Disaster Prevention and Management of Poultry Production in the UAE

Fadel M. A.[1] , Ahmed S. Hussein[2]
[1,2] College of Food and Agriculture, UAE University
mfadel@uaeu.ac.ae

Abstract

Agricultural production sectors represent a high-risk source of biological hazards. Facing disasters begins with preventing and reducing the risks. Huge investments are employed in poultry production to produce poultry products locally. On the other hand, zoonotic avian diseases, such as H1N5, are spreading around the world. A multidimensional system was developed to monitor the performance of poultry production farms, trace poultry products and associate the collected data with geographical information in GIS maps. The developed prototype consists of three major segments: flock identification system, website application and a GIS map. The first segment was designed to give a unique identification code to each flock produced locally in the United Arab Emirates, which was integrated into a poultry products identification system. The second segment was developed and hosted by UAE University servers (http://farmbiosecurity.uaeu.ac.ae/) to collect information from registered poultry farms on a daily basis. On the other hand, the collected information is stored on the server where it is used to develop a GIS map utilizing ArcGIS 10.1 Desktop which contains additional layers of information such as streets, villages, wind speed, and direction. The developed system was intended to help government authorities to predict and control epidemic outbreaks as an early warning system, manage biological disasters originating in poultry farms and handling food traceability crises. Each segment was examined on a pilot scale to assess its feasibility individually and in conjunction with the other segments. Preliminary results showed that the developed pilot system was very promising as an early warning mechanism to predict poultry-related epidemics and help the corresponding authorities to foresee the spread pattern of a problem according to the collected data and environmental conditions. On the other hand, authorities could allocate new production farms, live birds and litter transportation routes to minimize the possibility of initiating epidemic propagation. Furthermore, the food control authority could use the traceability system to handle biosafety food problems, and swiftly identify and isolate unsafe foodstuffs to prevent them from reaching the consumer. It was concluded that business owners were hesitant to apply such a system as, in their perception, it would place more of a burden on their staff. They were also cautious in revealing detailed information regarding their farm's environmental condition to control authorities, as it might mean investing more in biosecurity systems. It is recommended that this system is implemented by law to protect human health, the environment, and the economy.

Keywords: *poultry, biosecurity, outbreak, traceability, GIS.*

Introduction

Unexpected outbreaks of trans-boundary animal diseases (TADs) represent a significant cause of Animal disease emergencies which is related to animal health events. Consequences of those outbreaks affect include serious socio-economic catastrophes which may damage economic, trade and/or food security is the affected country(s). International cooperation is a must to face such events in order to control the spread of the diseases and avoid reaching to epidemic magnitudes. FAO report [1].

Geographical Information System GIS is an excellent tool to monitor and manage animal production sectors in both National and International levels where outbreaks could be catastrophic at both levels. In addition to public health concerns, zoonotic avian diseases outbreaks have economic, social and environmental impacts which may sustain in societies for a long time creating public anxieties. On the other hand, to assure food security requirements, supply chain should stay working robust and steadily without dramatic drops neither in quantity nor quality. National preparedness for food safety problems, biological disasters, and zoonotic avian outbreaks is an essential effectiveness parameter in the ability of disaster avoidance and control.

Several spatial features represented on GIS maps are feasible tools to describe and explain disease dynamics and patterns of epidemic spread. GIS can assist in increasing the response time and the precautions taken in case of an emergency linked with the introduction of disease. Updated data of farms, poultry premises, roads, etc., prior to an emergency is a key preparedness feature which can help in implementing disease control measures, surveillance activities including regulating of the movements of shipping trucks, vehicle maneuverability the civil roads, etc. The existence of digital data locating abattoirs, mines, incinerators, etc., helps in directing the trucks carrying susceptible animals to avoid imposing risk to the surrounding environment or the unaffected farms [1, 2].

