ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 01, pp.45189-45195, January, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM IN MAPPING THE DISTRIBUTION OF MUSCADOMESTICA IN AL-FAYOUM GOVERNORATE, EGYPT

[*,1]Ma'moun Sh., A. M., [2]Yones, M. A., [1]Mahmoud, D. M., [1]Al-Ashaal S. A., [2]Saleh, N. H., [1]Salama, M. S. and [1]Rady, M. H.

[1]Department of Entomology, Faculty of Science, Ain Shams University, Egypt
[2]National Authority for Remote Sensing and Space Sciences (NARSS), Egypt

ARTICLE INFO

Article History:
Received 27th October, 2016
Received in revised form
15th November, 2016
Accepted 19th December, 2016
Published online 31st January, 2017

Key words:
Remote Sensing, Geographic Information System, Fly borne diseases,
Land Surface Temperature,
Satelliteimages.

ABSTRACT

Environmental variability has important influences on fly life cycle, understanding the spatial and temporal patterns of fly populations is critical for fly control and vector-borne diseases prevention. In this study two satellite sensors were used namely, Rapid Eye and Landsat8 to characterize the fly breeding places in Al- Fauoum Governorate as one of the highly crowded Governorates in Egypt with low services. The study area encompassed 15 different sites as fly breeding sites and the location of the sites were taken by using Global Positioning System (GPS).Different environmental variables derived from both satellites imageries included Land Use Land Cover (LULC) and Land Surface Temperature (LST). (LST) were estimated from the thermal bands of the Landsat8 using Remote Sensing (RS) and Geographic Information System (GIS) techniques. The correlation between sanitation level, water supply and garbage management with fly distribution was measured. Application of (RS) and (GIS) may help the decision makers to take a decision about control program for fly borne diseases at right place, time and in right direction.

Citation: Ma'moun Sh, A. M., Yones, M. A., Mahmoud, D. M., Al-Ashaal S. A., Saleh, N. H., Salama, M. S., and Rady, M. H., 2017. "Remote sensing and geographic information system in mapping the distribution of muscadomestica in Al-fayoum governorate, Egypt", *International Journal of Current Research*, 9, (01), 45189-45195.

INTRODUCTION

Vector-borne diseases are becoming one of the major public health problems associated with rapid urbanization in many tropical countries. Insects are suspected as reservoirs and vectors for human and animal pathogens due to their contact with animal manure, food and human belongs (Rady*et al.,* 2014). Housefly, *M. domestica*is an arthropod distributed worldwide and the most abundant fly species in animal production, food at homes and restaurants. Itis considered a serious vectors or transporter of pathogenic microorganisms (Butler *et al.*, 2010). Of particular concern was the movement of house flies from animal or human feces to food that will be eaten uncooked by humans. When carried by flies, some pathogens can be harbored in the mouthparts or alimentary canal for several days, and then be transmitted when flies defecate or regurgitate (Sanchez-Arroyo and Capinera, 2014). One of the challenges facing decision makers concerning with control programs of diseases is detecting breeding sites, locating and surveying breeding habitats of disease vectors. Modern technologies such as (GIS) and (RS) have been progressively used by health authorities to assist in these operations (Beck *et al.*, 2000).

Corresponding author: Ma'moun Sh, A. M.
Department of Entomology, Faculty of Science, Ain Shams University, Egypt.

Satellite (RS) is increasingly being applied to locate and characterize breeding habitats of a variety of vectors (Severini *et al.*, 2008). This study characterized the fly breeding places based on the application of (RS) and (GIS) associated with the house fly, *M. domestica*bionomics, as a potential vector of diseases in Al-Fayoum Governorate. There is very scanty of work has been done on this field, it is hoped that, the findings will help in the future in overcoming the problems of infectious diseases in Egypt. Finally, further work could be achieved for better understanding and illustrating how these findings could be used to control this fly and perform data base for the prediction of the distribution of such vector.

MATERIALS AND METHODS

Study area: The present study was carried out in Al- Fayoum Governorate, Egypt. It is located in the western desert, only a few mileswest of the Nile between latitudes 29° 02′ and 29° 35′ N and longitudes 30° 23′ and 31° 05′ E, Fig. (1). The choice of the study area included four administrative centres (markaz) and city of Al- Fayoum, based on (WHO) study, 2003. Al- Fayoum Governorate is distinguished by its temperate climate along the year; daily air temperatures vary between 35°C°-- 38°C° in summer and 10°C°-20°C° in winter (Egyptian Meteorological Authority, 1996).

