UNIVERSITI PUTRA MALAYSIA

SPATIAL VARIABILITY OF SOIL SALINITY AND PLANT GROWTH IN THE SUNGAI BESAR COASTLINE MANGROVES

NE'RYEZ SINGH RANDHAWA

FP 2017 11

SPATIAL VARIABILITY OF SOIL SALINITY AND PLANT GROWTH IN THE SUNGAI BESAR COASTLINE MANGROVES

BY

NE'RYEZ SINGH RANDHAWA

A project report submitted to the Faculty of Agriculture, Universiti Putra Malaysia, in fulfillment of the requirement of PRT4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science.

FACULTY OF AGRICULTURE
UNIVERSITI PUTRA MALAYSIA
2016/2017

© COPYRIGHT UPM

CERTIFICATION

This project report entitled 'Spatial Variability of Soil Salinity and plant growth in the Sungai Besar Coastline Mangroves' is prepared by Ne'ryez Singh Randhawa and submitted to the Faculty of Agriculture in fulfillment of the requirement of PRT4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science.

Student's Name: Student's Signature

Ne'ryez Singh Randhawa - - - - - - - - - - - - - - -

Certified by:

- -

Assoc. Prof. Dr. Siva Kumar Balasundram
Department of Agricultural Technology
Universiti Putra Malaysia

Date:

© COPYRIGHT UPM

ACKNOWLEDGEMENT

With the grace and mercy of the Almighty, I have finally managed to finish writing my thesis. I would like to take this opportunity to express my outmost appreciation to a few people who were involved directly or indirectly in completing and perfecting my research.

First and foremost, thank you to my project supervisor, Assoc. Prof. Dr. Siva Kumar Balasundram, for his endless guidance, encouragement, advice and support throughout this whole thesis writing process. I would also like to thank my project partner, Nik Nurul Shahira bt Nooh, for always accompanying me and helping in making this thesis a reality.

A very warm appreciation to Dr. Jeyanny, the project coordinator from Forest Research Institute Of Malaysia (FRIM) in Kepong, Kuala Lumpur for allowing me to conduct this research along with them. Thank you to the FRIM staffs involved in this project, namely En. Fakhri, En. Norhisyam and En. Maznan. Their kindness and assistance are crucial in the success of this project.

I would like to give a small token of my appreciation to Mr. Kang Seong Hun, a post graduate student from the Department of Soil Science, Universiti Putra Malaysia for helping and providing quality information about my research, specifically helping me understand how to operate softwares such as GS+ and Surfer 8.

Last but not least, I would like to thank my family, especially my father and mother for their constant guidance and everlasting love throughout my study in UPM. I would also like to thank those friends who always pushed me to through the process of completing this research.

© COPYRIGHT UPM

TABLE OF CONTENT

© COPYRIGHT UPM

© COPYRIGHT UPM

LIST OF TABLES

© COPYRIGHT UPM

LIST OF FIGURES

© COPYRIGHT UPM

ABSTRACT

Mangrove forest plays an important part in our ecosystems. The most notable function of the mangroves is to provide protection along the coastlines. But due to the drastic decrease in population over the years, it is vital to conserve this unique species. UPM, along with their partners in FRIM, are collaborating to come up with a spatial variability map of the mangroves forest in Sungai Besar, Selangor. The map is created using parameters such as soil salinity and plant health. An area of 80m x 10m, with 40 quadrants within it, was formed. The soil salinity are measured in terms of electrical conductivity (EC). Soil samples from each quadrant was taken to analyze the EC at 2 different depths (0-15 cm and 15-30cm). Besides that, the chlorophyll content and girth (cm) of a random mangrove tree inside each quadrant is taken to measure plant growth. The samples are taken to UPM for labaratory analysis. Once all the data is formed, softwares such as GS+ and Surfer 8 (Golden Software) was used to analyze the data and come up with the spatial variability map. The results indicated that the middle of the sample plot are in better conditions, as compared to the sides and edges. This can accelerate site-specific management and save time and cost in terms of rapid assessment of the general health of the mangrove forest. Replication of similar experiments can also be conducted in the coastlines of Peninsular Malaysia for better utilization of resources based on site specific management.

