SPATIAL EXTENT OF THE BROWN PLANTHOPPER (BPH) *Nilaparvata lugens* (Stal.) IN FOUR PROVINCES OF CENTRAL THAILAND.

Laura ABRIL

Graduate School of Agriculture. Kyoto University
Oiwake-cho, Sakyo-ku, Kyoto, 606-8502, Japan

labril18@gmail.com; laura.garcia.74z@st.kyoto-u.ac.jp

Eiji NAWATA

Graduate School of Agriculture, Kyoto University
Oiwake-cho, Sakyo-ku, Kyoto, 606-8502, Japan

nawata@kais.kyoto-u.ac.jp

KEY WORDS: pest control, risk areas, spatial trends.

Abstract

The Brown planthopper (BPH), *Nilaparvata lugens* (Stal) is one of the most important rice insect pests in the central and lower northern regions of Thailand where important losses in rice production have occurred especially since 2009. Forecasting and predicting risk areas of BPH in Asian countries was established as one of the priorities and research actions by The International Conference on Brown Planthoppers (2008) in order to optimally control the pest (Heong, 2009). The objective of this research will be to follow and conduct in 32 districts in 4 provinces of Central Thailand the method proposed by Widyawati N et al. (2014) to detect the possible formation of Brown planthopper (BPH) (*Nilaparvata lugens*.Stal) endemic areas based on spatial trend and risks areas caused by spatial connectivity. Literature published until present, shows that there are no studies in this matter in the Central Region of Thailand where the pest has been reported as most important (Wantana 2010; Senakas *et al*. 2010). Previous research in this field has been done in Central Java in Indonesia where the spatial pattern of BPH endemic areas were identified from analysis using Moran 's I and Getis Ord (Prasetyo *et al*. 2012; Prasetyo *et al.* 2013).

INTRODUCTION

The Brown planthopper (BPH), *Nilaparvata lugens* (Stal.) is one of the most important rice insect pests in tropical and sub-tropical regions of Asia. In Thailand, is especially important in the central plain and lower northern regions of the country where the most consecutive outbreaks have occurred. Since 2009 to present, vast rice production areas have been damaged (Wantana, 2010; Senakas et al 2010). Rice production in Thailand suffered one of the biggest losses ever experienced. At least 1.1 million tons paddy rice with an export potential value of US$ 275 million was reported lost (Heong, 2009).

The Bureau of Rice Research and Development of Thailand (2010) informed that high population growth rates of the BPH in Thailand were mainly caused by: (i) the increase of rice planting areas with a single crop, (ii) the increase of planting areas with growing susceptible rice varieties, (iii) favorable weather conditions and (iv) misuse if insecticides. Moreover, following the Monsoon this pest has the ability to migrate long distances (Widyawati, N, et al 2014).

Due to the important consequences of BPH outbreaks in rice production in many Asian countries, The International Conference on Brown Planthoppers (2008) established that within the main knowledge gaps and research actions to enhance risk assessments and the design of current and future management options, mapping and forecasting the risk of the BPH, and regularly monitoring the pest and natural enemies were considered as priorities.

Geographic Information Systems (GIS) provide important tools in forecasting the risks of pests (Bouwmeeste et al. 2010). Using GIS makes possible to predict and create a warning system against BPH outbreaks in rice (Nguyen et al., 2012). GIS can also be used together with integrated pest management (IPM) programs when establishing pest hot-spots and assessing the probability of pest outbreaks in different parts of a region (Yadav *et al*. 2010).

This research aims to apply and conduct in 32 districts in 4 provinces of Central Thailand the method proposed by Widyawati N et al. (2014) to detect the possible formation of Brown planthoppers (BPH) (*Nilaparvata lugens*.Stal) endemic areas based on spatial trend and risks areas caused of spatial connectivity. Literature published until present, shows that there are no studies in this matter in the Central Region of Thailand where the pest has been reported as most important (Wantana 2010; Senakas *et al*. 2010). Previous research in this field has been done in Central Java in Indonesia where the spatial pattern of BPH endemic areas were identified based on hotspots and coldspots resulting from analysis using Moran 's I and Getis Ord (Prasetyo *et al*. 2012; Prasetyo *et al.* 2013).