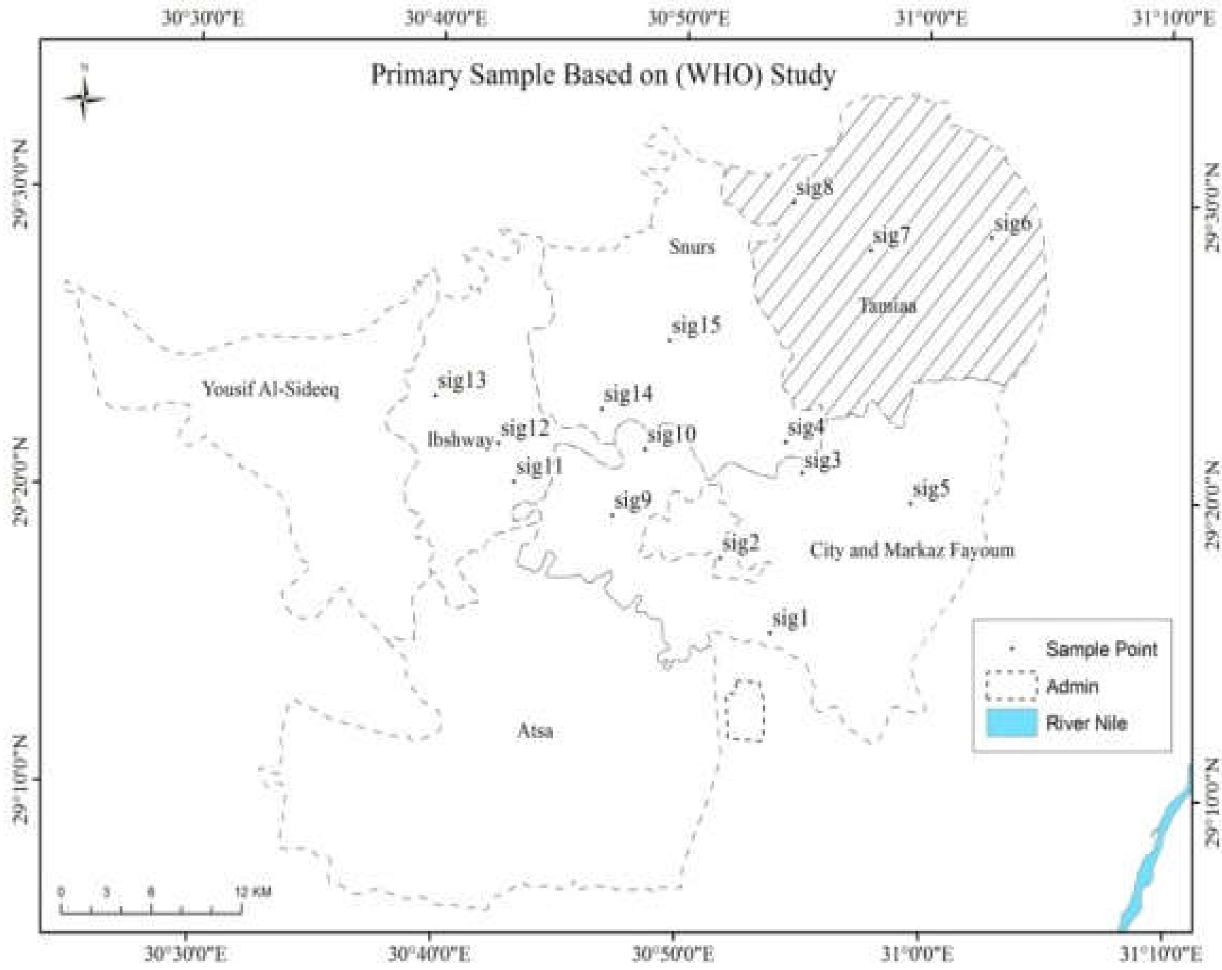

Figure 1. Fly samplingsites at Al-Fayoum Governorate

Fly collection

Fly sampleswere collected from 15 GPS points located in 15 villages at Al-Fayoum Governorate, Fig. (1). Samples collection was in February, 2015using 45 sticky traps. The traps were designated according to (Rady*et al.*, 2014). Collected traps were placed in plastic bags and transported to the laboratory for further investigations. Flies were taxonomically identified using the keys of Pont 1991; Crosskey and Lane 1993. Breeding habitats for flies were geo-referenced using a hand held GPS; also their type and their surrounding were described.

GIS database

The criteria for the selection of the 15 GPS points included: high population density, low health services, low sanitation and low water services (Ezz El- Arab, 2003). The Land Use classification of the study sites was done based on systematic sampling. Grid system based on WHO classification and field visit from the study area were selected and converted to a shape file using Arc GIS 9.3.

