UNIVERSITI PUTRA MALAYSIA

VULNERABILITY OF PADDY FARMERS TO CLIMATE CHANGE VARIABILITY IN PENINSULAR MALAYSIA

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By

DANLADI YUSUF GUMEL

Thesis Submitted to the School of Graduate Studies Universiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

January 2018

DEDICATION

To the memory of my beloved mother, late Fatima Umaru (Chime Doguwa), who untiringly and single handedly took the responsibility through toil (after the demise of my late father at my infancy, Yusuf Kitawuri), and nurtured as well as inspired my intellectual acumen. But unfortunately, she had never had the opportunity to survive and witness my journey and stepping my feet into this world of Academia, literally and axiomatically. I know you will be smiling from your grave to hear your loving son attained this academic feat. May ALLAH (SWA) reward your efforts and place you in the highest abode of Al-Jannah Firdaus.

To my Loving wife Maryam Abdulkadir, and my beloved children Ummi Rukayya, Abdul-Jalal, Abdul- Malik, Abdul- Hakim and Abdul- Karim for your love, patience, perseverance, support and prayers during the hectic period of my study.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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January 2018

Chairman : Associate Professor Ahmad Makmom Bin Abdullah, PhD
Faculty : Environmental Studies

Climate changes greatly affect agricultural crop production and the associated farming community. The magnitude of the climatic stressor, the sensitivity and capacity of the affected communities to adapt with such stressors affect farmer vulnerability. This study assessed the vulnerability of paddy farmers to climate change variability in Peninsular Malaysia. The study employed an integrated vulnerability assessment approach using three component of vulnerability i.e. exposure, sensitivity and adaptive capacity. Trend analysis was conducted using Mann – Kendall to detect temperature and rainfall variability from 1981- 2014. DSSAT Ceres- rice model was used to predict rice yield for the study areas from 2016 until 2035 and determine the sensitivity of rice yield to temperature and rainfall changes. Household survey was conducted using multi- stage systematic random sampling on 450 sampled respondents to measure their adaptive capacity. Trend analysis shows that annual maximum temperature warming trend ranges from 0.008^0C to 0.014^oC per year, while annual minimum temperature warming trend ranges from 0.018^oC to 0.063^oC per year.Rainfall variability analysis revealed greater variability in terms of annual, monthly as well as seasonal patterns for all the areas under this study. The mean annual rainfall ranges from as low as 2016.7mm to as high as 2576.5mm for all the areas. The DSSAT model rice yield prediction result shows that Muda Agricultural Development Area (MADA) Kedah, will have highest increase in yield of 24.9% in 2029, with few years of decreasing yield by up to -10.1% in 2035. In the Integrated Agricultural Development Area (IADA) Northwest Selangor, the model predicted decrease in yield of up to -7.1% by the year 2024. In the Kemubu Agricultural Development Area (KADA) Kelantan, the model predicted highest increase in the yield (14.0%) in the year 2028 and highest yield decline of -13.3% by the year 2030. 22.9% of respondents were found to be less vulnerable, 32% were vulnerable and45.1% were highly vulnerable.Based on granaries, MADA has the highest vulnerability followed by KADA with IADA as the least vulnerable. Ordinal logistic regression revealed that 17 factors have significant influence on the

vulnerability outcome of the respondents. Conclusively, the respondents in the study areas are vulnerable to the effects of climate change variability. Therefore, decision makers should tailor policies to address local specific conditions by placing climate change vulnerability issues within the broader developmental context.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KERENTANGAN PETANI PADI TERHADAP PERUBAHAN IKLIM DI SEMENANJUNG MALAYSIA

Oleh

DANLADI YUSUF GUMEL

Januari 2018

Pengerusi : Profesor Madya Ahmad Makmom Bin Abdullah, PhD
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Perubahan iklim telah menjejaskan pengeluaran tanaman pertanian dan secara tidak langsung menjejaskan komuniti petani. Mangnitud tekanan iklim, kepekaan dan kapasiti komuniti yang terjejas untuk penyesuaian terhadap pelbagai tekanan telah menjejaskan kerentanan petani. Kajian ini menilai kerentangan petani padi terhadap perubahan iklim di Semenanjung Malaysia. Kajian ini menggunakan pendekatan penilaian kerentangan bersepadu menggunakan tiga komponen kerentangan iaitu pendedahan, kepekaan dan kapasiti penyesuaian. Analisis trend dijalankan menggunakan Mann - Kendall untuk mengesan perubahan suhu dan hujan dari tahun 1981 hingga 2014. Model DSSAT Ceres telah digunakan untuk meramal hasil beras bagi kawasan kajian dari tahun 2016 hingga 2035 dan menentukan kepekaan hasil beras terhadap perubahan suhu dan taburan hujan. Kajian isi rumah telah dijalankan dengan menggunakan pensampelan rawak sistematik pelbagai peringkat pada 450 orang responden untuk mengukur kapasiti penyesuaian. Analisis Trend Mann-Kendall menunjukkan bahawa trend suhu pemanasan maksimum tahunan adalah dari 0.0080C hingga 0.0140C setahun, manakala suhu pemanasan suhu minimum adalah antara 0.018^{o}C hingga 0.063^{o}C setahun. Penemuan dari analisis kepelbagaian taburan hujan mendedahkan kepelbagaian yang lebih besar dari segi taburan hujan tahunan, bulanan dan hujan bermusim untuk semua kawasan di bawah kajian ini. Purata taburan hujan tahunan adalah dari serendah 2016.7mm hingga setinggi 2576.5mm untuk semua kawasan. Keputusan kajian ramalan hasil padi daripada model DSSAT menunjukkan bahawa Kawasan Pembangunan Pertanian Muda (MADA) Kedah, akan mengalami kenaikan tertinggi hasil mencecah 24.9% pada tahun 2029, dengan beberapa tahun penurunan hasil hingga -10.1% pada tahun 2035. Dalam Kawasan Pembangunan Pertanian Bersepadu (IADA) Barat Laut Selangor, model meramalkan penurunan hasil sehingga -7.1% menjelang tahun 2024. Di Kawasan Pembangunan Pertanian Kemubu (KADA) Kelantan, model meramalkan kenaikan tertinggi hasil (14.0%) pada tahun 2028 dan penurunan tertinggi hasil -13.3% menjelang tahun 2030. 22.9% responden didapati kurang terdedah, 32%

terdedah dan 45.1% sangat terdedah. Di peringkat kawasan jelapang, MADA mempunyai kerentanan tertinggi diikuti oleh KADA dan IADA yang paling lemah.Hasil daripada regresi logistik ordinal menunjukkan bahawa 17 faktor didapati mempunyai pengaruh yang signifikan terhadap hasil kerentanan responden. Secara keseluruhan, disimpulkan bahawa responden di kawasan kajian terdedah kepada pengaruh perubahan iklim.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Doctor of Philosophy. The members of the Supervisory committee were as follows:

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Declaration by graduating student

I hereby confirm that:

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This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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LIST OF ABBREVIATIONS

AEZ	Agro Ecological Zone
ANOVA	Analysis of Variance
ASPIM	Agricultural Production System sIMulator
BERNAS	Padiberas National Berhad
BLS	Barat Laut Selangor
CERES	Crop Environment Resource Synthesis
CGE	Cumulative General Equilibrium
COV	Coefficient of Variance
CRM	Coefficient of Residual Mass
CROPGROW	Crop template module
CROPSYST	Cropping System Simulation
CROPWAT	Crop Water Model
CSM	Crop Simulation Model
CV	Coefficient of Variation
D- Index	Index of Agreement
DOA	Department of Agriculture, Malaysia
DSSAT	Decision Support System for Agricultural Technology
ENSO	EL Nino South Oscillation
FAMA	Federal Agricultural Marketing Authority
FAO	Food and Agricultural Organization
FAOUN	Food & Agricultural Organization of the United Nation
FEM	Fixed Effect Model
FILEX	Experiment File
GCM	General Circulation Model
GCOS	Global Change Observational System
GHG	Green House Gases
HSD	Honest Significance Difference
IADA	Integrated Agricultural Development Authority
IBSNAT	International Benchmark Sites Network for Agro-technology Transfer Project

IOD	Indian Ocean Diapole
IPCC	Intergovernmental Panel on Climate Change
KADA	Kemubu Agricultural Development Authority
KETARA	North Terengganu Integrated Agricultural Development Authority
KMO	Kaiser – Meyer - Olkin
MADA	Muda Agricultural Development Authority
MARDI	Malaysia Agricultural Research & Development Institute
MK	Mann- Kendall
MMD	Malaysia Meteorological Department
MR- 219	Malaysia Rice Variety – 219
MR-84	Malaysian Rice variety- 84
MSD	Mean Squared Deviation
NAHRIM	National Hydrologic Research Institute of Malaysia
NEM	Northeast Monsoon
NOA	North Atlantic Oscillation
OECD	Organization For Economic Co-operation and Development
OLLRM	Ordinal Logistic Linear Regression Modelling
OLR	Ordinal Logistic Regression
OLS	Ordinary Least Square
ORYZA1	A Crop growth simulation for Rice
PCA	Principal Component Analysis
PDO	Pacific Decadal Oscillation
PPK	Pertubuhan Peladang Kawasan (Area Farmers' Organization)
PRECIS	Providing Regional Climates for Impact Studies
R&D	Research & Development
RCM	Regional Circulation Model
RM	Malaysian Ringitt
RMSD	Root Mean Squared Deviation
RMSE	Root Mean Squared Error

RMSPE	Root Mean Squared Percentage Error
SD	System Dynamic
SRES	Special Report on Emission Scenarios
SSL	Self- Sufficiency Level
SWB	Soil Water Balance Irrigation Scheduling
SWM	Southwest Monsoon
Turkey's HSD	Turkey- Kramer method of HSD
UHI	Urban Heat Island
UKMO	United Kingdom Meteorological Office
UNFCCC	United Nation Framework Convention on Climate Change
UNISRD	United Nations International Strategy For Disaster Reduction
WMO	World Meteorological Organization
WTO	World Trade Organization

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background of the study

Climate changes characterised by the increasing temperature, precipitation and extreme events are predicted along with the increase in Green House Gas(GHG) emissions(IPCC, 2007b). This has been one of the issues of primary concern all over the world for the past two decades. The variability and changes of climate condition affects the environment physically, socially, and economically all over the world. In the same vein the dominant influence of climate on agriculture set limits to food production (Fazal & Abdul Wahab, 2013), creating negative consequences on the farmers in terms of their food security and livelihood across the world, especially in the developing countries (FAO, 2008; Fazal & Abdul Wahab, 2013; IPCC, 2007b; Khee, Mee, & Keong, 2011).