Spatial patterns and structure factors like biotic interactions, topography and climate are known to form connectivity between spatial objects in ecosystems (Wang *et al*. 2009; Bottrell 2012; Rudnick 2012). The degree of this spatial connectivity can be measured using the method of Spatial Autocorrelation (Chowell *et al.* 2006; Chen & Jiang, 2010). As stated by Widyawati N *et al*. (2014) the Spatial Autocorrelation method can yield information migration patterns and population distribution of BPH in the surrounding area by looking at the spatial structure. Connectivity between the BPH outbreaks can be measured using time-series approach like the Triple Exponential Smoothing method assuming that BPH outbreaks occur following seasonality.

METHODOLOGY

Frequently, the GIS application objectives determine the GIS analyzing method to be used. Since the objective of this study will be to apply and conduct the method proposed by Widyawati N et al. (2014) to detect in Central Thailand, possible formation of endemic areas of BPH (*Nilaparvata lugens*.Stal) based on spatial trend and spatial connectivity the main method to be used will be Spatial Autocorrelation (Chowell et al., 2006; Chen & Jiang, 2010).

Spatial autocorrelation is a method used to test for the presence of general spatial trends in the distribution of a geographical variable over a whole space through the exploration and analysis of spatial data (ESDA). Until present, various natural phenomena have been modeled and simulated using ESDA. Some of the features that can be identified with ESDA are the visualization of the spatial distribution, the identification of the location of atypical or outliers, the representation of spatial association patterns, and the identification of hotspots, coldspots and spatial regimes (Anselin, 1993; Anselin 1996).

Spatial patterns of BPH endemic areas have previously been identified based on hotspot and coldspot as result from Moran 's I and Getis Ord analysis (Prasetyo *et al.* 2012) and connectivity between endemic areas as migration paths Can be modeled as well using Moran's and Getis Ord as it was done in 124 districts in Central Java Province, Indonesia (Prasetyo *et al.* 2013).

Based on the method suggested by Widyawati N *et al* (2014). The Stages that will be followed in this study are: (1) Pest collection data that will be classified in monthly and year data 2) database development, (3) the create of the component class Exponential Smoothing, and the local spatial autocorrelation function- Getis and Ord's local statistics-G and G * function, (4) development of the GIS applications, (5) visualization of the information in the form of graphs, maps and tables.

STUDY AREA

The study area will cover 32 Districts in 4 provinces in central Thailand, Chainat (8 districts), Suphan Buri (10 districts), Pathum Thani (7 districts) and An Thong (7 districts). These provinces were reported as the most severe affected by 2009 outbreaks. (Heong KL 2009; Thongdeethae S 2009; DANIDA 2003) Figure 1. The data that will bused for this research is BPH Outbreak data derived from Rice Department in Thailand. Stages of research can be seen in Figure 2.

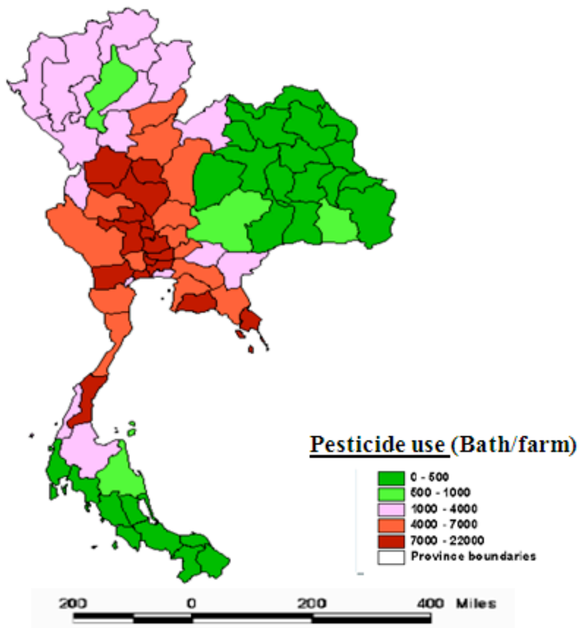
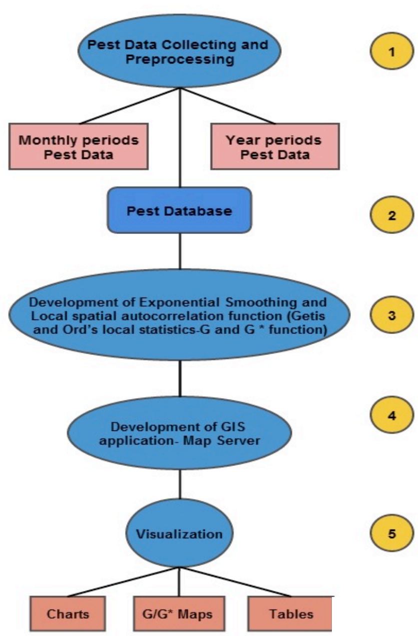