Remote sensing data acquisition

Images of the study area were obtained from Rapid Eye satellite sensor and land surface temperature from Landsat8. The Rapid Eye image was acquired on 14th February 2015.

Image analysis

Variables including Land Use Land Cover and Land Surface Temperature (LST) were selected for GIS analysis based on their potential influence on the house fly ecology.

Land use land covers (LULC) classification

Al-Fayoum Governorate was covered by one RapidEye image with 5 meter spatial resolution; 5.5 days temporal resolution (at nadir) and five spectral bands. An image file including 5 spectral bands and NDVI (Normalized Difference Vegetation Index) was created. Unsupervised classification with 60 classes has been used in this study and the result was saved as *.img. Using ENVI software, the output file was taken after re-coding step and was applied to a majority of analysis in ENVI used Kernel function and defined the range. Using Arc GIS All land cover classes were re-labeled according to FAO land cover classification system and linear features were delineated.

LST measures

Landsat8 at date of 14th of Feb. used to derive (LST) and the recorded digital numbers (DN) were converted to radiance units (Rad) using the calibration coefficients specific for each band from the satellite (Shirbeny *et al.*, 2016). Band 10 was used to extract LST as follow:

Rad= 0.0003342* DN+ 0.10000

(1) Rad was used to calculate surface emissivity (Eo) which estimated from NDVI using the empirical equation developed from raw data on NDVI and thermal emissivity (Valor and Caselles, 1996).

$$Eo= 0.9932 + 0.0194 \ln NDVI$$

NDVI calculated from Red and NIR bands in Landsat8 data. NDVI vary according to crop age, planting density and chlorophyll activity.

(2) The radiant temperature (To) can be calculated from band 10 radiance (Rad10) using calibration constants K1=774.89 and K2=1321.08.

$$To=K2/\ln ((K1/Rad10) +1)$$

(3) The resulting temperature (Kelvin) is a satellite radiant temperature of the viewed Earth atmosphere system, which is correlated with, but not the same as, the surface (kinetic) temperature. The atmospheric effects and surface thermal emissivity have to be considered in order to obtain the accurate estimate of surface temperature from satellite thermal data (Norman *et al.*, 1995).

(4) LST is calculated from the top of atmosphere radiant temperature (To) and estimated surface emissivity (Eo) by using ENVI program as: LST=To/Eo

Urbanization measures at Al- Fayoum Governorate

Some measures indicated the level of urbanization as water supply, sewage network, waste management treatment, health activityand community network were obtained from the Central Agency for Public Mobilization and Statisticsand were used to correlate these factorsin rerlation to the house fly density.

Statistical analysis

The data were given as individual values and as means (X) ± standard deviation (SD). Comparisons between calculated means were analyzed using least significant difference (LSD) test. All statistical analyses were performed using the statistical software SPSS, version 18.

RESULTS

Estimationof fly densities

During the present study, taxonomic identification of collected flies indicated the presence of six species of flies which were; *Muscadomestica*, *Musa.sorbens*, *Drosophila melanogaster*, *Sarcophagaaegyptica* and *Chrysomyiamegacephala*. Results showed that *M. domestica* was the most dominant fly in the collected samples. Results in Table (1) proved that Mansheit El- Gammal, site (6) and BaniSaleh, site (3) recorded the highesthousefly density during this study with mean values 42.6 ± 9.29 and 39.3 ± 4.04 fly/trap followed by Matr Taresand Kalmasha, sites (4 and 2) with mean values 28.6 ± 3.21and 26.6 ± 4.16 fly/trap, respectively, while sites (5, 9, 10, 14 and 8) revealed moderate density of the house fly with mean values 20.6 ± 4.04, 18 ± 4.58, 17.3 ± 3.05, 15.3 ± 6.65and 14.6 ± 2.51 fly/trap respectively, and sites (12, 7, 1, 13, 11and 15) showed a relatively low fly density reached to 6.6 2.08 fly/trap for Terssa village.