In the Middle East, few countries are applying GIS technology to manage or monitor animal production facilities due to various reasons such as lack of investment or absence of research projects studying applying such technology in agriculture. Difficulty of having good quality data in some countries made it almost impossible to utilize GIS in serving such crucial food production sector [3].

Furthermore, VetGIS was employed [4] and applied to actual avian influenza data during the 1999-2001 outbreak in Italy. A specific veterinary GIS (VetGIS) toolbox was developed to perform the calculation of indices such as Lorenz curve, GINI index, NNI (Nearest Neighbor Index) and a kernel-based animal density estimation. On the other hand, employed VetGIS to simulate a swine flu outbreak in Styria to define a protection zone of 3 km radius and a surveillance zone of 10 km radius to be set up around the suspect farm [5].

Also, zoning of zoonotic avian disease is needed for effective prevention and control and also to reduce the socio-economic impact of the outbreak. [6] modeled the risk area affected or under the risk of contracting H1N5 using GIS tools, while [7] studied the relation between free range ducks and native birds and the spread of H1N5 in Thailand. Results demonstrate a strong association between H5N1 virus in Thailand and abundance of free-grazing ducks and, to a lesser extent, native chickens, cocks, wetlands, and humans.

In the United Arab Emirates, [8] designed a mobile application to help farm supervisors to document daily works online.

To identify each flock of birds and makes it feasible to document daily practices in the farm. Then, [10] and [9] developed a unique identification code based on the standard European EAN128 barcode to identify poultry products and mapped the collected data using GIS maps using ArcGIS 10.1®. An integrated monitoring system for poultry farms in UAE was developed to achieve the major objectives to protect customers, investments, and environmental to guarantee both food security and biosecurity as well.

All-hazards planning and preparation approach is based on the realization that regardless of the cause of a disaster (natural, accidental, or intentional). The similarities are generally greater than the differences in how authorities go about lessening the likelihood of human harm, preparing for the eventuality, responding to incidents, and recovering from the aftermath. When adversity strikes or disaster looms large, our citizens, communities, and infrastructures must be prepared. Particular consideration must be given to the needs of vulnerable and diverse populations in order to better serve all members of a community [11].

This problem should be faced internationally utilizing various tools, one of them is GIS, for example [12] surveyed poultry farms working in Republic of Macedonia in order to determine its infection with avian influenza viruses in commercial farms. Also, [13] developed an effective model to predict wind-borne spread of highly pathogenic Avian Influenza Virus among poultry farms in Holland, where it was applied to predict the rate of spreading the diseases related to wind speed. They concluded that birds in farms within 25km of the infected farms have a probability of almost 25% to get the infection, where this probability ratio doubles to 50% if it lays within 3km of the infected farm.

Materials and Methods

The major functions of the developed system:

- Identify each flock of birds produced in any of the commercial poultry farms registered in the country

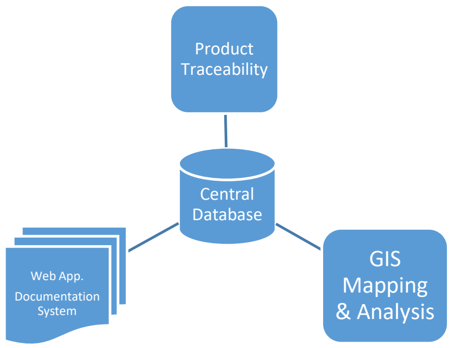

Figure 1: Poultry farms surveillance system.

- Traceability of registered poultry products
- Real-time collection of detailed data via a website application,
- Mapping the collected data using ArcGIS 10.1 on UAE dynamic map in addition to the weather data collected from weather station around the country.

ArcGIS 10.1 was the selected platform to integrate collected information from major commercial poultry farms in the UAE in addition to different layers of roads, villages, cities, farms and other civil amenities. Weather information was also incorporated into the base map of the country. Toolbox proximity functions such as intersect and distance were utilized to analyze the risk of getting infection among farms and between farms and villages which are most probably have backyard poultry.