© COPYRIGHT UPM

ABSTRAK

Hutan bakau memainkan peranan yang penting dalam ekosistem kita. Fungsinya yang paling ketara adalah untuk memberi perlindungan di sepanjang persisiran pantai. Tetapi disebabkan oleh penurunan populasi bakau yang mendadak selama ini, ia adalah penting untuk memulihara spesies unik ini. UPM, bersama-sama dengan rakannya di FRIM, bekerjasama untuk membina peta kepelbagaian spatial hutan bakau di Sungai Besar, Selangor. Peta ini dicipta menggunakan parameter seperti kemasinan tanah dan pertumbuhan tumbuhan. Kawasan seluas 80m x 10m, yang merangkumi 40 quadran, telah ditubuhkan. Kemasinan tanah diukur dari segi kekonduksian elektrik. Sampel tanah dari setiap kuadran telah diambil untuk menganalisis kekonduksian elektrik pada 2 kedalaman yang berbeza (0-15sm dan 15-30sm). Selain itu, kandungan klorofil dan lilitan pokok (sm) pokok bakau, yang diambil secara rawak dalam setiap kuadran, diambil untuk mengukur pertumbuhan tumbuhan. Sampel tersebut dihantar ke UPM untuk analisis makmal. Setelah memperolehi semua data, perisian seperti GS + dan Surfer 8 (Golden Software) telah digunakan untuk menganalisis data dan mencipta peta kepelbagaian spatial. Keputusan menunjukkan bahawa pertengahan sampel plot berada dalam keadaan yang lebih baik, berbanding dengan kedua-dua bahagian tepi. Ini boleh mempercepatkan pengurusan tapak secara terperinci dan menjimatkan masa dan kos dari segi penilaian kesihatan umum hutan bakau. Replikasi eksperimen yang sama juga boleh dilakukan pada pokok bakau di sepanjang persisiran pantai semenanjung Malaysia untuk pengurusan sumber yang lebih efisyen

© COPYRIGHT UPM

CHAPTER 1

1.1 Background

Mangrove forest occurs worldwide on tropical, sheltered shores (Chapman, 1976; Tomlinson, 1986). Mangroves are salt tolerant trees (halophytes), and can adapt to harsh coastal conditions. They have a salt filtration system and complex root system to cope with salt water immersion and wave action. They can withstand low oxygen conditions of waterlogged mud. Mangroves are an integral part of the ecosystem, providing functions such as coastline protection, aquaculture, firewood, charcoal production and conserving flora and fauna species.

Figure 1.1: A Mangrove Tree (Source: http://treepicturesonline.com).

However, like other coastal ecosystems, mangroves are not safe from human intervention and destruction. They were traditionally managed by small coastal communities at a

sustainable level, but their intense exploitation has led to an ever-worsening picture. These ecosystems have become an easy target for the extraction of wood for fuel and construction, the production of food and waste disposal (Adeel, 2001). This unique ecosystem is under tremendous stress due to erosion, excessive anthropogenic activities and natural disasters such as tsunami. The mangroves in Malaysia have experienced a drastic decline and the Malaysian government is trying to come up with ways to preserve these mangroves. Due to the importance of mangrove forest to the ecological system and environment, it is necessary to have good management and conservation of mangrove forest. It will help to solve mangrove forest's issues and problems and eventually help to achieve sustainability.

1.2 Justification and Problem Statement

Soil salinity and plant health are important indicators of the status of a plant. Hence, the electrical conductivity and also the chlorophyll content and girth are used to determine the status of the mangrove forest. All these parameters are used as the medium in creating the spatial variability map. This spatial variability map help us in carrying out site specific ecosystem management to help preserve the mangrove forest.

1.3 Objective

- To determine and analyse the spatial variability of soil salinity and plant growth in the mangrove forest of Sungai Besar, Selangor.

© COPYRIGHT UPM

REFERENCES

Abdu, H. R. & D.A. Jones, S. 2007. Comparing bulk soil electrical conductivity determination using the DUALEM-1S and EM38-DD electromagnetic induction instruments. Soil Science Society of America Journal, 71, 189.

Adeel, Z., 2001. Integrated Land Management in Dry Areas, in "New Approaches to Water Management in Central Asia,"

Adrian, A. M. 2006. Factors influencing adoption and use of precision agriculture. PhD Thesis, Auburn University.