Urbanization measures at Al- Fayoum Governorate

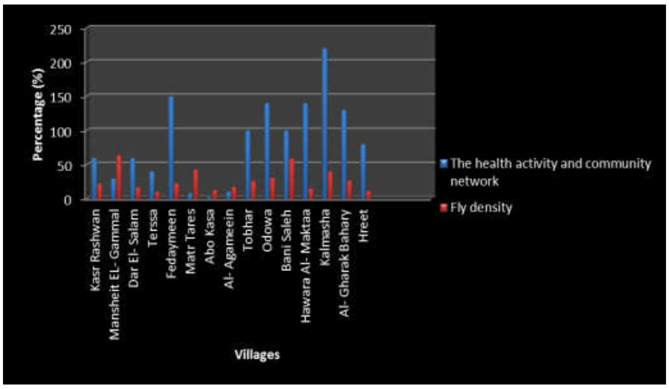

Figure 2. The health activity and community network in relation to fly densityat Al- Fayoum Governorate

Kalmasha, Fedaymeen, Odowa, Hawara Al- Makataa and Al- Gharak Baharyvillages proved to have satisfactory health activity with relatively low fly densities which recorded 11.5 %, 15.5 %, 23 %, 26 % and 27 %respectively. While Mansheit El- Gammal and Matr Tares with the lowest percentage of health activity showed high percentage of the fly densities, recorded 64 % and 43 % respectively.

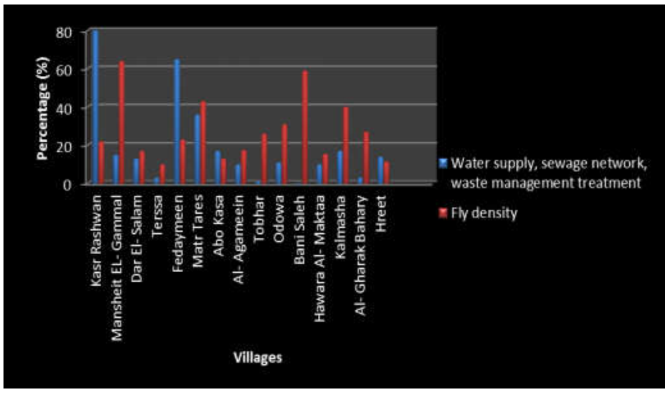

Figure 3. Water supply, sewage network and waste management treatment in relation to fly densityat Al- Fayoum Governorate

Water supply, sewage network and waste manegment in KasrRashwan and Fedaymeen villages were relatively high with low fly densities, recording13 % and 15.5 % respectively, while Mansheit El- Gammal village and Bani Saleh villages with the lowest percentage of the water supply, sewage network and waste manegment services, accompanied with the highest fly densities,64 % and 59 % respectively fig (2).

GIS database

GIS owing to its inherent ability to manage both spatial and non-spatial information, provided an excellent framework for disease management.

Land use/ Land cover

In order to identify the combination of variables that best characterize the presence of breeding sites within study districts, the environmental variables (LULC) derived from Rapid Eye was calculated for each district in relation to the occurrence of breeding sites.

Table 1. Estimation of*M.domestica*densities collected from 15 sites at Al- Fayoum Governorate

Site	No. of collected f lies/ trap			Total	Mean ± SD
	1	2	3		
(1) Hawara Al- Maktaa	8	10	13	31	10.3 ± 2.51
(2)Kalmasha	22	28	30	80	26.6 ± 4.16
(3)BaniSaleh	35	40	43	118	39.3 ± 4.04
(4) Matr Tares	30	25	31	86	28.6 ± 3.21
(5)Odowa	20	17	25	62	20.6 ± 4.04
(6)Mansheit EL- Gammal	40	53	35	128	42.6 ± 9.29
(7) Dar El- Salam	9	13	12	34	11.3 ± 2.08
(8)KasrRashwan	15	12	17	44	14.6 ± 2.51
(9) Al- GharakBahary	19	22	13	54	18 ± 4.58
(10)Tobhar	14	18	20	52	17.3 ± 3.05
(11) Hreet	8	6	9	23	7.6 ± 1.52
(12) Al- Agameein	10	13	12	35	11.6 ± 1.52
(13) Abo Kasa	4	9	13	26	8.6 ± 4.50
(14)Fedaymeen	21	8	17	46	15.3 ± 6.65
(15)Terssa	6	5	9	20	6.6 ± 2.08
P- value < 0.05					

Table 2. Waste component descriptions of visited sites and its relation to house fly density