The impacts of climate change variability on agricultural crop production has been negative in recent times, through increase in temperatures, rainfall variation and extreme events like flooding, droughts, cyclones and the rise in sea levels(IPCC, 2007b, 2012b; Kotir, 2011). As such, many scientific and policy analysts have doubted whether farmers will have the capacity to adapt as agriculture is becoming more vulnerable to the current climate changes (Mertz, Halsnaes, Olesen, & Rasmussen, 2009; Reid, Smit, Caldwell, & Belliveau, 2007).

Malaysia's tropical climate for the last twenty years has shown uniform characteristics of high temperature, humidity, precipitation, cloud cover and less variation of solar radiation all the year round, but in recent times the climate has witnessed an unprecedented widespread weather variability resulting to an extended dry spell and rising temperature. Hence, many parts of the country experiences reduction in rainfall of about 5% in others up to 26% and rising temperatures ranging from 0.5^0c and 1.7^0c(Tawang, Ahmad, & Abdullah, 2001). These changes in the climate conditions have created serious consequences on agricultural productivity and pattern of land use. Drought condition which is the result of climate changes is normally associated with two forms of stresses; water deficiency and rising temperature. The high temperature condition lead to serious water stress by setting in high rate of water loss through transpiration and there by increases dehydration in plant (Tawang et al., 2001).

Yields of crops and its annual variability and pattern of world agriculture are all weather dependent. Effective crop growth depends on the environmental factors of rainfall, temperature, solar radiation and atmospheric gases particularly carbon dioxide and oxygen. Any change in these factors will certainly affect productivity of

crops and land use patterns. Moreover, water deficiency can affect plant growth in a number of ways depending on its intensity, extent and the period at which the stress sets in whether it coincided with the plants biological stage of growth and development. Most plants normally flourishes better in an average annual rainfall higher than 2000mm and also not less than 150mm of average monthly rainfall. There is therefore a linear relationship between rainfall and plant productivity and production is seriously affected when rainfall amount falls below 1000mm, and this condition is more or less the same with most perennial and annual crops including rice which shows high sensitivity at the stages of flowering and fruit development (Tawang et al., 2001). Amount of solar radiation like rainfall and temperature is equally another environmental factor that has significant control over crop productivity as it directly influence plant photosynthetic and other biological mechanisms. Increase in yields of rice like most other crops corresponds with high amount of solar radiation at the crop's stage of reproduction. Besides climate there are non-climatic factors that significantly influence crop yield performance and output with time, these factors includes changes in technology, farm inputs and better farm management practices amongst others (Tawang et al., 2001).

1.2 Paddy Rice Production in Malaysia

Paddy rice is an important crop for Malaysia's food security being the main staple food of majority of the people in the country. It is therefore, based on this consideration that government gave considerable attention to this sector of the economy even before the country attained its independence in 1957 (Fahmi, Abu Samah, & Abdullah, 2013). Starting with the establishment of a Rice Production Commission in 1937, and in 1956 a Federation of Rice Malay Commission was created for the same purpose. In 1965 post- independence, Federal Agricultural Marketing Authority was then formed as an institution responsible for marketing other agricultural commodities including rice, later on in 1971 National Paddy and Rice Board was created to substitute FAMA in rice marketing. To give more support to national paddy rice industry, the board was privatized in 1996 which resulted in changing its name to Padiberas National Berhad (BERNAS). Paddy rice is considered very significant by the government mainly because of two reasons. Firstly as a staple food its per capita consumptions accounted to about 500 to 799 of calorie intake per day and secondly, it has served as the main source of livelihood to majority of small scale farmers whose income largely depend on rice cultivation (Fahmi et al., 2013).

Paddy rice production is mainly carried out in Peninsular Malaysia which accounted for More than 85.5% of the total rice production (Radin Firdaus, Abdul Latiff, & Borkotoky, 2013). The total rice production per annum in Malaysia is about 2.0 million tons, and the production figure has been in the increase since 1980. The total production figure rose from 2,044,604 tons in 1980 to 2,126,000 tons in 1995, but it started to decline in 1997 when production figure fell to 1,970,000 and later began to

rise up to 2,235,000 in the year 2000 (DOA, 2014).Since then rice production figure continue to fluctuate along with paddy parcels (see Table1.1).

Table 1.1 : Paddy Statistics in Malaysia (2005-2013)

Item/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013
Parcel Area (Ha)	440,961	429,805	426,224	426260	320931	320931	292500	292500	289882
Planted Area(Ha)	666823	676034	676111	656602	674928	677884	687940	684545	671679
Paddy Production ('000 Tones)	2,314	2,187	2,375	2,384	2511	2465	2579	2599	2604
Rice Production ('000Tones)	1,490	1,407	1,531	1,516	1,620	1,588	1,661	1,209	1,207
Av.Yield (kg/ha.)	3471	3236	3514	3556	3720	3636	3746	3797	3876
Rice Imports ('000 Tones)	5847	8433	7987	6579	1086	930	1031	1006	876

Source: Department of Agriculture (DOA), 2014

Moreover, Malaysia seriously needs sustainability in rice production as a means of ensuring food security and at the same time tackling poverty. The desire of increase in food safety is receiving serious attention nationally and internationally. As such, the National Agro- food Policy (NAP) for Malaysia was designed to substitute the Third National Agricultural Policy (NAP3). It was a policy that aimed at increasing food production in the country in order to match with its expanding demand as well as high cost of development of agriculture. It means expanding the share of rice production in national income and developing entrepreneurship in agriculture (Siwar, Idris, Yasar, & Morshed, 2014). The major thrust of the policy was to enhance production and productivity to guarantee food availability, high value agricultural exploration, enhancement of the supply chain, implementation of sustainability in agricultural operations , development of human capital, private sector participation and efficient support by the government (MOA, 2011).

Climate change scenarios developed by the National Hydraulic Research Institute of Malaysia(NAHRIM (2006), the Malaysian Meteorological Department (MMD (2009)and other recent climate change impact studies (Al-Amin , Filho, Kabir, Azam, & Abdul Hamid, 2011; Al Amin & Filho, 2011; Kwan, Tangang, & Juneng, 2013; Masud, Rahman, Al-Amin, Kari, & Leal Filho, 2014; Radin Firdaus et al., 2013), by and large revealed the vulnerability of paddy rice farming activity. In particular, the smallholder farmers will be more vulnerable to this change due to their low adaptive capacity. One of the ways to manage these challenges arising from the climate change is to examine the vulnerability and how to build their adaptive capacity for the farmers to adapt effectively to the changing situations.

1.3 Problem Statement

There is a general consensus among scientists globally that due to the anthropogenic greenhouse gas emissions along with the changes in the pattern of climatic elements will negatively affects the socio- economic and other aspects of the environment (IPCC, 2007; 2012b). Furthermore, the impact of climate change will seriously affect the developing countries even though these countries have contributed less to its causes (Nicholas, 2007). In view of this, it has been pointed out that the direct consequences of climate change will include loss of life, damages to resources, infrastructure and livelihoods for all places including Malaysia (Al-Amin et al., 2011). Moreover, evidences from modeling of climate and crop revealed the disproportionate impact of climate on agriculture more than all other sectors (Thornton, Jones, Ericksen & Challinor, 2011; Lobell *et al.*, 2008; Ericksen *et al.*, 2011).

Malaysia has encountered dramatic variability in its climatic settings for several years as demonstrated using scenarios developed by NAHRIM (2006). According to this simulation, temperature was forecasted to rise within Malaysia and the adjoining subtropical regions by 0.3 to 4.5°C for the next 50 years to come (NAHRIM, 2006). Also results from the initial simulation developed showed that there will be changes in rainfall by ±30% over Malaysia (NAHRIM, 2006). More so, estimation of the climate changes will cause a decline in the yield of major cereal crops, such as in South Africa maize production with about 30% by the year 2030, while in south East Asia including Malaysia the region was predicted to suffer major grain yield lost including rice and other cereal crops by up to 10% (Lobell et al., 2008).

Similarly, climatic change influence on pest and other factors have contributed to the further agricultural vulnerability by exacerbating declining crop yield, as well as subjecting vulnerable drought areas into marginal land which cannot support cultivation of many crops including oil palm, rubber, rice and cocoa. This situation will create serious food security uncertainties and decline in earnings from export (NRS, 2001; Al-Amin, Azam, Yeasmin, & Kari, 2010). Meanwhile, scientific researches were conducted to estimate the impact of climate change on agriculture within the last couple of years (Tilman, et al., 2002; Ching-Cheng, 2005; Ahmed, Sumalatha & Nik Mohamed, 2010). The outcome indicated the continuous decline in crop productivity. In such a way that, the potential average rice yield differs from around 10 tons per hectare in areas around the tropics to more than 13 tons per hectare in the high latitudes areas, but for Malaysia the actual farm yield varies from 3 tons to 5 tons per hectare (NRS, 2001).