Results and Discussion

National preparedness protocol to avoid, predict, and manage biological outbreaks in society is one of the pillars of national security structure. Surveillance of animal production farms is a vital practice in such complicated world of constantly changing supply chains, infrastructure, environment and societal concerns. The developed surveillance system allows food control authority to collect enough information about daily practices in the registered farms to monitor its compliance with the laws and regulation as well as protect the whole industry, nevertheless, the society from being faced with outbreaks.

As shown in Fig. 1 and Fig 2, the developed web application is designed to collect information about daily performs in each poultry house including mortality rate, vaccinations, the source of vaccine, source of feed and checks.

The developed map accommodated major poultry farms as seen in Fig. 3 where different levels of buffers ranging between 1km to 25km shown various intersections among four poultry farms and between six farms and the surrounding villages.

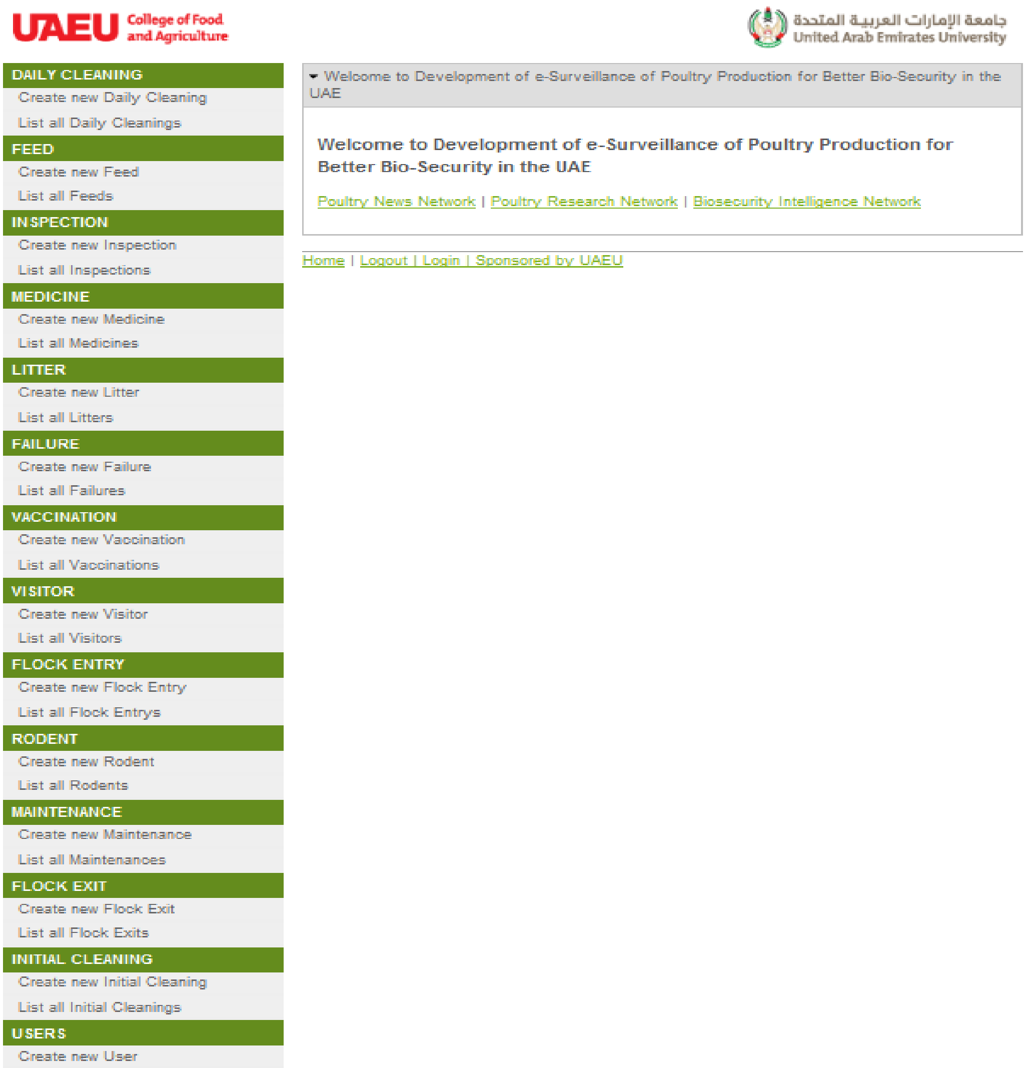

Figure 2: A snapshot of the developed web application.