Markaz	Site	Village	Site description	Fly breeding places	% of collected house fly
Tamayia	(Sig 8)	KasrRashwan	Vegetable market Souk	Bird viscera, plastics, plant peeles and manure	13 %
	(Sig 6)	Mansheit EL- Gammal	Waste collection area Sewage sludge	Food remainders, mud, rotten leaves,animal rudiments, grass and animal manure	64 %
	(Sig 7)	Dar El- Salam	Food processing area Constructed area	Plastics, papers, grass and sand	34 %
Snores	(Sig 15)	Terssa	Cafeteria Constructed area	Metals, glasses, plastics as well as papers	20 %
	(Sig 14)	Fedaymeen	Farming area	Agricultural wastes, animals, bird wastes and plastics	15.5 %
	(Sig 4)	Matr Tares	Slaughter-house area Area between houses	Animals, birds and some kitchen wastes and wild vegetation	43 %
Ibshwaie	(Sig 13)	Abo Kasa	Area between houses	Metals, glasses and plastics	22 %
	(Sig 12)	Al- Agameein	Area between houses	Plastics, papers bagsand tissue paper	24 %
	(Sig 10)	Tobhar	Collecting area of garbage	Household wastes, animal wastes and fermented kitchen wastes	25 %
Fayoum	(Sig 5)	Odowa	Farm area	Wild vegetation and rotten vegetables	23 %
	(Sig 3)	BaniSaleh	Garbage collecting Area Slaughtering area Fruit market	Rotten vegetables and fruits, meat, bird reminders, bones, household wastes and manure	59 %
	(Sig 1)	Hawara Al- Maktaa	Garbage area Area between houses	Rotten vegetable, glass, plastics and plant peeling remainders	26 %
Itsa	(Sig 2)	Kalmasha	Slaughter-house area Restaurant	Food reminders, skin and animal vescira	11.5 %
	(Sig 9)	Al- GharakBahary	Farm area Garbage collecting area	Plants and food reminders, plant parts and glass	27 %
	(Sig 11)	Hreet	Area between houses	Metals, glasses, plastics as well as papers	23 %

Table 3. Estimation of *M. domestica* densities collected from 15 sites at Al- Fayoum Governorate regarding to LST

Site	Density of *M. domestica* Mean ± SD	LST
(1) Hawara Al- Maktaa	10.3 ± 2.51	27.6
(2)Kalmasha	26.6 ± 4.16	27.3
(3)BaniSaleh	39.3 ± 4.04	25.8
(4) Matr Tares	28.6 ± 3.21	30.3
(5)Odowa	20.6 ± 4.04	31.6
(6)Mansheit EL- Gammal	42.6 ± 9.29	23
(7) Dar El- Salam	11.3 ± 2.08	31.5
(8)KasrRashwan	14.6 ± 2.51	19.5
(9) Al- GharakBahary	18 ± 4.58	19.1
(10)Tobhar	17.3 ± 3.05	33
(11) Hreet	7.6 ± 1.52	18.1
(12) Al- Agameein	11.6 ± 1.52	19.4
(13) Abo Kasa	8.6 ± 4.50	17.3
(14)Fedaymeen	15.3 ± 6.65	27.3
(15)Terssa	6.6 ± 2.08	28.6
P- value< 0.05		

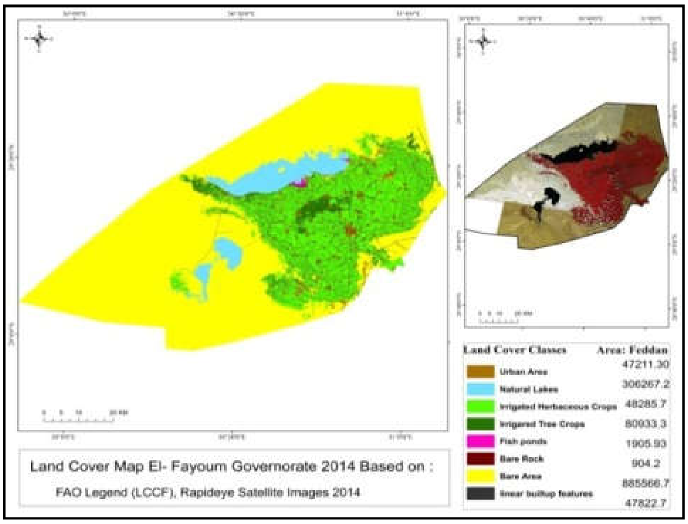

Figure 4. Land cover map of the study area

The output of the whole processes are shown as classified images with attached attribute tables that show the information about all FAO land cover classes. Accuracy assessment was carried out using one hundred ground check points distributed in the whole study area based on Kappa analysis.

Remote sensing

Rapid Eye processing

Unsupervised classification was carried out using all reflective bands, (NDVI) and principal component analysis (PCA). It was found that using all reflective bands with NDVI gave a best result for vegetation cover classification while using reflective bands with PCA1, 2 gave the best results for non-vegetation covers classification. The results were observed and validated using (50) ground observation points and the overall accuracy of the land cover map was 96.4%.