Other climate prediction by MMD (2009) projected changes in the mean temperature (26^0 C)in Malaysia may probably rise and will continue to be warmer towards the end of the century(Al-Amin et al., 2011).Significant number of the previous studies in Malaysia including (Al-Amin, et al. 2011; Kwan, et al. 2013; Masud, et al. 2014; Radin Firdaus, et al., 2013) has consistently indicated that the impact of climate

change variability will continue to militate against sufficient increase in paddy productivity. Specifically, the sensitivity of Paddy rice to climatic perturbation has been identified as one of the issues that led not only to decline in paddy productivity, but also reduction in the paddy farmers' income thus exacerbating their socio-economic wellbeing and poverty level (Alam et al., 2012).

These revelations have called for the pressing need for more interdisciplinary research efforts to provide comprehensive understanding into agricultural production along with assessment of the socioeconomic conditions of farming communities. This is required to systematically examine the real effects of climate change and variability on various systems of food production as well as rural livelihoods (Mueller *et al.*, 2012). An integrated approach enables various aspects of climate change and variability to be explored (Antwi- Agyei, 2012). However, to this date, there is little research done on vulnerability studies using integrated framework at the national as well as at local levels, especially in developing countries including Asia (UNFCCC, 2007). Moreover, other studies have also stressed the need to address issues of vulnerability and adaptation to climate changes in the developing countries, due to the fact that these countries highly depend on agriculture with low adaptive capacities (Ompraksah , Rishi, & Mudaliar, 2010).

In the case of Malaysia, no comprehensive vulnerability assessment studies were conducted at micro level using integrated framework in particular to assess the relative vulnerabilities of paddy farmers to enable effective adaptation planning. Many of the previous studies so far dwelt on the physical and economic impacts of climate change using econometric or eco-physiological modelling. There is the urgent need to understand the vulnerability of the paddy sector through multiple stressors approach by analyzing the exposure, sensitivity and adaptive capacity of the paddy farmers. Such a micro –level vulnerability study is desirable to enable policy makers to deal with climate change issues with all the precision that it requires (Klein et al., 2007). Furthermore, for individuals and communities to benefit from the opportunities and reduce the hazards associated with climate change it requires comprehension, good planning and adaptation (Madu, 2012).It is on this basis that this study is aimed at filling this gap through quantitative assessment of the vulnerability of paddy farmers to climate change variability in Peninsular Malaysia.

1.4 The Objectives of the Study

The main objective of this study is to assess vulnerability of the paddy farmers to climate change variability in Peninsular Malaysia. Therefore, to achieve this main objective, the following are the specific objectives;

1.4.1 The Specific Objectives

1) To analyse the variability of temperature and rainfall trends from 1981 to 2014 on the annual, monthly and seasonal timescale in the study area.
2) To assess the potential effects of climate change (temperature and rainfall) on paddy rice yield using DSSAT CERES- rice model in the study areas.
3) To develop an index for assessing the relative vulnerability of the farmers in the study areas.
4) To assess and determine the important factors influencing the relative vulnerability of farmers in the study areas.

1.5 Research Questions

The study will attempt to find answers to the following questions;

1) What are the trends of temperature (minimum & maximum) and rainfall in the study areas from 1981 to 2014?
2) How does temperature and rainfall variation affects rice productivity in the study areas?
3) What are the variables for developing vulnerability index for assessing the effects of climate change variability on farmers in the study areas?
4) What will be the level of, and the important factors influencing the relative vulnerability of farmers in the study areas?

1.6 Significance of the Study (Policy and Research Context)

There is the increase and urgent need among the scientific researcher communities, policy makers and non- governmental organizations to comprehend the role of adaptation in facilitation, supporting, and invariably sustaining those communities affected by the climate change risks (Coulthard, 2008). Perhaps, the raising consciousness of the looming threat posed by changing climate is what necessitates adaptation needs among societies (IPCC, 2007b). This instance is clearly demonstrated through two important changes in the global research and policy forums (Nelson , Kokic, Crimp, Meinke, & Howden, 2010). Firstly, by increasing the discussion looking at the most appropriate way of responding to the threats of

climate change, the initial emphasis was on mitigation, and later the recent considerations shifted on adaptation needs (Adger , Arnell, & Tompkins, 2005; Smit & Pilifosova, 2003).

As climate change has become unavoidable (IPCC, 2007b; Smit, Burton, Klein, & Street, 1999), hence the need for adaptation is therefore inevitable (Howden et al., 2007). Moreover, it is evident that with the levels of past emitted GHG, it is enough to influence global temperature changes for the next centuries, even if current emission is to be reduced dramatically (Matthews, Gillett, Stott, & Zickfeld, 2009). Therefore, the high probability of the changing climate as evidenced from biotic systems (Lenoir, Gégout, Marquet, De Ruffray, & Brisse, 2008; Rosenzweig et al., 2008) makes mitigation to no longer be a lone option. Adaptation is indispensable (Schipper, 2006) and has become entrenched in the global climate change debate as an important remedy to the dangers of the current and or future climate changes arising from anthropogenic GHG emissions (Ford, 2007; Schipper, 2006).

Furthermore, with the high level of confidence that global climate will continue to change, the exactitude of the attendant consequences from these changes remain extremely uncertain due largely to the complexity of 'feedback mechanisms' associated with the various components of the climate systems (IPCC, 2007b). This necessitated changes in the old methods of managing risk associated with climate change. Traditionally, the science of climate change lends more credence to analysing and predicting climate change extremes and to model and predict their possible impacts(Keenan, Maria Serra, Lloret, Ninyerola, & Sabate, 2011; Schubert, Suarez, Pegion, Koster, & Bacmeister, 2008). Initially, modelling was employed to analyse the impact of climate change on agriculture to understand the pattern of the regional climate and its likely changes linearly (Parry , Rosenzweig, & Livermore, 2005; Schubert et al., 2008).

In recent times, understanding the climate change impacts on agriculture do not necessarily depend on computer modelling alone. As the scale of management of variability to climate is inherent to agricultural practices, this has provided a premise on the existence of climate change adaptation (Howden et al., 2007). This has been so difficult to realise through computer model, largely due to the conceptualization of adaptation to climatic change and variability as a linear sequence of technically identifying, assessing and predicting source of risks (Nelson et al., 2010; O'Brien, Eriksen, Nygaard, & Schjolden, 2007). A limited understanding of the nature of risks to be assessed and determined can result in maladaptation, and cause accidental effect of underrating more enduring and thorough adaptive capacity (Barnston, Kumar, Goddard, & Hoerling, 2005). Such approach do not consider the essential limit to predicting global climate and always emphasize on the causes of climate variability and change which the policy decision makers could do nothing about (Meinke et al., 2009; Nelson, Kokic, & Meinke, 2007). Many of the previous studies on climate change impacts in Malaysia follow this tradition.

Available record shows that there are nearly 300,000 paddy farmers in Malaysia and 40% of them are full time farmers. Nearly 65% of the total farmers (195,000) are small holders with less than one hectare (DOA, 2008; Man & Ismaila, 2009).Recent climate change variability has been a threat to paddy rice cultivation, challenging the country's food security needs as a whole and to the farmers' livelihood in particular. Assessment of farmers' vulnerability and adaptation to climate change in Malaysia will give an insight into the extent of farmers' exposure, sensitivity and the extent of their adaptive capacity needs.

Such an assessment will create the opportunity of comprehending the farmers' potentials or capability to successfully adapt to the climate variability and change. This will serve as a fulcrum of successful adaptation planning policy (Adger et al., 2007). As effective adaptation to climate change depend on the availability of information to understand "what to adapt to and who to adapt, and the resources to implement the adaptation strategies" (Füssel, 2007). Therefore, this study will help to collect information regarding the extent of paddy farmers' vulnerability to the climate change through the various components or otherwise what Luers (2005) referred to as 'vulnerability layers'. This will help policy makers to effectively target the most vulnerable farmers and the nature and levels of the vulnerability and therefore, make optimum allocation and utilization of resources on climate change adaptation planning. This will help the farmers to prepare for and cope with the inevitable impacts of climate change as well.

Specifically, the result from this study will enhance local understanding of climate change vulnerability, and assist in mainstreaming climate change adaptation into planning and development for sustainable Paddy rice production. Thus, it is hope that the findings from this research will be directly beneficial to Department of Agriculture Malaysia, and other agencies such as Integrated Agricultural Development Authority, Muda Agricultural Development Authority and Kemubu Agricultural Development Authority.

In the context of academic research, the outcome of this study will further our understanding on the contribution of each factors of exposure, sensitivity and adaptive capacity to vulnerability of paddy farmers in Peninsular Malaysia. It is equally hope that this work will contribute to the existing body of literature on the vulnerability assessment of climate change variability using indicator approach and serve as a spring board for future micro- levels research endeavours.

1.7 Scope and Limitation of the Study

In this study, Paddy farmers' vulnerability will be assessed in terms their exposure, sensitivity and adaptive capacity. Vulnerability is viewed as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability therefore, is said to be a function of the character, magnitude, and rate of climate variation to which a *system* is exposed, its sensitivity, and its adaptive capacity"(IPCC, 2007b). Even though there are several concepts of vulnerability, this study focuses on framing of vulnerability as proposed by the Inter-Governmental Panel on Climate Change (IPCC, 2007b).