Atanasov, A., Kangalov, P., Stoianov, K. & Angelov, I. Some aspects in preparation of transport and field operations in large Bulgarian farms by using GPS and GOOGLE EARTH. 9th International Scientific Conference Engineering for Rural Development 27-28.05. 2010. 2010 Jelgava, Latvia. 62-66.

Auernhammer, H. 1999. Precision farming for site-specific fertilisation. Zeitschrift für Agrarinformatik, 7, 58-66.

Auernhammer, H. 2001. Precision farming--the environmental challenge. Computers and Electronics in Agriculture, 30, 31-43.

Aziz, A. S., Steward, B., Tang, L. & Karkee, M. 2009. Utilizing repeated GPS surveys from field operations for development of agricultural field DEMs. Transactions of the ASAE, 52, 1057-1067.

Backes, M. & Plümer, L. On the adequacy of GIS-Generated weed maps for precision farming. ScanGIS, 2003. 261-268.

© COPYRIGHT UPM

Bacon, P. R. (1987). Use of wetlands for tourism in the insular Caribbean. Annals of Tourism Research 14, 104.

Berry, J. K., Delgado, J. A., Khosla, R. & Pierce, F. 2003. Precision Conservation For Environmental Sustainability. Journal of Soil and Water Conservation-USA, 58, 332-339.

Blackmore, S. 2003. The role of yield maps in precision farming. PhD Thesis, Cranfield University.

Bouma, J. 1997. Precision agriculture: introduction to the spatial and temporal variability of environmental quality. In: 210, C. F. S. (ed.) CIBA foundation symposium 210-precision agriculture: spatial and temporal variability of environmental quality. Chichester, UK: Wiley

Bullock, D. S., Lowenberg-Deboer, J. & Swinton, S. M. 2002. Adding value to spatially managed inputs by understanding site-specific yield response. Agricultural Economics, 27, 233-245.

Chan H. T., 1996. Mangrove reforestation in peninsular Malaysia: a case study of Matang. In Field C (ed.) Restoration of Mangrove Ecosystems, International timber Trade Organization and International Society for Mangrove Ecosystems, Okinawa, Japan, 64.

Chapman, V. J., 1976. Mangrove vegetation. J Cramer, FL-9490 Vaduz, Germany.

Chu Su, P. 2011. Statistical geocomputing: Spatial outlier detection in precision agricultur. MSc. Thesis, University of Waterloo.

Clay, S. A. 2011. GIS applications in agriculture Boca Raton-USA, CRC Press Inc.

Corwin, D. & Lesch, S. 2005. Apparent soil electrical conductivity measurements in agriculture. Computers and Electronics in Agriculture, 46, 11-43.

© COPYRIGHT UPM

Dahlan, Hj bin Taha and Shahshiah, A. K. (2007). Policy and Management Of Mangrove Forests In Peninsular Malaysia. International Seminar on Wetlands and Sustainability (ISWS). Forestry Department Peninsular Malaysia.

Diacono, M., De Benedetto, D., Castrignanò, A., Rubino, P., Vitti, C., Abdelrahman, H., Sollitto, D., Cocozza, C. & Ventrella, D. 2013. A combined approach of geostatistics and geographical clustering for delineating homogeneous zones in a durum wheat field in organic farming. NJAS-Wageningen Journal of Life Sciences, 64, 47-57.

Flowers, T. J., Yeo, A. R., 1995. Breeding for salinity resistance in crop plants - where next? Australian Journal of Plant Physiology 22, 875–884.

Fraisse, C.W., K.A. Sudduth, N.R. Kitchen, and J.J. Fridgen. 1999. USDA. 1980. Soil Survey of Weld County, Colorado, Southern Part. Use of unsupervised clustering algorithms for delineating within- USDA-SCS, Colorado Agricultural Experiment Station, Fort Col- field management zones. ASAE Paper No. 993043. International lins, CO Meeting, Toronto, Ontario, Canada. July 18–21.

Francois, L.E. and Maas, E.V. 1994. Crop response and management on salt-affected soils. p. 149-181.

Gao, J. 2002. Integration of GPS with remote sensing and GIS: reality and prospect. Photogrammetric Engineering and Remote Sensing, 68, 447-454.

Gavric, M. & Martinov, M. 2007. Low cost GPS-based system for site-specific farming at flat terrains-case study. International Commission of Agricultural Engineering (CIGR).