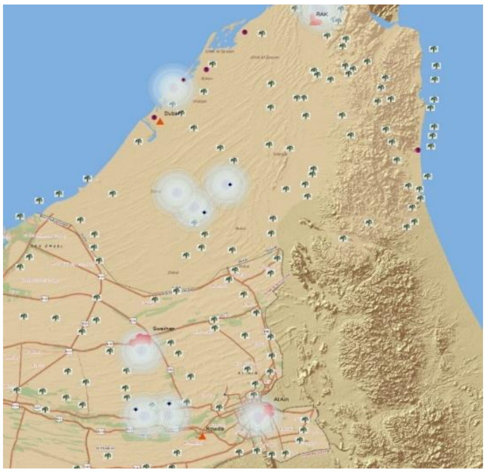

Figure 3: Major commercial poultry farms in UAE.

Farms A and B is shown in Fig. 4 were used as an example of the intersection between commercial farms buffer zones and small-scale plant which most of them have animals. Unfortunately, plant farms layer was not active, and analysis was not possible. Fig. 5 shows wind roses of July where most of the days wind are directed towards 150-200 degrees when the analysis is carried out on the map. For the sake of preparedness, two hypothetical scenarios were studied. For farm A, if it is infected, most probably the wind would transport the pathogen towards the 150-200 degrees. Hence, live birds transportation via road E22 should be prohibited, and birds and humans in plant farms located in the same direction should be monitored closely. On the other hand, if farm B is proofed infected, transporting live birds in road E30 should be prohibited, and its litter trucks should not use road E22 to avoid infecting farm A as well. Humans and birds in farms located down the wind should be monitored closely.

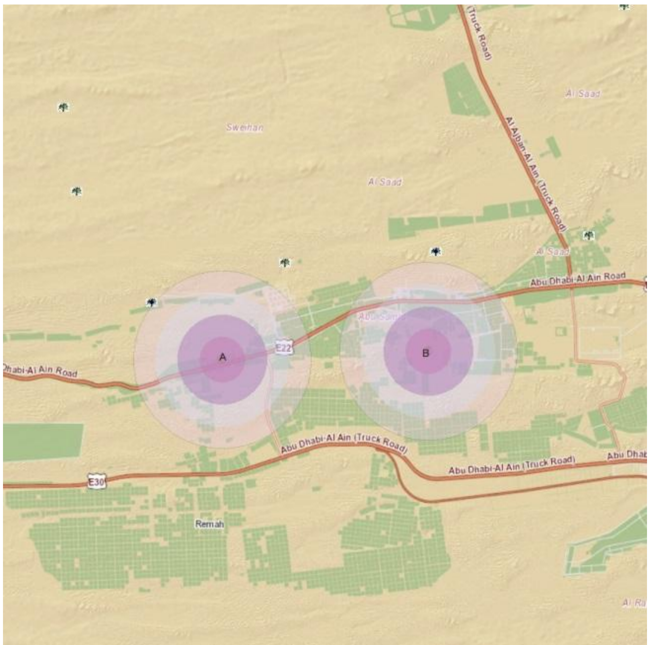

Figure 4: An example of two farms intersecting with roads and surrounding farms.

