Summary and Conclusion

Bancroftian (lymphatic) filariasis is a major cause of clinical suffering and disability. It is endemic in eight Governorates in Egypt.

Filariasis is not just a disease but an economic and social problem that burdens our country.

Because of effective diagnostic techniques, knowledge of disease vector, potent treatment, and lack of animal reservoirs, filariasis is a potentially eliminable disease. Lymphatic filariasis (LF) has been targeted by the World Health Organization for elimination as a public health problem by the year 2020.

The global initiative to eradicate bancroftian filariasis currently relies on Mass Drug Administration (MDA) with four to six annual doses of antifilarial drugs. The goal is to reduce the reservoir of microfilariae in the blood to a level that is insufficient to maintain transmission by the mosquito vector.

Many control measures have been implemented to eradicate the disease but the results were controversial and incur very high amount of money and time. Spatial modeling helps in formulating strategies to control, which would have not been possible physically.

Within the field of spatial epidemiology, knowledge about host, agent and environment is needed to get insight into the etiology of the disease and to develop and promote disease control measures.

Recent advances in geographic information systems and mapping technologies have created new opportunities for the generation of reliable information about the disease.

Geographic Information Systems (GIS) adds a powerful graphical and analytical dimension to public health. The spatial modeling capacity offered by GIS is directly applicable to understanding the spatial variation of disease, and

its relationship to environmental factors. Unfortunately, the importance of the spatial distribution of disease has been too often overlooked.

Analysis of the study data indicated that geo-climatic factors play an important role in determining the distribution of filariasis in Kalyobiya governorate.

The study provided a GIS – based information system related to filariasis disease distribution in Kalyobiya governorate.

Epidemiologists have traditionally used maps when analyzing associations between location, environment, and disease. The study shows that GIS is particularly well suited for studying these associations because of its spatial analysis and display capabilities.

The study used two different modeling methods to predict the prevalence risk probability of bancroftian filariasis within Kalyobiya governorate. These methods are the statistical and the spatial modeling.

Statistical modeling involved the use of a logistic regression model in combination with data mining to recognize the geo-climatic variables that are associated with filariasis infection in the study area.
The combination of tree based data mining tool and logistic regression analysis constitute a novel analytical approach, providing an accurate and dynamic picture of the main risk factors for filariasis infection. Data mining can give further insights on the analysis used by regression analysis and reciprocally regression analysis can quantify data mining results leading to a more refined understanding of the actual importance and interplay between risk factors.

Spatial modeling involves the use of Kriging interpolation method. This method accurately estimated the distribution of *bancroftian filariasis* across the entire study region. This procedure investigates and projects the spatial

pattern of *bancroftian filariasis* prevalence based on spatial autocorrelation among sampled populations.
Kriging analysis provides the most accurate estimate of *filariasis* distribution. It has significantly improved the prediction of filariasis risk produced by the statistical methods. The predicted risk for filariasis infection could be extrapolated to points outside the observed data set.
Large clusters of villages with similar prevalence status were accurately detected in the final filariasis prediction map produced using co-kriging procedure.
Geographically weighted regression (co-kriging) has the potential to integrate spatial and ecologic information into a unified modeling framework. These approaches hold promise for improving prediction accuracy and for elucidating stronger relationships with ecologic predictor variables.

The final filariasis prediction map is in agreement with eco-geographical descriptive epidemiology of filariasis in literature as adjacent areas tend to have similar environmental conditions and the probability of occurrence in one location is not independent of occurrence in neighboring locations. Spatial autocorrelation shows that the distribution of filariasis infection is nonrandom and dependent on geo-climatic variables.
Lymphatic filariasis transmission in Kalyobiya governorate is mainly determined by climatic factors and the formation suitable breeding sites for the vector, even on a small scale, which in turn governs filarial transmission dynamics.

In rural settings, the most prominent man-made breeding sites are water bodies created by irrigation systems. The study provided evidence that nearness to water bodies is strongly associated with disease prevalence on the small scale.

The two-stage approach that was used by the study, offers an appealing tool to predict the risk of filariasis disease. The statistical model provides the

covariate adjustment and prediction of disease risk in an area. Kriging allows for spatial dependence and provides accurate estimate of filariasis *risk*.

The approach presented in this thesis enables to incorporate the pattern of spatial dependence of disease prevalence into the mapping of disease risk and the quantification of its interpolated values at every point in the study region.

In conclusion, the model produced by the study is a reliable representation of filariasis risk in Kalyobiya governorate. The final predictions make sense from the epidemiological perspective.

Disease maps can serve to display prevalence rates geographically, to inform decision makers about the success or failure of interventions, and to make hypothesis or to provide evidences concerning disease etiology and factors associated with disease spread.

The main conclusion that emerged from the simulation model based analysis in this study is that 5 rounds of MDA are not enough to eliminate filarial infection.

Major challenges remain if simulation modeling of filariasis control is to be used more widely for decision support.

A major challenge lies in the quantification and validation of model parameters for different regions. Many of modeling parameters need to be quantified and validated for the transmission dynamics of disease in the study location.
The parameters of the model provided by this study were quantified for transmission of W. bancrofti by Culex quinquefasciatus and tested against data from Pondicherry, India.

Programs report only coverage of drug distribution; no data on actual consumption of the drug are currently available. There are considerable gaps between coverage (measured as the proportion of the population that

received the drug) and consumption (measured as the proportion of the population that actually consumed the drug) (Subramanian et. al; 2008).

Individuals differ in compliance and responsiveness to treatment, which may also contribute to aggregation of parasites. This aggregation enhances transmission because it increases the probability that female and male worms mate. Heterogeneity may also occur in the parasite population, e.g. with respect to the lifespan and resistance to treatment (Plaisier et al; 1999).

The outcomes of elimination program need to be monitored and evaluated. This can provide the data required to evaluate the results of simulation modeling. Data about the local conditions, local coverage, actual consumption of the drugs, heterogeneity of treatment responses and the achieved reduction in filarial prevalence, are needed to evaluate these models. They also can be used to refine the parameters of simulation to produce more accurate results so that the models could help to determine when mass treatment can be stopped.