah, I.A., Shehata, Z.I.A. & Saeed, M.S. (2019). Effectiveness evaluation of Chrysomya albiceps (Diptera: Calliphoridae) and Musca domestica (Diptera: Muscidae) maggots extracts as antimicrobial and antiviral agent. *Egyptian Journal of Aquatic Biology and Fisheries, 23*(3), 561-573.

Babu, B. S., Kumar, R., El-Sharnouby, M., Salah, M., Sayed, S., Alhazmi, A., . . . Bala, M. (2022). Calliphorids as forensic indicator to facilitate PMI estimation: a case study from Chhattisgarh, India. *Journal of King Saud University-Science, 34*(1), 101709.

Bolón-Canedo, V., & Alonso-Betanzos, A. (2019). Ensembles for feature selection: A review and future trends. *Information fusion, 52*, 1-12.

Clark, K., Evans, L., & Wall, R. (2006). Growth rates of the blowfly, Lucilia sericata, on different body tissues. *Forensic science international, 156*(2-3), 145-149.

El-Hawagry, M., & El-Azab, S. (2019). Catalog of the Calliphoridae, Rhiniidae, and Sarcophagidae of Egypt (Diptera: Oestroidea). *Egyptian Journal of Biological Pest Control, 29*, 1-4.

Evans, J., Murphy, M., Holden, Z., Cushman, S., & Drew, C. (2011). Predictive species and habitat modeling in landscape ecology. *Predictive species and habitat modeling in landscape ecology: concepts and applications. Springer, New York*, 139-159.

Gallagher, M. B., Sandhu, S., & Kimsey, R. (2010). Variation in developmental time for geographically distinct populations of the common green bottle fly, Lucilia sericata (Meigen). *Journal of Forensic Sciences, 55*(2), 438-442.

Ganjirad, M., & Bagheri, H. (2024). Google Earth Engine-based mapping of land use and land cover for weather forecast models using Landsat 8 imagery. *Ecological Informatics, 80*, 102498.

Gosselin, M., & Braet, Y. (2008). Découverte de Chrysomya albiceps Wiedermann 1819 (Diptera, Calliphoridae), nouvelle espèce pour l'entomofaune nécrophage en Belgique et mise en evidence de son expansion à travers l'Europe. *Bulletin de la Société royale belge d'Entomologie, 144*, 22-28.

Holdaway, F. (1933). The synonymy and distribution of Chrysomyia rufifacies (Macq.), an Australian sheep blowfly. *Bulletin of Entomological Research, 24*(4), 549-560.

Jadav, D., & Sathe, T. (2014). Altitudinal Diversity of Forensic Blow flies (Diptera: Calliphoridae) of Western Ghats (Maharashtra). *Journal of Forensic Research, 5*(6), 1-4.

Jayasundara, B., Banneheke, H., Wickremasinghe, S., Kallora, J. B., & Dissanayake, K. P. (2023). Human Oro-Nasopharyngeal Myiasis by Chrysomya Bezziana (Old-World Screwworm): The First Reported Case in Sri Lanka. *Ear, Nose & Throat Journal*, 01455613231207283.

Kordshouli, R. S., Grzywacz, A., Akbarzadeh, K., Azam, K., AliMohammadi, A., Pasha, M. G., & Oshaghi, M. A. (2021). Thermal requirements of immature stages of Chrysomya albiceps (Diptera: Calliphoridae) as a common forensically important fly. *Science & Justice, 61*(3), 227-234.

Mirjalili, S., Mirjalili, S. M., & Lewis, A. (2014). Grey wolf optimizer. *Advances in engineering software, 69*, 46-61.

Rodrigues-Filho, S. J. M., dos Santos Lobato, F., de Abreu, C. H. M., & Rebelo, M. T. (2023). Where in Europe is Chrysomya albiceps? Modelling present and future potential distributions. *NeoBiota, 85*, 81-99.

Salimi, M., Rassi, Y., Oshaghi, M., Chatrabgoun, O., Limoee, M., & Rafizadeh, S. (2018). Temperature requirements for the growth of immature stages of Blow flies species, Chrysomya albiceps and Calliphora vicina,(Diptera: Calliphoridae) under laboratory conditions. *Egyptian Journal of Forensic Sciences, 8*, 1-6.

Sawaby, R. F., Hamouly, H. E., & Abo-El Ela, R. H. (2018). Diagnosis and keys of the main dipterous families and species collected from rabbit and guinea pig carcasses in Cairo, Egypt. *The journal of basic and applied zoology*, *79*, 1-14.