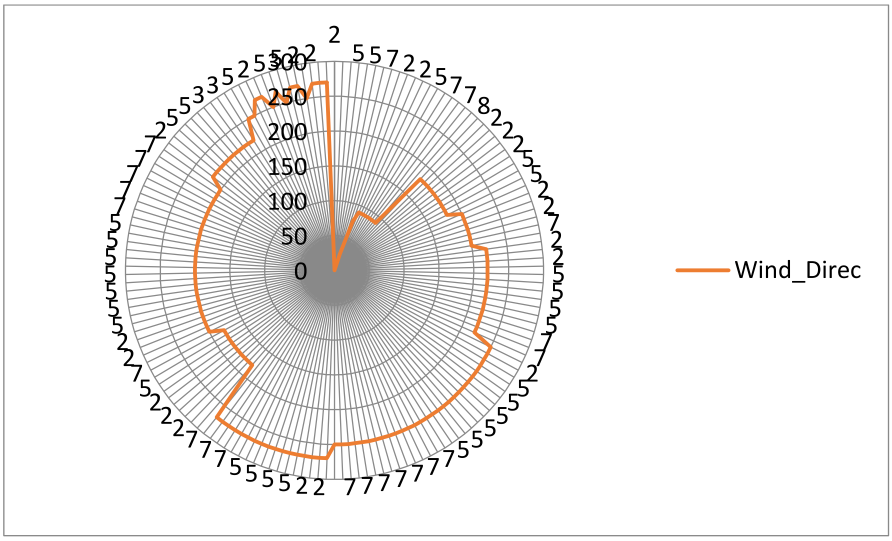

Figure5: Weather data in July.

From Fig. 6 and Fig. 7, it can be concluded that 2% of the farms are located within 5Kms, where 11% of the registered commercial farms are located within 25Kms from each other. Calculations using the model developed by [13] showed that it can be expected that there is a probability of about 37% that wind-borne avian flu from-to the farms located within 5Kms from each other. When the same model used to expect the potential wind-borne infection among registered farms and villages which have open range small scale poultry farms, Fig. 2 shows that about 30% of the farms are located within 25Kms or less from those villages. According to the resulted calculations, that there is a probability of at least 15% that the infection might be transmitted via wind-borne route from-to non-registered small scale farms and registered farms as well.

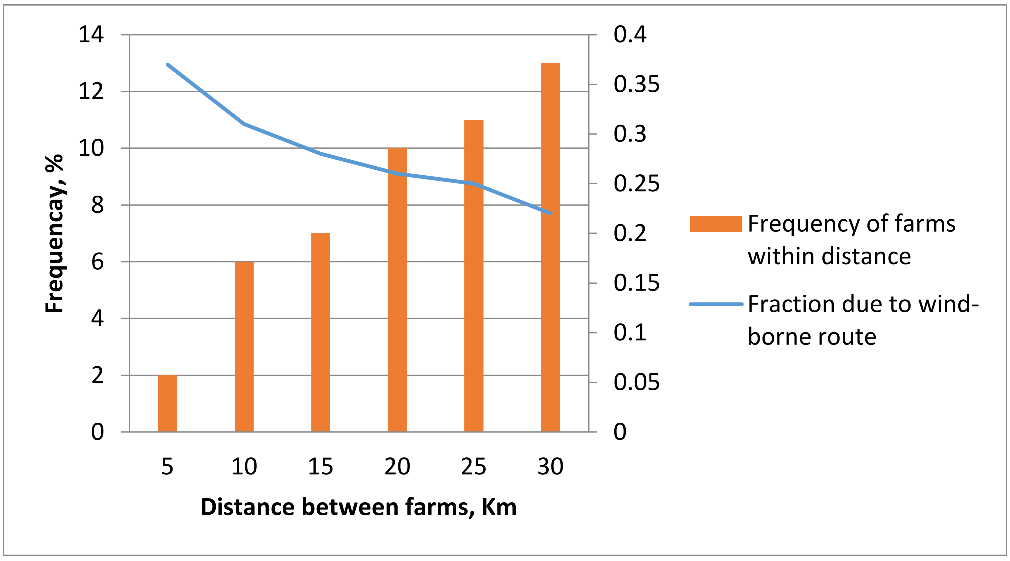

Figure 6: Estimated fractions of local commercial farms based on the model developed by [1].