Hamilton LS, Snedaker SC (eds) (1984). Handbook for mangrove area management. Honolulu, Hawaii: Environment and Policy Institute, East-West Center, 123

© COPYRIGHT UPM

Heege, H. J. 2013. Precision in crop farming. In: Heege, H. J. (ed.) Site specific concepts and sensing methods: Applications and results Heidelberg-Germany: Springer.

Hengl, T. 2007. A practical guide to geostatistical mapping of environmental variables. JRC Scientific and Technical Reports. European Commission, Joint Research Centre, Luxemburg.

Jayanthi, H. 2003. Airborne and ground-based remote sensing for the estimation of evapotranspiration and yield of bean, potato, and sugar beet crops. PhD Thesis, Utah State University.

Johnson, C. K., Doran, J. W., Duke, H. R., Wienhold, B. J., Eskridge, K. M. & Shanahan, J. F. 2001. Field-scale electrical conductivity mapping for delineating soil condition. Soil Science Society of America Journal.

Kairo, J. G. (1995). Artificial regeneration and sustainable yield management of mangrove forests in Gazi Bay, Kenya. MSc Thesis, University of Nairobi, Nairobi, Kenya, 116.

Karaman, M. R., Susam, T., Yaprak, S. & ER, F. Computer based geostatistical strategies in assessing of spatial variability of agricultural phosphorus on a sugar beet field. International conference of information management and engineering 2009b Kuala Lumpur. IEEE, 201-204.

Kitchen, N., Snyder, C., Franzen, D. & Wiebold, W., 2002. Educational needs of precision agriculture. Precision Agriculture, 3, 341-351.

Lavergne, C. B., 2004. Factors determining adoption or non-adoption of precision agriculture by producers across the cotton belt. MSc. Thesis, Texas A&M University.

© COPYRIGHT UPM

Liu AR, Chen SC, Lin XM, Wu SY, Xu T, Cai FM, Raesh J., 2010. Endophytic *Pestalotiopsis* species spp. associated with plants of Palmae, Rhizophoraceae, Planchonellae and Podocarpaceae in Hainan, China. Afr. J. Microbiol. Res. 4: 2661-2669.

Lund, E., Christy, C. & Drummond, P. 1999. Practical applications of soil electrical conductivity mapping. Precision Agriculture, 99, 771-779.

Meroni, M., Rossini, M., Guanter, L., Alonso, L., Rascher, U., Colombo, R. & Moreno, J. 2009. Remote sensing of solar-induced chlorophyll fluorescence: Review of methods and applications. Remote Sensing of Environment, 113, 2037-2051.

Mondal, P., Basu, M., Bhadoria, P., Emam, A. A., Salih, M. H., Adegbite, A. A., Ayinde, T. B., Omolehin, R., Ibrahim, U. & Fola, A. J. 2011. Critical review of precision agriculture technologies and its scope of adoption in India. American Journal of Experimental Agriculture, 1, 49-68.

Mutluoglu, Ö. & Ceylan, A. 2009. Accuracy and cost comparison of spatial data-acquisition methods for the development of geographical information systems. Journal of Geography and Regional Planning, 2, 235-242.

Muzzneena A.M, Sharina S, Zaidi C.C and Othman B.H.R. (2002). Kepentingan Rangka Perundangan Dan Peraturan Dalam Pemeliharaan Dan Pengurusan Paya Bakau Di Malaysia, Proceedings of the Regional Symposium on Environment and Natural Resources, 10-11th April 2002, Hotel Renaissance Kuala Lumpur, Malaysia. Vol. 1: 612-619.

Nagchaudhuri, A., Mitra, M., Brooks, C., Earl, T., Ladd, G. & Bland, G. Initiating environmentally conscious precision agriculture at UMES. Annual Conference of American Society of Engineering Education, 2005 Portland Oregon.

© COPYRIGHT UPM

Najafabadi, M. O., Hosseini, S. J. F. & Bahramnejad, S. 2011. A Bayesian confirmatory factor analysis of precision agricultural challenges. African Journal of Agricultural Research, 6, 1219-1225.