It is within the scope of this work also to survey only sampled paddy farmers within three granary areas consisting of the Integrated Agricultural Development Authority (IADA) Barat Laut Selangor, Muda Agricultural Development Authority (MADA) Kedah and Kemubu Agricultural Development Authority (KADA) Kelantan.

Every research endeavor has its own limitation. Similarly, this study was conducted with the following limitations:

1) The meteorological data used were selected based on availability, accessibility, completeness and proximity to the selected areas under this study. The meteorological data are very expensive. Three of the meteorological stations used in this study were the only one accessible to the researcher meeting up with the stated requirements and were gotten from principal meteorological stations. One of the chosen stations, Subang Jaya was the only principal station out of three stations in Selangor (Petaling, Sepang and Subang Jaya) which is somewhat closer to Barat Laut Selangor study area; and it is the only meteorological station data that is accessible.
2) The DSSAT model needs sufficient data for its calibration, though most of the data are optional. The minimum data set needed for the model which was available was used, but detailed data about soil profile could not be gotten.
3) The extent and scope of data collected were limited to items identified in the questionnaire; and
4) Due to time and financial constraints, this study was only done on three sampled granary areas from west and east coast regions of Peninsular Malaysia.

REFERENCES

Abdullah, A. M. (2007). Malaysian paddy and rice industry: policy implementation and directions. In 50years of Malaysian agriculture: transformational issues challenges & direction, p. 281-308. License:http://www.oceandocs.org/license. URI: http://agris.upm.edu.my:8080/dspace/handle/0/9099.ISBN: 968-967-5026-14-0.

Abid, M., Scheffran, J., Schneider, U., & Ashfaq, M. (2015). Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab province, Pakistan. *Earth System Dynamics, 6*(1), 225.

Abson, D. J., Dougill, A. J., & Stringer, L. C. (2012). Using Principal Component Analysis for information-rich socio-ecological vulnerability mapping in Southern Africa. *Applied Geography, 30*, 1-10. doi http://dx.doi.org/10.1016/j.apgeog.2012.08.004

Adams, R. M. (1989). Global climate change and agriculture: an economic perspective. *American Journal of Agricultural Economics, 71*(5), 1272-1279.

Adams, R. M., Fleming, R. A., Chang, C.-C., McCarl, B. A., & Rosenzweig, C. (1995). A reassessment of the economic effects of global climate change on US agriculture. *Climatic change, 30*(2), 147-167.

Adger , N. W., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change, 15*(2), 77-86.

Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World development, 27*(2), 249-269.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change, 16*(3), 268-281.

Adger, W. N., Agrawala, S., Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin, J., . . . Takahashi, K. (2007). Assessment of adaptation practices, options, constraints and capacity. *Climate Change*, 717-743.

Adger, W. N., Brooks, N., Bentham, G., Agnew, M., & Eriksen, S. (2004). *New indicators of vulnerability and adaptive capacity* (Vol. 122): Tyndall Centre for Climate Change Research Norwich.

Adger, W. N., & Kelly, P. M. (1999). *Assessing vulnerability to climate change and facilitating adaptation*: Centre for Social and Economic Research on the Global Environment.

Ahmed O.H, Sumalatha G., Nik Muhamad A.M. (2010). Use of zeolite in maize (*Zea mays*) cultivation on nitrogen, potassium and phosphorus uptake and use efficiency. Int. J. Phys. Sci., 5(15): 2393-2401.

Ahsan, M. N., & Warner, J. (2014). The socioeconomic vulnerability index: A pragmatic approach for assessing climate change led risks–A case study in the south-western coastal Bangladesh. *International Journal of Disaster Risk Reduction, 8*, 32-49.

Al-Amin, A. Q., Azam, M. N., Yeasmin, M., & Kari, F. (2010). Policy challenges towards potential climate change impacts: In search of agro-climate stability. *Scientific Research and Essays, 5*(18), 2681-2685.

Al-Amin , A. Q., Filho, W. L., Kabir, M. A., Azam, M. N. J., & Abdul Hamid, K. F. (2011). Climate change impacts: prioritizing mechanism and needs for future Malaysian agriculture. *International Journal of the Physical Sciences, 6*, 1742-1748.

Al-Amin, A. Q., Jaafar, A. H., Azam, M. N., Kari, F., & Agil, S. O. S. (2013). Climate change issues and Malaysian initiatives *Climate Change Governance* (pp. 141-151): Springer.

Al-Amin, A. Q., Leal, W., de la Trinxeria, J. M., Jaafar, A. H., & Ghani, Z. A. (2011). Assessing the impacts of climate change in the Malaysian agriculture sector and its influences in investment decision. *Middle-East Journal of Scientific Research, 7*(2), 225-234.

Al Amin, A. Q., & Filho, W. L. (2011). An overview of prospects and challenges in the field of climate change in Malaysia. *International Journal of Global Warming, 3*(4), 390-402.

Alam , M. M. (2010). *The Impacts of climate change on Paddy cultivation in the Integrated Agricultural Development Area in North - Weat Selangor, Malaysia: A socio-economics and Respondent Perception studies.* (Masters of Arts), Institute for Environment and Development University Kembangsaan Bangi, Malaysia.

Alam , M. M., Siwar, C., Jaafar, B. T., & Saleh, K. O. (2013). Agricultural vulnerability and adaptation to climate changes in Malaysia: A review on paddy sector. *Current World Environment, 8*(1), 1-12. doi:http:/dx.doi.org/10.12944/CWE. 8.1.01

Alam , M. M., Siwar, C., Murad, M. W., Molla, R. I., & Toriman, M. E. (2010). Socioeconomic profile of farmer in Malaysia: study on integrated agricultural development area in North-West Selangor. *Agricultural Economics and Rural Development, 7*(2), 249-226.

Alam, M. M., Siwar, C., Murad, M. W., & Toriman, M. E. (2011). Farm level assessment of climate change, agriculture and food security in Malaysia. *World Applied Sciences Journal, 14*(3), 431-442.

Alam, M. M., Siwar, C., Talib, B., & Jaafar, A. (2013). Climate change and the socio-economic sustainability of the paddy respondent in Malaysia. *Natural Science, 5*(1A), 163-166. doi:10.4236/ns.2013.51A025

Alam, M. M., Siwar, C., Talib, B., Mokhtar, M., & Toriman, M. E. (2012). Climate change adaptation policy in Malaysia: Issues for agricultural sector. *African Journal of Agricultural Research, 7*(9), 1368-1373.

Alam, M. M., Siwar, C., Toriman, M. E., Molla, R. I., & Talib, B. (2012). Climate change induced adaptation by paddy respondent in Malaysia. *Mitigation, Adaptation Strategy Global Change, 17*, 173-186. doi:10.100/s11027-011-9319-5

Alam, M. M., Toriman, M. E., Siwar, C., Molla, R. I., & Talib, B. (2011). Impact of Agricultural Supports for Climate Change Adaptation: A Farm Level Assessment. *American Journal of Environmental Sciences, 7*(2), 178.

Alam, M. M., Toriman, M. E., Siwar, C., & Talib, B. (2011). Rainfall variation and changing pattern of agricultural cycle. *American Journal of Environmental Sciences, 7*(1), 82.

Alam., M. M., Siwar, C., Jaafar, A., Talib, B., & Osman, K. B. (2013). Climate Change adaptability of respondent: Malaysian case study. *International Journal of Plant, Animal and Environmental Science, 3*(3).

Alias, E. F., Mohamed, A. F., Mohd, N. K., & Tasrif, M. (2011). Food security: Self sufficiency of rice in Malaysia. *International Journal of Management Studies (IJMS), 18*(2), 83-100.

Amirabadizadeh , M., Huang, Y. F., & Shui Lee, T. (2015). Recent trends in temperature and precipitation in the Langat river basin, Malaysia. *Advances in Meteorology, 2015*. doi:10.1155/2015/579437

Antwi-Agyei, P., Dougill, A. J., Fraser, E. D., & Stringer, L. C. (2012). Characterising the nature of vulnerability to climate variability: empirical evidence from two regions of Ghana. *Centre for Climate Change Economics and Policy Working Paper*(105).

Arshad, F. M. (2010). *Food Security and Climate Change: Some Evidences on their Dynamics and policy Responses*. Paper presented at the International Conference on Food Safety and Security under Climate Change, Parkroyal Hotel, Penang, Malaysia.

Ary , D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2010). Introduction to research in education. *USA: Wadsworth, 10*, 94002-93098.

Baltagi, B. (2008). *Econometric analysis of panel data* (Vol. 1): John Wiley & Sons.

Barlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. *Information technology, learning, and performance journal, 19*(1), 43.

Barnston, A. G., Kumar, A., Goddard, L., & Hoerling, M. P. (2005). Improving seasonal prediction practices through attribution of climate variability. *Bulletin of the American Meteorological Society, 86*(1), 59.

Barnwal, P., & Kotani, K. (2010). Impact of variation in climatic factors on crop yield: A case of rice crop in Andhra Pradesh, India. *Economics and Management series*.

Basak, J. K., Ali, M. A., Islam, M. N., & Rashid, M. A. (2010). Assessment of the effect of climate change on boro rice production in Bangladesh using DSSAT model. *J. Civ. Eng, 38*, 95-108.

Batchelor, W., Jones, J., Boote, K., & Pinnschmidt, H. (1993). Extending the use of crop models to study pest damage. *Transactions of the ASAE, 36*(2), 551-558.

Batchelor, W., Paz, J., Thorp, K., & Mulla, D. (2004). *Development and evaluation of a decision support system for precision agriculture.* Paper presented at the Proceedings of the 7th International Conference on Precision Agriculture and Other Precision Resources Management, Hyatt Regency, Minneapolis, MN, USA, 25-28 July, 2004.