Land Surface Temperature (LST) and the distribution of *M. domestica*

The spatial and temporal patterns of air surface temperature, which is measured at 2-m above ground, are essential to monitor and define the climate and meteorology of a specific geographic region (Valiente*et al.*, 2010). Data in Table (1) showed that the highest fly density was recorded in the villages with (LST) within 20ºCº -25ºCº and areas with the temperature above and below this range recorded low fly densities.

Discussion

*M. domestica*is known as a vector for wide variety of human and animal pathogens in Egypt (Rady*et al.*, 2014) and all over the world (Forster *et al*., 2009; SinthusiriandSoonwera, 2013). In this study, the systematic random sampling method and GIS for predicting the population density of *M. domestica* in Al-Fayoum Governorate was used. From the total number of flies collected, *M. domestica* was revealed as the dominant species when compared with other flies, the domination of *M. domestica* was previously recognized by (Nurita*et al.,* 2008) whocollected flies from different habitats in USA. Data in Table (1) showed that the highest fly densities were recorded at Manshiet El- Gammal village and BaniSaleh, sites (6 and 3), while the lowest fly density was recorded at Hreet, site (11) and Terssa, site (15). The waste compositions of sites (6 and 3) with high fly density are sharing the presence of animal and human manure, while waste composition of sites (11 and 15) mainly contained plastics and plant reminders. It seems that outdoor defecation and improper treatment of animal and man excreta is an important and limiting factor controlling fly density in our habitat (Rady *et al*., 2014; Sanchez-Arroyo and Capinera, 2014). The sites (6 and 3) with high fly densities and high population densities with low water services and low sanitation level. Wastes were left outdoors for long time enough for complete fermentation of organic components (Figure 3), providing favorite places for fly breeding. Alam and Zurek, 2004 assumed that animal feces and manure are potential environmental factors increasing fly densities in USA, while Emerson *et al.*, 2001 proved that human faeces was favorite for fly breeding.

Fly densities recorded from Matr Taresand Kalmasha, sites (4 and 2) followed sites (6 and 3) with relatively high fly density with mean values (28.6 ± 3.21 and 26.6 ± 4.16)fly/trap, respectively, wastes of both sites included agricultural, restaurant and slaughtering wastes which contained huge quantities as animal skin, viscera, bones and manure. Avancini and silveir, 2000 reported that house flies were related to poultry facilities in south Brazil, poultry manure was an attractive breeding materials, Sanchez-Arroyo and Capinera, 2014also found that the hog and poultry farms, horse stables and ranches were the most favorable habitats for fly collection. Villages (Odowa, Al- GharakBahary, Tobhar, Fedaymeen and KasrRashwan) showed moderate density of fly populations with means ranged from (20.6 ± 4.04 to 14.6 ± 2.51) fly/trap. Wastes of those sites had mixture from household wastes and farming wastes. Also we realized that residents always burn wastes every few days. Sites (12, 7, 1, 13, 11and 15) revealed a relatively low fly density, wastes of those sites free of household, food reminder or slaughterhouse type of wastes but contained sand, grass, glass, plastics and plant leaves. Waste component was a limiting factor in attracting flies. Hot, dry climates, dust and water scarcity are thought to be associated with the distribution of fly borne diseases (Vanwambeke and Lambin, 2013). Data showed that there is low water supply, sewage networks and waste management treatment in some villages and in the health activities and community network on most of them for Al- Fayoum Governorate including Kasr Rashwan, Mansheit El- Gammal, Terssa and Hreet districts. Poverty associated with rapid population growth leads to crowding of people without the necessary infrastructure for the safe storage and distribution of water and drainage of waste water. In addition, the deteriorating public health infrastructure in many countries exacerbates the health problems (Cairncross and Feachem, 1993). Each of these negative social trends is expected to continue, while water related issues are expected to increase in the developing world over the next few decades (Hespanhol, 1996).

More than 65 % of the interviewed persons in Al- Fayoum Governorate were engaged in harmful water, sanitation, and garbage disposal practices that exacerbate the disease process. Household water usage is greatly limited by the availability of sewage systems at the household level. As water is in fact a burden to dispose of after use, many water-related house tasks are avoided, with water used only for more high-priority tasks such as cooking and drinking (Ezz El-Arab, 2003). In the present investigation, Rapid Eye multispectral was used for the characterization of flies breeding habitats. Land use/Land cover data are essential for planner to study land resources management (Small, 2003). The nowadays application of (GIS) and (RS) are the most recent advanced approach in studying information which are important in studying our vector distribution. Anyhow, environmental changes on land surface owing to climate change or land cover change are expected to change fly abundance and distribution. Engelthaler *et al.*, 1999stated that when eco-systems changes, disease problems arise. Land Surface Temperature is a good indicator of the Earth's surface temperature because it is one of the key parameters in the physics of the land-surface processes. LST is defined on radiation basis emitted by the land surface observed by MODIS at instant viewing angles (Akhoondzadeh and Saradjian, 2008).The resulting temperature profiles depend on details of the methods that are used to obtain temperatures from radiances. Satellites do not measure temperature, they measure radiances in various wavelength bands, which must then be mathematically inverted to obtain indirect inferences of temperature (National Research Council (U.S.), 2000).