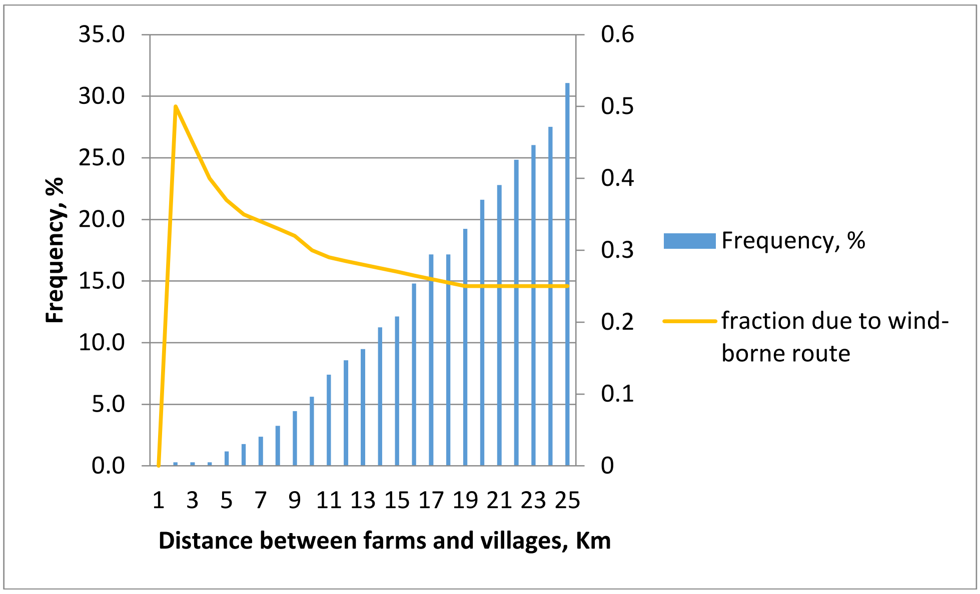

Figure 7: Estimated fractions of local commercial farms and villages.

Conclusion

At the UAE University, a multidimensional system was developed to monitor the performance of poultry production farms, trace poultry products and associate the collected data with geographical information in GIS maps. The developed prototype consists of three major segments: flock identification system, website application and a GIS map. The developed system was intended to help government authorities to predict and control epidemic outbreaks as an early warning system, manage biological disasters originating in poultry farms and handling food traceability crises. Each segment was examined on a pilot scale to assess its feasibility individually and in conjunction with the other segments. Geographical Information System is an excellent tool to monitor and manage animal production sectors in both National and International levels where outbreaks could be catastrophic at both levels. National preparedness for food safety problems, biological disasters, and zoonotic avian outbreaks is an essential effectiveness parameter in the ability of disaster avoidance and control. Only a few countries in the Middle East regularly use GIS in their routine activities. While is a general understanding of the facilities offered by the application of GIS in the control and prevention of animal diseases. The availability of up-to-date data on the location of farms, poultry premises, roads, etc., before an emergency can help in implementing disease control measures, surveillance activities including control of the movements of vehicles. The developed surveillance system allows food control authority to collect enough information about daily practices in the registered farms to monitor its compliance with the laws and regulation as well as protect the whole industry, nevertheless, the society from being faced with outbreaks. These studies showed that the developed pilot system was very promising as an early warning mechanism to predict poultry-related epidemics and help the corresponding authorities to foresee the spread pattern of a problem according to the collected data and environmental conditions. Also, authorities could allocate new production farms, live birds and litter transportation routes to minimize the possibility of initiating epidemic propagation.

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