Senay, S. D., Worner, S. P., & Ikeda, T. (2013). Novel three-step pseudo-absence selection technique for improved species distribution modelling. *PloS one*, *8*(8), e71218.

Setyaningrum, H., & Al Dhafer, H. M. (2014). The calliphoridae the blow flies (Diptera: Oestroidea) of Kingdom of Saudi Arabia. *Egyptian Academic Journal of Biological Sciences. A, Entomology*, *7*(1), 49-139.

Simoes, R., Camara, G., Queiroz, G., Souza, F., Andrade, P. R., Santos, L., . . . Ferreira, K. (2021). Satellite image time series analysis for big earth observation data. *Remote Sensing*, *13*(13), 2428.

Tamiminia, H., Salehi, B., Mahdianpari, M., Quackenbush, L., Adeli, S., & Brisco, B. (2020). Google Earth Engine for geo-big data applications: A meta-analysis and systematic review. *ISPRS Journal of Photogrammetry and Remote Sensing*, *164*, 152-170.

Vijayakumar, S., Saravanakumar, R., Arulanandam, M., & Ilakkiya, S. (2024). Google Earth Engine: empowering developing countries with large-scale geospatial data analysis a comprehensive review. *Arabian Journal of Geosciences*, *17*(4), 139.

Zurqani, H. A. (2024). High-resolution forest canopy cover estimation in ecodiverse landscape using machine learning and Google Earth Engine: Validity and reliability assessment. *Remote Sensing Applications: Society and Environment*, *33*, 101095.

ARABIC SUMMARY

تحسين اختيار الميزات للنمذجه المكانية والزمانيه للذباب باستخدام محرك جوجل للارض

إيمان زاهر[1]، مروة مصطفي[2]، أميرة صبحي[2]، منى يونس[2]، روضة بدوى[3]، شيرين مأمون[3]

[1]قسم علم الحيوان، كلية العلوم، جامعة الزقازيق

[2]الهيئة القومية للاستشعار من البعد وعلوم الفضاء، القاهرة، مصر

[3]قسم علم الحشرات، كلية العلوم، جامعة عين شمس، القاهرة، مصر

يعتبر ذباب الطب الشرعي ذات أهمية حيوية في عمليات التحلل. تأتي أهميتها الطبية والبيطرية من موطنها الغذائي حيث تتغذى على البراز والجثث. كما أنها ناقلات للفيروسات والبكتيريا والديدان الطفيلية. في الآونة الأخيرة، تم الإبلاغ عن أنها تسبب النغف في الإنسان والماشية. يعد Google Earth Engine (GEE) نظامًا أساسيًا قائمًا على السحابة لتسهيل التحليل الجغرافي المكاني على نطاق واسع من خلال واجهة الويب. وهو يوفر الوصول إلى صور الأقمار الصناعية واسعة النطاق ومجموعات البيانات الجغرافية المكانية، مما يتيح إجراء دراسات مكثفة حسابيا. يعد اختيار العوامل المؤثرة على الحشرة من اهم الخطوات لعمل نموذج لاختيار البيئة المفضلة للحشرة. ومن خلال اختيار المتغيرات البيئية ذات الصلة بعناية، يمكننا تعزيز التنبؤ، وتقليل تعقيد النموذج، وتحسين فهم المتطلبات البيئية للأنواع المختلفة من الآفات. يعد الاختيار الفعال للميزات أمرًا بالغ الأهمية لمواجهة التحدي المتمثل في مجموعات البيانات عالية الأبعاد، خاصة في النمذجة البيئية المعقدة. في حين أن الأساليب التقليدية أظهرت نتائج واعدة، فإن تحديد المزيج الأمثل من تقنيات اختيار الميزات والنماذج التنبؤية يظل مجالًا بحثيًا مفتوحًا. تقترح هذه الدراسة نهجًا جديدًا لنموذج توزيع الذباب من خلال الاستفادة من إمكانات البيانات الزمانية المكانية الواسعة لمحرك Google Earth (GEE) الذي يهدف إلى تعزيز دقة ملائمة والمساهمة في فهم أعمق لبيئة الذباب. ستكون نمذجة توزيع الذباب ذات أهمية كبيرة في الحفاظ على الحياة البرية والبشرية. بالإضافة إلى ذلك، فإن البيانات الممثلة قد تخدم علم الطب الشرعي.