Landsat 8 was used to determine the (LST). The difference between (LST) and the air temperature (Tair) varied particularly with the surface water status, the roughness length and wind speed. LST was lower than T-air at night but at day it was the opposite, because of the surface energy emitted during the day more than during the night and Tair affected by wind speed and air humidity (Shirbeny *et al.*, 2016). In this study, *M. domestica* revealed a relatively high density, with most collections made at (LST) ranging from 20°C to 25°C. Our results showed that LST (°C)derived from Landsat8 in regions under investigation measured between 20°C and 25°C representing the favorite temperature range for flies to breed and aggregate outside as recorded at sites 3 representing BaniSaleh village and site 6 in Manheit El- Gammal recording the highest fly population densities within this range of temperature. Cold temperatures ranged between 17°C-22 °Chave adverse effect on fly densities which reduced density to reach 8.6 ± 4.50 fly/trap at 17.3 °C. Relatively high temperatures ranged from 26°C-31 °Cslightly affect fly densities reached to11.3 ± 2.08 fly/trap at31.5 °C. RapidEye and Landsat8 satellite sensors could be used together in planning and implementing a fly control program. RapidEye in conjunction with information on the location and number of breeding sites in (GIS) would be adequate force major characterization of fly breeding habitats. Using image classification emerged from (RS) satellites proved to be essential for planner and researchers in making decision concerning land resources and marks (Lu and Weng, 2007). Some difficulties may interfere with image analysis like nature of input images, classification methods, algorithm (Ezeomedo and Igbkwe, 2013). To avoid such problems, the integration of (GIS) and (RS) with the aid of additional database management systems (DBMS) was used during our study as an applicable approach (Vanwambeke and Lambin, 2013).

Conclusion

(RS) and (GIS) were increasingly and successfully used for the study of spatial and temporal patterns of vector borne diseases. (GIS) estimate of the house fly densities was based on two variables (LULC) and (LST). The present study was carried out to identify risk area of the study area associated with the distribution of *M. domestica* in Al- Fayoum Governorate using Rapid Eye and Landsat8 satellite sensor data. The result of this study provided information regarding spatial and temporal distribution for such fly. The relationship of the distribution for the housefly with climatic factors and physio-environmental aspects yielded data that can be used for controlling and helpingin public health practitioners in making decisions on each specific landscape for fly control strategies. The analyses also proved that the highest fly densities were found in Mansheit El- Gammal village and BaniSaleh villages and also, indicated that over 90% of flies breeding sites at Al- Fayoum Governorate were found in places with high population density, low health services, low sanitation, low water services and highly fermented and untreated wastes.

REFERENCES

Akhoondzadeh, M., and Saradjian, M.R. 2008. "Comparison of land surface temperature mapping using MODIS and ASTER images in semi-arid are".Intern. Arch. Photogram., Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B8. Beijing 2008.

Alam, J.A. and Zurek, L. 2004. "Association of *Escherichia coli* O157:H7 with houseflies on a cattle farm". *Applied and Environmental Microbiology*, 70: 7578-7580.

Avancini, R.M., and Silveira, G.A. 2000. "Age structure and abundance in populations of muscoid flies from a poultry facility in Southern Brazil". Memorias do InstitutoOswaldo Cruz, 95 (2), 259-264.

Beck, L.R., Lobitz, B.M., and Wood, B.L. 2000. "Remote Sensing and Human Health: New Sensors and New Opportunities'. *Emerging Infectious Diseases,* 6, no. 3(May–June): 217–227.

Butler, J.F., Garcia, M. A., Meek, F., and Maruniak, J.E. 2010. "Wild Florida house flies (*Muscadomestica*) as carriers of pathogenic bacteria". *Florida Entomol,* 93: 218-223

Cairncross, S., and Feachem, R. 1993)." Environmental Health Engineering in the Tropics". 2nd ed. Chichester, U.K.: John Wiley & Sons.

Crosskey, R.W., Lane, R.P. 1993. "House-flies, blow-flies and their allies (calyptrate Diptera)". Medical Insects and Arachnids pp 403-428.

Egyptian Meteorological Authority, 1996. The Climatic Atlas of Egypt. Cairo.