Baumann, P. (2000). *Sustainable livelihoods and political capital: Arguments and evidence from decentralisation and natural resource management in India*: Working Paper 136, Overseas Development Institute London.

Baumann, P. & Sinha, S. (2009) *Linking development with democratic processes in India: political capital and sustainable livelihoods analysis.* Natural Resource Perspectives No. 68, London: Overseas Development Institute.

Begum, R. A., Sarkar, M. S. K., Jaafar, A. H., & Pereira, J. J. (2014). Toward conceptual frameworks for linking disaster risk reduction and climate change adaptation. *International Journal of Disaster Risk Reduction, 10, Part A*(0), 362-373. doi:http://dx.doi.org/10.1016/j.ijdrr.2014.10.011

Begum, R. A., Siwar, C., Abidin, R., & Pereira, J. J. (2011). Vulnerability of climate change and hardcore poverty in Malaysia. *Journal of Environmental Science and Technology*.

Belay, A., Recha, J. W., Woldeamanuel, T., & Morton, J. F. (2017). Smallholder respondents' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. *Agriculture & Food Security, 6*(1), 24.

Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S., Siebert, R., & Tscherning, K. (2012). Can respondents' adaptation to climate change be explained by socio-economic household-level variables? *Global Environmental Change, 22*(1), 223-235.

Benhin, J. K. (2008). South African crop farming and climate change: An economic assessment of impacts. *Global Environmental Change, 18*(4), 666-678.

Berry, H. L., Hogan, A., Ng, S. P., & Parkinson, A. (2011). Farmer health and adaptive capacity in the face of climate change and variability. Part 1: Health as a contributor to adaptive capacity and as an outcome from pressures coping with climate related adversities. *International journal of environmental research and public health, 8*(10), 4039-4054.

Blaikie, P., Cannon, T., David, I., & Wisner, B. (1994). *At Risk, natural hazards, people's vulnerability and disasters*. London: Routledge.

Bloomfleld, P. & Steiger, W.L., (1983), *Least Absolute Deviations: Theory, Applications and Algorithms,* Birkhauser, Boston, Mass.

Boote, K. J., Jones, J. W., & Hoogenboom, G. (1998). Simulation of crop growth: CROPGRO model.

Borre, K., Ertle, L., & Graff, M. (2010). Working to eat: vulnerability, food insecurity, and obesity among migrant and seasonal farmworker families. *American Journal of Industrial Medicine, 53*(4), 443-462.

Bradshaw, B., Dolan, H., & Smit, B. (2004). Farm-level adaptation to climatic variability and change: crop diversification in the Canadian prairies. *Climatic change, 67*(1), 119-141.

Brooks, N. (2003). Vulnerability, risk and adaptation: A conceptual framework. *Tyndall Centre for Climate Change Research Working Paper, 38*, 1-16.

Brooks, N., Adger, W. N., & Kelly, P. M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change, 15*(2), 151-163.

Brown, M. E., & Funk, C. C. (2008). Food security under climate change.

Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints. *Environmental Science & Policy, 12*(4), 413-426.

Burfisher, M. E. (2011). *Introduction to computable general equilibrium models*: Cambridge University Press.

Burchi, F., & De Muro, P. (2016). From food availability to nutritional capabilities: Advancing food security analysis. *Food Policy, 60*, 10-19.

Campra , P., & Morales , M. (2016). Trend analysis by a piecewise linear regression model applied to surface air temperatures in Southeastern Spain (1973-2014). *Nonlinear Processes in Geophys. Discussions*. doi:doi:10.5194/npg-2016-29, 2016

Cardona, O.-D., Van Aalst, M., Birkmann, J., Fordham, M., McGregor, G., Perez, R., . . . Sinh, B. (2012). Determinants of risk: exposure and vulnerability. *Managing the risks of extreme events and disasters to advance climate change adaptation*, 65-108.

Carney, D. (1998). *Sustainable rural livelihoods: What contribution can we make?* : Department for International Development.

Carney, D; Drinkwater, M.; Rusinow, T.; Neefjes, K.; Wanmali, S. and Singh, N.(2000): Livelihoodsapproached compared. In: Forum on Operationalizing Sustainable

LivelihoodsApproaches. Proceedings. Annex 4. Pontignano (Siena). 7-11 March, 2000.

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems, 4*(8), 765-781.

Carter, T. R., Jones, R. N., Lu, X., Bhadwal, S., Conde, C., Mearns, L. O., . . . Zurek, M. B. (2007). New assessment methods and the characterisation of future conditions.

Chakraborty, D., Saha, S., Singh, R. K., Sethy, B. K., Kumar, A., Saikia, U. S., . . . Daschaudhuri, D. (2017). Trend Analysis and Change Point Detection of Mean Air Temperature: A Spatio-Temporal Perspective of North-Eastern India. *Environmental Processes*. doi:10.1007/s40710-017-0263-

Chambers, R. (1983). Rural Development: Putting the Last First (Essex: Longman Scientific & Technical).

Chambers, R. (1995). Poverty and livelihoods: whose reality counts? *Environment and urbanization, 7*(1), 173-204.

Chang, C. C. (2002). The potential impact of climate change on Taiwan's agriculture. *Agricultural Economics, 27*(1), 51-64.

Chee-Wan, C., & Meng-Chang, C. (2012). *Country Report: Malaysia.* Paper presented at the Asia Pacific Economic Cooperation (APEC) Workshop on food security.

Ching-Cheng C (2005). The Potential Impact of Climate Change on Taiwan's Agriculture. Agric. Eco., 27: 51-64.

Cifdaloz, O., Regmi, A., Anderies, J. M., & Rodriguez, A. A. (2010). Robustness, vulnerability, and adaptive capacity in small-scale social-ecological systems: The Pumpa Irrigation System in Nepal. *Ecology and Society*, *15*(3), 39.

Claussen, M. (2005). *Radiative Forcing of Climate Change: Expanding the concept and addressing the uncertainties*. Washington D.C.: National Research Council, Division of Earth and Life Studies, Board on Atmospheric Science and climate, National Academy of Science.

Cline, W. R. (1996). The impact of global warming of agriculture: comment. *The American Economic Review*, 1309-1311.

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*: Academic press.

Connelly, L. M. (2008). Pilot studies. Medsurg Nursing, 17(6), 411-2.

Coulthard, S. (2008). Adapting to environmental change in artisanal fisheries—insights from a South Indian Lagoon. *Global Environmental Change*, *18*(3), 479-489.

Cramer, D., & Howitt, D. L. (2004). *The Sage dictionary of statistics: a practical resource for students in the social sciences*: Sage.

Crane, T. A., Roncoli, C., & Hoogenboom, G. (2011). Adaptation to climate change and climate variability: The importance of understanding agriculture as performance. *NJAS-Wageningen Journal of Life Sciences*, *57*(3), 179-185.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative* (Fourth Edition ed.). Boylston street, Boston, USA: Pearson Education,Inv.

Curtis, P. (1993). Famine Household Coping Strategies: Their Usefulness for Understanding Household Response to Armed Conflict. Refugee Studies Centre, RSC/A-51 CUR, Forced Migration Online, University of Oxford.http://repository.forcedmigration.org/show_metadata.jsp?pid=fmo:1014

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards*. *Social science quarterly*, *84*(2), 242-261.

Daño, E. C., & Samonte, E. D. (2005). Public sector intervention in the rice industry in Malaysia. *State intervention in the rice sector in selected countries: Implications for the Philippines*, 187-216. Davies, S. (1993). Are coping strategies a cop out? *IDS bulletin*, *24*(4), 60-72.

Davies, S. (1993). Are coping strategies a cop out? *IDS bulletin*, *24*(4), 60-72.

Defiesta, G. D., & Rapera, C. L. (2014). Measuring Adaptive Capacity of Respondent to Climate Change and Variability: Application of a Composite Index to an Agricultural Community in the Philippines. *Journal of Environmental Science and Management*, *17*(2).

Deininger, K. W. (2003). *Land policies for growth and poverty reduction*: World Bank Publications.

Deressa , T., Hassan, R. M., & Ringler, C. (2008). *Measuring Ethiopian respondents' vulnerability to climate change across regional states*.

Deressa , T., Hassan , R. M., Ringler, C., Alemu, T., & Yesuf, M. (2009). Determinants of respondents' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, *19*(2), 248-255.

Deressa , T. T., & Hassan , R. M. (2009). Economic impact of climate change on crop production in Ethiopia: evidence from cross-section measures. *Journal of African Economies*, ejp002.

Deressa, T. T., Hassan, R. M., & Ringler, C. (2011). Perception of and adaptation to climate change by respondent in the Nile basin of Ethiopia. *The Journal of Agricultural Science*, *149*(1), 23.

Deschenes, O., & Greenstone, M. (2007). The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather. *The American Economic Review*, 354-385.

Devereux, S. (2006). Cash transfers and social protection *In: Paper presented at the regional workshop on cash transfer activities in Southern Africa*, Johannesburg, 9-10 October.

Devereux, S. (2001). Sen's entitlement approach: critiques and counter-critiques. *Oxford Development Studies*, *29*(3), 245-263.