Figure 1. Map showing the distribution of pesticide use in Thailand.
Source: IPM DANIDA 2003



Modified from:

Figure 2. Research stages. *Widyawati N et al. 2014*

EXPECTED RESULTS

Information about BPH spatial trends and predictions of distribution patterns are expected to be the main outcomes. From the analysis and calculation using the Local Spatial Autocorrelation function (Getis Ord and G*) thematic maps showing connectivity are also expected to be one of the products of this research. The interpretation of value in the analysis of Getis Ord using indicators Z (Gi) compared to values of G * will provide the sources of information for early detection as stated by Widyawati N *et al* (2014).

REFERENCES

Anselin L. (1993a). Exploratory Spatial Data Analysis and Geographic Information System, National Center for Geographic Information and Analysis University of California, Santa Barbara.

Anselin L. (1996). The Moran Scatterplot as an ESDA Tool to Asses Local Instability in Spatial Association. Spatial Analytical Perspective in GIS, Taylor and Francis, London, 1996.

Bottrell, D. G., & Schoenly, K. G. (2012). Resurrecting the ghost of green revolutions past: The brown planthopper as a recurring threat to high-yielding rice production in tropical Asia. Journal of Asia-Pacific Entomology, 15, 122-140. http://dx.doi.org/10.1016/j.aspen.2011.09.004

Bouwmeester, H., Abele, S., Manyong, V.M., Legg, C., Mwangi, M., Nakato, V., Coyne, D., and K. Sonder. 2010. The PotentialBenefits of GIS Techniques in Disease and Pest Control: an Example Based on a Regional Project in Central Africa. Proc. IC on Banana &Planta in Africa. Eds.: T. Dubois et al.Acta Hort. 879, ISHS.

Heong, K.L., and B. Hardy, eds. Planthoppers: new threats to the sustainability of intensive rice production systems in Asia. Int. Rice Res. Inst., 2009.

Heong, K.L., 2009. Planthoppers Outbreaks in 2009. Available source : http://ricehoppers.net/2009/09/planthopper outbreaks-in-2009. posted by Moni Sept. 25, 2009.

Nguyen, V. G. N., Drogoul, A., & Huynh, H. X. (2012). Toward an Agent-based Multi-scale Recommendation System for Brown Plant Hopper Control, Institut de recherche pour le développement Bondy, France.

Prasetyo, S. Y., Subanar, J., Winarko, E., & Daryono, B. S. (2012). Endemic Outbreaks of Brown Planthopper (Nilaparvata lugens Stal.) in Indonesia using Exploratory Spatial Data Analysis. IJCSI International Journal of Computer Science Issues, 5(1), 162-171.

Prasetyo, S. Y. J., Subanar, S., Winarko, E., & Daryono, B. S. (2013). The Prediction of Population Dynamics Based on the Spatial Distribution Pattern of Brown Planthopper (Nilaparvata lugens Stal.) Using Exponential Smoothing–Local Spatial Statistics. Journal of Agricultural Science, 5(5), p209.

Senakas P. Rattanakarn W, Sriratanasak W and Soitong K., 2009. Current Outbreak Situation of Brown planthopper in Thailand. Rice Department Report. Thailand.

Sriratanasak, W., 2010. Brown Planthopper: a Formidable Rice Insect Pest in Rice Growing Areas and New Concept of Its Management . Thai Rice Research Journal, Vol. 4 No. 1.

Wang, C., Li, D., Hu, Y., Wu, X., & Qi, Y. (2009). Research of spatio-temporal analysis of agricultural pest, LIESMARS. International Symposium on Spatial Analysis, Spatial-Temporal Data Modeling, and Data Mining. Retrieved from http://adsabs.harvard.edu/abs/2009SPIE.7492E.117W

Widyawati, N., Kristoko, D. H., & Hasiholan, B., 2014. Geographic Information System for Detecting Spatial Connectivity Brown Planthopper Endemic Areas Using a Combination of Triple Exponential Smoothing-Getis Ord. Computer and Information Science, 7(4), p21.

Yadav, D.S., Chander,S.,Selvaraj, K., 2010. Agro-ecologicalzoning of Brown planthopper (Nilaparvatalugens (Stal) incidenceon rice (Oriza sativa L.). Journal of Scientific and Insdustrial research, Vol 69. November 2010. pp 818-822.