El-Shirbeny, M.A., Abdellatif, B., Abd-Elraouf, M.A. and Nasser, H.S. 2016. "Hargreaves based on remote sensing method to estimate potential crop evapotranspiration". *Internat. J. of Geomate*, July, 2016, Vol. 11, Issue 23, pp.

Emerson, P.M., Bailey, R.L., Walraven, G.E. and Lindsay, S.W. 2001. Human and other faeces as breeding media of the trachoma vector *Muscasorbens*. Medical and Veterinary Entomology 15, 314-20.

Engelthaler, D.M., Mosley, D.G., Cheek, J.E., Levy, C.E. and Komatsu, K.K. 1999. Climatic and environmental patterns associated with hantavirus pulmonary syndrome, Four Corners region, United States. *Emerg Infect Dis.,* 5: 87–94.

Ezeomedo, I. and Igbokwe, J. 2013. "Mapping and Analysis of Land Use and Land Cover for a Sustainable Development Using High Resolution Satellite Images and GIS FIG Working Week 2013 Environment for Sustainability Abuja, Nigeria.

Ezz, El. Arab. G. 2003. "Trachoma Rapid Assessment and Planning for Intervention A Pilot Study in Fayoum Governorate". Partnership in Development Research Research Briefs No. 9.

Forster, M., Klimpel, S., and Sievert, K. 2009. "The house fly (*Muscadomestica*) as a potential vector of metazoan parasites caught in a pig-pen in Germany'. *Vet Parasitol*., 160: 163–167.

Hespanhol, I. 1996. “Health Impacts of Agricultural Development In book”: Sustainability of Irrigated Agriculture, pp.61-83.

Lu, D., and Weng, Q. 2007. “survey of image classification methods and techniques for improving classification performance A”. *Intern.J. of Remote Sensing,* 28(5): 823-870.

Machault, V., Vignolles, C., Borchi, F., Vounatsou, P., Pages, F., Briolant, S., and Rogier, C. 2011. “The use of remotely sensed environmental data in the study of malaria”. Geospatial health, 5 (2), 151-168.

National Research Council (U.S.).Committee on Earth Studies (2000. "Atmospheric Soundings". Issues in the Integration of Research and Operational Satellite Systems for Climate Research: Part I. Science and Design. Washington, D.C.: National Academy Press. pp. 17–24.

Norman, J.M., Divakarla, M., and Goel, N.S. 1995).”Algorithms for extracting information from remote thermal-IR observations of the Earth’s surface”, Remote Sens. Environ., 51: 157-168.

Nurita, A.T., Abu, H.A., and Nur, A.H. 2008. “Species composition surveys of synanthropic fly populations in northern peninsular Malaysia”. *Trop. Biomed.,* 25:145–153.

Pont, A.C. 1991. “A preliminary list of the Fanniidae and Muscidae (Insecta: Diptera) from Turkey and the Middle East”. *J.Zool. in the Middle East.,* (5), 1991 - Issue 1

Rady, M.H., Merdan, B.A., Essa, E., Salama, M.S. and Sayes, S. 2014. “he First Record of Escherichia coli O157: H7 Isolated from Wastes and Associated Houseflies in Egypt”. *World Appl. Sci. J.,* 31 (8): 1437-1447.

Sanchez-Arroyo, H. and Capinera, J.L. 2014. “House fly, *Muscadomestica* Linnaeus (Insecta: Diptera: Muscidae)”. IFAS Extension University of Florida.

Severini, F., Di Luca, M., Toma, L., and Romi, R., (2008. “Aedesalbopictus in Rome: results and perspectives after 10 years of monitoring”. *Parasitol*., 50 (1–2), 121–123.

Sinthusiri, J., and Soonwera, M. 2013. “Efficacy of herbal essential oils as insecticides against the house fly, *Muscadomestica* L”. *Southeast Asian J Trop Med Public Health.,* 44: 188-196.

Small, C. 2003).”High spatial resolution spectral mixture analysis of urban reflectance”. Remote Sensing Environ. 88, 170–186.

Valiente, J.A., Niclòs, R., Barberá, M.J., Estrela, M.J. 2010. Anal.differ. air-land Surf.temp. estim. land Surf. air temp. msg data.

Valor, E., and Caselles, V. 1996. “Mapping land surface emissivity from NDVI: application to European, African and South American areas”. *Remote Sensing of Environment,* 57, 167 – 184.

Vanwambeke, S.V. and Lambin, E.F. 2013. “Environmental change and vector borne diseases: the contribution of remote sensing and spatial analysis”. *Med. Sci.,* vol., 1.

****