Devereux, S., Baulch, B., Hussein, K., Shoham, J., & Wilcock, D. (2004). Improving the analysis of food insecurity. Food insecurity measurement, livelihoods approaches and policy: applications in FIVIMS *Improving the analysis of food insecurity. Food insecurity measurement, livelihoods approaches and policy: applications in FIVIMS*: FIVIMS. Available at http://www.bvsde.paho.org/texcom/nutricion/devereuxwilcock.pdf

DFID (1999) *Sustainable livelihoods guidance sheets* [Accessed 8 June 2016]. Available from: http://www.eldis.org/go/livelihoods/

DFID (2000): Sustainable Livelihoods Guidance Sheets. Department for International Development.http://www.livelihoods.org/info/info_guidancesheets.htmlaccessed: 23.07.2016)

Di Falco, S. (2014). Adaptation to climate change in Sub-Saharan agriculture: assessing the evidence and rethinking the drivers. *European Review of Agricultural Economics, 41*(3), 405-430. doi:10.1093/erae/jbu014

Dijk, T. V. (2011). Livelihoods, capitals and livelihood trajectories: A more sociological conceptualisation. *Progress in Development Studies, 11*(2), 101-117.

Dindang , A., Bin Taat, A., Eng Beng, P., Binti Mohd Alwi, A., Ak Mandai, A., Binti Mat Adam, S. F., . . . Lah, D. (2013). *Statistical and trend analysis of rainfall data In Kuching, Sarawak from 1968-2010*. Retrieved from Malaysia:

DOA. (2008). *Statistical Handbook*. Malaysia: Ministry of Agriculture.

DOA. (2014). Paddy Statistics of Malaysia 2013 (First Edition ed., Vol. BK 15/01-07/400, pp. xx). Peninsular Malaysia: Department of Agriculture Peninsular Malaysia.

Doane, D. P., & Seward, L. E. (2011). Measuring skewness: a forgotten statistic. *Journal of Statistics Education, 19*(2), 1-18.

Dobbie, M. J., & Dail, D. (2013). Robustness and sensitivity of weighting and aggregation in constructing composite indices. *Ecological Indicators, 29*, 270-277.

Douglas, E., Vogel, R., & Kroll, C. (2000). Trends in floods and low flows in the United States: impact of spatial correlation. *Journal of hydrology, 240*(1), 90-105.

Du Toit, A. (2005). Poverty measurement blues: some reflections on the space for understanding 'chronic'and'structural'poverty in South Africa. Manchester: Chronic Poverty Research Centre Working Paper 55.

Du Toit, A. S., & Prinsloo, M. A. (2001). El Niño-southern oscillation effects on maize production in South Africa: A preliminary methodology study. *Impacts of El Niño and climate variability on agriculture*(impactsofelnino), 77-86.

Eakin, H., & Bojorquez-Tapia, L. A. (2008). Insights into the composition of household vulnerability from multicriteria decision analysis. *Global Environmental Change, 18*(1), 112-127.

Eakin, H., & Luers, A. L. (2006). Assessing the vulnerability of social-environmental systems. *Annual review of environment and resources, 31*.

Eischeid, J. K., Bruce Baker, C., Karl, T. R., & Diaz, H. F. (1995). The quality control of long-term climatological data using objective data analysis. *Journal of Applied Meteorology, 34*(12), 2787-2795.

Elasha, B.-O., Elhassan, N. G., Ahmed, H., & Zakieldin, S. (2005). Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan. *Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper, 17*. Available from: http://www.iflea.org/pdf/AIACC_WP_No017.pdf.

Ellis, F. (2000). The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics, 51*(2), 289-302.

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change, 21*(2), 647-656.

Eriksen, S., & Kelly, P. M. (2007). Developing credible vulnerability indicators for climate adaptation policy assessment. *Mitigation and Adaptation Strategies for Global Change, 12*(4), 495-524.

Ericksen, P., Thornton, P., Notenbaert, A., Cramer, L., Jones, P. & Herrero, M. (2011) *Mapping hotspots of climate change and food insecurity in the global tropics*. [Accessed 20 November, 2013]. Available from: http://cgspace.cgiar.org/handle/ 10568/3826.

Eze, S., & Bola, A. (2013). Effect of ambient temperature and rainfall on rice production in The Gambia: a case study of the central river region (CRR). *Agricultural Science Service research and development reports Storage pests/Ministry of Agriculture, Fisheries and Food, 2*, 79-83.

Fahmi, Z., Abu Samah, B., & Abdullah, H. (2013). Paddy Industry and Paddy Respondent Well-being: A Success Recipe for Agriculture Industry in Malaysia *Asian Social Science, 9*(3).

FAO. (2006). *Livelihood and adaptation to climate variability and changes in drought- prone areas of Bangladesh*. Retrieved from Rome:

FAO. (2008). *Climate Change AND Food Security: A Framework Document*. Rome: Fod and Agricultural Organization of the United Nation.

Fazal, S. A., & Abdul Wahab, S. (2013). Economic impact of climate change on agricultural sector: A Review. *Journal of Transformative Entrepreneurship, 1*(1), 39-49.

Fellmann, T. (2012). The assessment of climate change related vulnerability in the agricultural sector: Reviewing conceptual frameworks. *Building resilience for adaptation to climate change in the agriculture sector, 23*, 37.

Field , A. (2014). *Discovering statistics using IBM SPSS statistics* (4th Edition ed.). London: Sage Publications, .

Filmer, D., & Pritchett, L. H. (2001). Estimating wealth effects without expenditure Data—Or tears: An application to educational enrollments in states of india*. *Demography, 38*(1), 115-132.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockstrom, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability.

Ford, J. (2007). Emerging trends in climate change policy: the role of adaptation. *Journal of Climate, 3*(2), 12.

Fraser, E. D. (2007). Travelling in antique lands: using past famines to develop an adaptability/resilience framework to identify food systems vulnerable to climate change. *Climatic Change, 83*(4), 495-514.

Füssel , H. (2007). Vulnerability: a generally applicable conceptual framework for climate change research. *Global Environmental Change, 17*(2), 155-167.

Füssel , H., & Klein, R. J. T. (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic change, 75*(3), 301-329.

Gallopin, G. C. (1996). Environmental and sustainability indicators and the concept of situational indicators. A systems approach. *Environmental modeling & assessment, 1*(3), 101-117.

Garson, G. D. (2014). *The Delphi method in quantitative research*. Asheboro, NC: Statistical Associates Publishers.

Gbetibouo, G. A. (2009). *Understanding respondents' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa* (Vol. 849): Intl Food Policy Res Inst.

Gbetibouo , G. A., & Hassan , R. M. (2005). Measuring the economic impact of climate change on major South African field crops: a Ricardian approach. *Global and Planetary Change, 47*(2), 143-152.

Gbetibouo, G. A., & Ringler, C. (2009). *Mapping South African farming sector vulnerability to climate change and variability: A subnational assessment*: International Food Policy Research Institute (IFPRI) and Center for Environmental Economics and Policy in Africa (CEEPA).

Gbetibouo , G. A., Ringler , C., & Hassan , R. (2010). Vulnerability of the South African farming sector to climate change and variability: An indicator approach. *Natural Resources Forum, 34*(3), 175-187.

Ghimire, Y. N., Shivakoti, G. P., & Perret, S. R. (2010). Household-level vulnerability to drought in hill agriculture of Nepal: implications for adaptation planning. *International Journal of Sustainable Development & World Ecology, 17*(3), 225-230.

Gilbert, R. O. (1987). *Statistical methods for environmental pollution monitoring*: John Wiley & Sons.

Gitz, V., & Meybeck, A. (2012,). *Risks, vulnerabilities and resilience in a context of climate change* Paper presented at the Building Resilience for Adaptation to Climate Change in Agriculture sector, Proceedings of a Joint FAO/OECD Workshop, Rome.

Godwin, D., Ritchie, J., Singh, U., & Hunt, L. (1989). *A user's guide to CERES wheat*. Retrieved fromhttp://www.sidalc.net/cgi-bin/wxis.exe/?IsisScript=CIMMYT on 24th June, 2014

González-Rouco, J. F., Jiménez, J. L., Quesada, V., & Valero, F. (2001). Quality control and homogeneity of precipitation data in the southwest of Europe. *Journal of Climate, 14*(5), 964-978.

Gravetter, F. J., & Wallnau, L. B. (2016). *Statistics for the behavioral sciences*: Cengage Learning.

Greene, W. H. (1997). *Econometric analysis*. New Jersey: Prentice Hall.

Greenfield, M. L. V. H., Kuhn, J. E., & Wojtys, E. M. (1997). A statistical primer: Power analysis and sample size determination. *The American Journal of sports Medicine, 25*(1), 138-140.

Gregory, P. J., Ingram, J. S., & Brklacich, M. (2005). Climate change and food security. *Philosophical Transactions of the Royal Society B: Biological Sciences, 360*(1463), 2139-2148.

Griggs, D. J., & Noguer, M. (2002). Climate change 2001: the scientific basis. Contribution of working group I to the third assessment report of the intergovernmental panel on climate change. *Weather, 57*(8), 267-269.

Guiteras, R. (2009). The impact of climate change on Indian agriculture. *Manuscript, Department of Economics, University of Maryland, College Park, Maryland*.

Hair , J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis* (7th Edition ed.). Englewood Cliffs: Prentice Hall.

Hardesty, D. M., & Bearden, W. O. (2004). The use of expert judges in scale development: Implications for improving face validity of measures of unobservable constructs. *Journal of Business Research, 57*(2), 98-107.

Haris, N. M., Hamzah, A., Krauss, S. E., & Ismail, I. A. (2013). Relationship between Decision-Making Inputs and Productivity among Paddy Respondent‟ in Integrated Agriculture Development Areas (IADAs), in Malaysia. *International Journal on Advanced Science, Engineering and Information Technology, 3*(1), 64-70.