Nutter, F. W., Emmanuel Z. Byamukama, Rosalee A. Coelho-Netto, Sharon K. Eggenberger, Gleason, M. L., , A. G., Alison E. Robertson & Rij, N. V. 2011. Integrating GPS, GIS,and remote sensing technologies with disease management principles to improve plant health. In: Clay, S. (ed.) GIS applications in agriculture. Boca Raton-USA: CRC Press.

Oliver, M., Bishop, T. & Marchant, B. 2013. Precision agriculture for sustainability and environmental protection, Abingdon, Oxon-UK, Routledge.

Oliver, M. A. 2010. Geostatistical applications for precision agriculture, London-UK, Springer.

Pati, F. M., Clay, D. E. & Carlson, G. 2011. Nutrient management for improved energy efficiency. In: Clay, D. E. & Shanahan, J. F. (eds.) GIS applications in agriculture, nutrient management for energy efficiency. Boca Raton-USA: CRC Press.

Pierce, F. J. & Clay, D. 2007. GIS applications in agriculture, USA, CRC Press.

Rains, G. C. & Thomas 2009. Precision farming an introduction. In: ATHENAEUM@UGA (ed.) Cooperative extension. University of Georgia: Athenaeum@UGA.

Reichardt, M., Jürgens, C., Klöble, U., Hüter, J. & Moser, K. 2009. Dissemination of precision farming in Germany: acceptance, adoption, obstacles, knowledge transfer and training activities. Precision Agriculture, 10, 525-545.

Rhoades, J.D., and J. Loveday. 1990. Salinity in Irrigated Agriculture. p. 1089-1142.

© COPYRIGHT UPM

Rocchini, D., Foody, G. M., Nagendra, H., Ricotta, C., Anand, M., HE, K. S., Amici, V., Kleinschmit, B., Förster, M. & Schmidtlein, S. 2013. Uncertainty in ecosystem mapping by remote sensing. Computers & Geosciences, 50, 128-135.

Shahbazi, F., Aliasgharzad, N., Ebrahimzad, S. & Najafi, N. 2013. Geostatistical analysis for predicting soil biological maps under different scenarios of land use. European Journal of Soil Biology, 55, 20-27.

Shaner, D., Khosla, R., Brodahl, M., Buchleiter, G. & Faraham, H. 2008. How well does zone sampling based on soil electrical conductivity maps represent soil variability. Agronomy Journal, 100, 1472- 148.

Shanwad, U., Patil, V., Dasog, G., Mansur, C. & Shashidhar, K. Global Positioning System (GPS) in Precision Agriculture. The Asian GPS Conference 24–25 October 2002 New Delhi-India.

Sherman, M. 2011. Spatial statistics and spatio-temporal data: covariance functions and directional properties, USA, John Wiley & Sons.

Sivarajan, S. 2011. Estimating Yield of Irrigated Potatoes Using Aerial and Satellite Remote Sensing. PhD Thesis, Utah State University.

Slinger, Deborah, Tania Midgley, and Elizabeth Madden. "How Salinity Is Measured". NSW Department of Primary Industries.

Sudduth, K., Kitchen, N., Wiebold, W., Batchelor, W., Bollero, G., Bullock, D., Clay, D., Palm, H., Pierce, F. & Schuler, R. 2005. Relating apparent electrical conductivity to soil properties across the north-central USA. Computers and Electronics in Agriculture, 46, 263-283.

Szabolcs, I. 1989. Salt affected soils, Boca Raton, CRC Press.

© COPYRIGHT UPM

Tomlinson, P. B., 1986. The Botany of Mangroves. Cambridge University Press, New York.

Wang, X., Bo, J., Bridges, T., Dugan, K.D., Pan, T.C., Chodosh, L.A., Montell, D.J., 2006. Analysis of cell migration using whole-genome expression profiling of migratory cells in the Drosophila ovary. 483-495.

Watson JG (1928). Mangrove forests of the Malay Peninsula. Malaysian Forest Records. No. 6.

Webster, R., and Oliver, M. A., 2001. Geostaatistics for Environmental Scientists.

Wiebold, W., Sudduth, K., Davis, J., Shannon, D. & Kitchen, N. 1998. Determining barriers to adoption and research needs of precision agriculture.

Zhang, X., Seelan, S. & Seielstad, G. 2010a. Digital northern great plains: a web-based system delivering near real time remote sensing data for precision agriculture. Remote Sensing, 2, 861-873.

© COPYRIGHT UPM