Hartmann, D. L., Tank, A. M. K., Rusticucci, M., Alexander, L. V., Brönnimann, S., Charabi, Y. A. R., . . . Kaplan, A. (2013). Observations: atmosphere and surface *Climate Change 2013 the Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*: Cambridge University Press.

Hashim, M., Ismail, W. R., Nayan, N., Ngah, M. S. Y. C., & Ibrahim, M. H. (2012). Analisis Trend Hujan di Bandaraya Ipoh Perak 1970-2007 (Analysis of Rainfall Trend in Ipoh City, Perak 1970-2007). *e-BANGI, 7*(1), 149.

Hegglin, E., & Huggel, C. (2008). An integrated assessment of vulnerability to glacial hazards: a case study in the Cordillera Blanca, Peru. *Mountain Research and Development, 28*(3), 299-309.

Herath, S. M., & Sarukkalige, R. (2017). Evaluation of empirical relationships between extreme rainfall and daily maximum temperature in Australia. *Journal of hydrology*.

Hertzog, M.A. (2008). Considerations in determining sample size for pilot studies, Research in Nursing & Health, 31,180-191.

Hesselberg, J., & Yaro, J. A. (2006). An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework. *GeoJournal, 67*(1), 41-55.

Hill, R. (1998). What sample size is “enough” in internet survey research? Interpersonal Computing and Technology: An Electronic Journal for the 21st Century, 6(3-4).

Hinkel, J. (2011). “Indicators of vulnerability and adaptive capacity”: Towards a clarification of the science–policy interface. *Global Environmental Change, 21*(1), 198-208.

Hirsch, R. M., Slack, J. R., & Smith, R. A. (1982). Techniques of trend analysis for monthly water quality data. *Water resources research, 18*(1), 107-121.

Hoogenboom, G., Jones, J., Wilkens, P., Porter, C., Batchelor, W., Hunt, L., . . . Bowen, W. (2004). Decision support system for agrotechnology transfer version 4.0. *University of Hawaii, Honolulu, HI (CD-ROM).*

Hoogenboom , G., Jones, J. W., Porter, C. H., Wilkens, P. W., Boote, K. J., Hunt, L. A., & Tsuji, G. Y. (Eds.). (2010). *Decision Support System for Agrotechnology Transfer Version 4.5* (Vol. 1 Overview): University of Hawaii, Honolulu, HI.

Hoogenboom , G., Jones, J. W., Wilkens, P. W., Porter, C. H., Boote, K. J., Hunt, L. A., . . . J., K. (2012). *Decision Support System for Agrotechnology Transfer (DSSAT)*

Howden, S. M., Soussana, J.-F., Tubiello, F. N., Chhetri, N., Dunlop, M., & Meinke, H. (2007). Adapting agriculture to climate change. *Proceedings of the National Academy of Sciences, 104*(50), 19691-19696.

Hunt, L., White, J., & Hoogenboom, G. (2001). Agronomic data: advances in documentation and protocols for exchange and use. *Agricultural Systems, 70*(2), 477-492.

Hussein, K. (2002). Food security: Rights, livelihoods and the World Food Summit–five years later. *Social Policy & Administration, 36*(6), 626-647.

IADA (2009) Integrated Agricultural Development Area, Internal Unpublished Data from the record of North-West Selangor, Malaysia, March

Iglesias, A., Rosenzweig, C., & Pereira, D. (2000). Agricultural impacts of climate change in Spain: developing tools for a spatial analysis. *Global Environmental Change, 10*(1), 69-80.

Ingram, R. (1998). Power analysis and sample size estimation. *Nursing Times Research, 3*(2), 132-139.

IPCC. (2007a). *Climate change 2007-impacts, adaptation and vulnerability: Working group II contribution to the fourth assessment report of the IPCC* (Vol. 4): Cambridge University Press.

IPCC. (2007b). *Climate Change: Synthesis Report*. Retrieved from Valencia; IPPC, 2007 - cridlac.org,Valentia, Geneva

IPCC. (2012a). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation - Summary for policy Makers. Aspecial Report of Working Groups I &II*. Retrieved from

IPCC. (2012b). *Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change*: Cambridge University Press.

Isaac, S., & Michael, W. B. (1995). *Handbook in Research and Evaluation*. San Diego, CA: Educational and Industrial Testing Services.

Israel, G. D. (1992). *Determining sample size*: University of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences, EDIS Gainesville.

Iyengar, N., & P. Sudarshan. (1982). A Method of Classifying Regions from Multivariate Data. *Economic and Political Weekly,17*(51), 2047-2052. Retrieved from http://www.jstor.org/stable/4371674

Jain, S., & Kumar, V. (2012) Trend analysis of rainfall and temperature data for India, *Current Science, 102* (1), 37-49, Retrieved from http://www.jstor.org/stable/24080385

Jones, C. A., Kiniry, J. R., & Dyke, P. T. (1986). *CERES-Maize: A simulation model of maize growth and development*: Texas AandM University Press.

Jones , J., Hoogenboom, G., Porter, C. H., Boote, K. J., Batchelor, W. D., Hunt, L., . . . Ritchie, J. T. (2003). The DSSAT cropping system model. *European Journal of Agronomy, 18*(3), 235-265.

Johanson, G. A., & Brooks, G. P. (2010). Initial Scale Development: Sample Size for Pilot Studies. *Educational and Psychological Measurement, 70*, 394–400. http://doi.org/10.1177/0013164409355692

Jones , P. G., & Thornton, P. K. (2003). The potential impacts of climate change on maize production in Africa and Latin America in 2055. *Global Environmental Change, 13*(1), 51-59.

Juahir, H., Zain, S. M., Aris, A. Z., Yusof, M. K., Samah, M. A. A., & Mokhtar, M. (2010). Hydrological trend analysis due to land use changes at Langat River Basin. *Environment Asia, 3*(2010), 20-31.

Juneng, L., & Tangang, F. T. (2005). Evolution of ENSO-related rainfall anomalies in Southeast Asia region and its relationship with atmosphere–ocean variations in Indo-Pacific sector. *Climate Dynamics, 25*(4), 337-350.

Kabubo-Mariara, J., & Karanja, F. K. (2007). The economic impact of climate change on Kenyan crop agriculture: A Ricardian approach. *Global and Planetary Change, 57*(3), 319-330.

KADA, (2014) Kemubu Agricultural Development Authority, Summary of Paddy Incentive List. Internal Unpublished Data from the record of KADA, Kelantan

Kamaruddin, R., Ali, J., & Saad, N. M. (2013). Happiness and its Influencing Factors among Paddy Respondent in Granary Area of Mada. *World Applied Sciences Journal, 28*(EFMO)), 91-99.

Kandji, S. T., Verchot, L., & Mackensen, J. (2006). *Climate change and variability in Southern Africa: impacts and adaptation in the agricultural sector*: World Agroforestry Centre.

Karfakis, P., Knowles, M., Smulders, M., & Capaldo, J. (2011). Effects of global warming on vulnerability to food insecurity in rural Nicaragua. *ESA-FAO WP series*(11-18).

Karmeshu, N. (2012). Trend detection in annual temperature & precipitation using the Mann Kendall test–a case study to assess climate change on select states in the northeastern United States.

Kasperson, J., Kasperson, R., Turner, B., Hsieh, W., & Schiller, A. (2003). Vulnerability to global environmental change. The human dimensions of global environmental change: Cambridge, MA: MIT.

Kaufmann, R. K. (1998). The impact of climate change on US agriculture: a response to Mendelssohn et al.(1994). *Ecological Economics, 26*(2), 113-119.

Kaufmann, R. K., Kauppi, H., Mann, M. L., & Stock, J. H. (2011). Reconciling anthropogenic climate change with observed temperature 1998–2008. *Proceedings of the National Academy of Sciences, 108*(29), 11790-11793.

Keenan, T., Maria Serra, J., Lloret, F., Ninyerola, M., & Sabate, S. (2011). Predicting the future of forests in the Mediterranean under climate change, with niche-and process-based models: CO2 matters! *Global Change Biology, 17*(1), 565-579.

Keeney, S., McKenna, H., & Hasson, F. (2010). The Delphi technique in nursing and health research. doi:http://doi.org/10.1002/9781444392029.ch1

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change andFacilitating adaptation. *Climatic change, 47*(4), 325-352.

Kendall , M. G. (1975). *Rank correlation methods* (4th ed.). London: Charles Griffin,.

Khee, P. C., Mee, L. Y., & Keong, C. (2011). The economic impact of climate change and food security in Malaysia. *Munich Personal RePEc Archive*.

Klein, R. J., Eriksen, S. E., Næss, L. O., Hammill, A., Tanner, T. M., Robledo, C., & O'Brien, K. L. (2007). Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. *Climatic change*, *84*(1), 23-44.

Kline, P. (1999). The handbook of psychological testing (2nd ed.). Routledge: London.

Kobayashi, K., & Salam, M. U. (2000). Comparing simulated and measured values using mean squared deviation and its components. *Agronomy Journal*, *92*(2), 345-352.

Kotir, J. H. (2011). Climate change and variability in sub- Saharan Africa: a review of current and future trends and impacts on agriculture and food security. *Environment, Development and Sustainability*, *13*(3), 587-605.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Kundzewicz, Z. W., & Robson, A. (2000). Detecting Trend and other changes in hydrological data. (WMO/TD-No. 1013). From World Meteorological Organization : http://www.wmo.ch/web/wcp/wcdmp/wcdmp.html

Kundzewicz, Z. W., & Robson, A. J. (2004). Change detection in hydrological records—a review of the methodology/revue méthodologique de la détection de changements dans les chroniques hydrologiques. *Hydrological sciences journal*, *49*(1), 7-19.

Kurukulasuriya, P., & Mendelsohn, R. O. (2008). A Ricardian analysis of the impact of climate change on African cropland. *African Journal of Agriculture and Resource Economics*, *2*(1).

Kwan, M. S., Tangang, F. T., & Juneng, L. (2013). Projected changes of future climate extremes in Malaysia. *Sains Malaysiana*, *42*(8), 1051-1059.

Labonne, J., Biller, D., & Chase, R. (2007). Inequality and relative wealth: do they matter for trust? *Evidence from poor communities in the Philippines. World bank-social development papers*(103).

Lansigan, F., De Los Santos, W., & Coladilla, J. (2000). Agronomic impacts of climate variability on rice production in the Philippines. *Agriculture, ecosystems & environment*, *82*(1), 129-137.

Leichenko, R. M., & O'Brien, K. L. (2002). The dynamics of rural vulnerability to global change: the case of southern Africa. *Mitigation and Adaptation Strategies for Global Change, 7*(1), 1-18.

Lenoir, J., Gégout, J., Marquet, P., De Ruffray, P., & Brisse, H. (2008). A significant upward shift in plant species optimum elevation during the 20th century. *Science, 320*(5884), 1768-1771.

Li, Q., Zhang, H., Liu, X., & Huang, J. (2004). Urban heat island effect on annual mean temperature during the last 50 years in China. *Theoretical and applied climatology, 79*(3-4), 165-174. Lilja, K. K., Laakso, K., & Palomäki, J. (2011). *Using the Delphi method.* Paper presented at the Technology Management in the Energy Smart World (PICMET), 2011 Proceedings of PICMET'11:.

Lilja, K. K., Laakso, K., & Palomäki, J. (2011). *Using the Delphi method.* Paper presented at the Technology Management in the Energy Smart World (PICMET), 2011 Proceedings of PICMET'11:.

Lin , R. M., Ariff, E. E. E., Serin, T., & Ghani, M. A. Z. (2010). Food security assessment under climate change scenario in Malaysia. *CAPSA*, pp. 1-5.

Lobell , D., & Burke, M. (2010). *Climate Change and Food Security*: Springer.

Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P. & Naylor, R.L. (2008) Prioritizing climate change adaptation needs for food security in 2030. *Science*, 319(5863): 607-610.

Lovejoy, S. (2014). Return periods of global climate fluctuations and the pause. *Geophysical Research Letters, 41*(13), 4704-4710.

Lowry, C. A., & Montgomery, D. C. (1995). A review of multivariate control charts. *IIE transactions, 27*(6), 800-810.

Lucas, P. L., & Hilderink, H. B. (2005). Vulnerability Concept and its Application to Food Security.RIVM rapport 550015004 Available online @ http:// hdl. handle.net /10029/8984

Luers, A. L. (2005). The surface of vulnerability: an analytical framework for examining environmental change. *Global Environmental Change, 15*(3), 214-223.

Luers, A. L., Lobell, D. B., Sklar, L. S., Addams, C. L., & Matson, P. A. (2003). A method for quantifying vulnerability, applied to the agricultural system of the Yaqui Valley, Mexico. *Global Environmental Change, 13*(4), 255-267.

Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing research, 35*(6), 382-386.

MADA (2012) Muda Agricultural Development Authority, List of PPK members from Internal unpublished Data, MADA Kedah. Available at www.mada.gov.my

Maddison, D. (2000). A hedonic analysis of agricultural land prices in England and Wales. *European Review of Agricultural Economics, 27*(4), 519-532.

Madu, I. (2012). *Partial vulnerability of rural households to climate change in Nigeria:Implication for internal security.*

Man, N., & Ismaila, S. S. (2009). Off-farm employment participation among paddy respondent in the Muda Agricultural Development Authority and Kemasin Semerak granary areas of Malaysia. *Asia-Pacific Development Journal, 16*(2), 141-153.

Masud, M. M., Rahman, M. S., Al-Amin, A. Q., Kari, F., & Leal Filho, W. (2014). Impact of climate change: an empirical investigation of Malaysian rice production. *Mitigation and Adaptation Strategies for Global Change, 19*(4), 431-444.

Matthews, H. D., Gillett, N. P., Stott, P. A., & Zickfeld, K. (2009). The proportionality of global warming to cumulative carbon emissions. *Nature, 459*(7248), 829-832.

McCarthy, J. J. (2001). *Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change*: Cambridge University Press.

Meinke, H., Howden, S. M., Struik, P. C., Nelson, R., Rodriguez, D., & Chapman, S. C. (2009). Adaptation science for agriculture and natural resource management—urgency and theoretical basis. *Current Opinion in Environmental Sustainability, 1*(1), 69-76.

Mendelsohn, R., & Dinar, A. (2003). Climate, water, and agriculture. *Land economics, 79*(3), 328-341.

Mendelsohn , R., Nordhaus, W. D., & Shaw, D. (1994). The impact of global warming on agriculture: a Ricardian analysis. *The American Economic Review*, 753-771.

Mendelsohn, R., & Reinsborough, M. (2007). A Ricardian analysis of US and Canadian farmland. *Climatic change, 81*(1), 9-17.

Mendelsohn , R. O., & Tiwari , D. N. (2000). *Two essays on climate changes and agriculture: Adeveloping country perspective* (Vol. 145). Rome: Food and Agricultural Organization.

Mertz, O., Halsnaes, K., Olesen, J. E., & Rasmussen, K. (2009). Adaptation to climate in developing countries. *Environmental Management, 43*(5), 743-752.

MMD , Malaysia Meteorological Department (2009). *Climate Change Scenario for Malaysia, (2001 - 2099)*. Retrieved from www.met.gov.my/documents/10661 /194684/climate-scenarios.pdf/

MOA. (2011). National Agro-Food Policy 2011-2020. Putrajaya Malaysia, ISBN: 978-983-9863-41-3

MOA ,Ministry of Agriculture and Agro- Based Industry(2015). *(Perangkaan Agromakanan) AgroFood Statistics 2014*. Retrieved from www.moa.gov.my/documents/10157/0e0596cf-203b-474e-ba02-8e018ce68433

Molua, E. L. (2008). Turning up the heat on African agriculture: The impact of climate change on Cameroon's agriculture. *African Journal of Agricultural and Resource Economics, 2*(1), 45-64.

Molua, E. L. (2009). An empirical assessment of the impact of climate change on smallholder agriculture in Cameroon. *Global and Planetary Change, 67*(3), 205-208.

Monterroso, A., Conde, C., Gay, C., Gómez, D., & López, J. (2014). Two methods to assess vulnerability to climate change in the Mexican agricultural sector. *Mitigation and Adaptation Strategies for Global Change, 19*(4), 445-461.

Morita, S., Yonemaru, J.-I., & Takanashi, J.-i. (2005). Grain growth and endosperm cell size under high night temperatures in rice (Oryza sativa L.). *Annals of Botany, 95*(4), 695-701.

Moser, C., & Satterthwaite, D. (2010). Toward pro-poor adaptation to climate change in the urban centers of low-and middle-income countries. *Social Dimensions Of Climate Change*, 231.

Moser , C. O. (1998). The asset vulnerability framework: reassessing urban poverty reduction strategies. *World development, 26*(1), 1-19.

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences, 107*(51), 22026-22031.

Moss, R. H., Brenkert, A. L., & Malone, E. L. (2001). Vulnerability to climate change: a quantitative approach. *Pacific Northwest National Laboratory (PNNL-SA-33642). Prepared for the US Department of Energy*, 155-167.

Mueller, N.D., Gerber, J.S., Johnston, M., Ray, D.K., Ramankutty, N. & Foley, J.A. (2012) Closing yield gaps through nutrient and water management. *Nature,* 490: 254-0257.

Muñoz-Díaz, D., & Rodrigo, F. (2006). Seasonal rainfall variations in Spain (1912–2000) and their links to atmospheric circulation. *Atmospheric Research, 81*(1), 94-110.

Mustapha, A. (2013). Detecting Surface Water Quality Trends Using Mann-Kendall Tests and Sen's Slope Estimates. *International Journal of Advanced and Innovative Research (IJAIR)*, 108-114.

NAHRIM. (2006). *Final Report: Study of the Impact of Climate Change on the hydrologic Regime and Water Resources of Peninsular Malaysia*. Retrieved fromwww.nahrim.gov.my/.../100-study-of-the-impact-of-climate-chang...

Nardo, M., & Saisana, M. (2008). OECD/JRC handbook on constructing composite indicators. Putting theory into practice: Paris: OECD Publishing.

Nassar-McMillan, S. C., & Borders, L. D. (2002). Use of focus groups in survey item development. *The Qualitative Report, 7*(1), 1-12.

Ndamani, F., & Watanabe, T. (2016). Determinants of respondents' adaptation to climate change: A micro level analysis in Ghana. *Scientia Agricola, 73*(3), 201-208.

Nelson , R., Kokic, P., Crimp, S., Meinke, H., & Howden, S. (2010). The vulnerability of Australian rural communities to climate variability and change: Part I—Conceptualising and measuring vulnerability. *Environmental Science & Policy, 13*(1), 8-17.

Nelson, R., Kokic, P., & Meinke, H. (2007). From rainfall to farm incomes—transforming advice for Australian drought policy. II. Forecasting farm incomes. *Crop and Pasture Science, 58*(10), 1004-1012.

Newell, B., Crumley, C. L., Hassan, N., Lambin, E. F., Pahl-Wostl, C., Underdal, A., & Wasson, R. (2005). A conceptual template for integrative human–environment research. *Global Environmental Change, 15*(4), 299-307.

Nhemachena, C., & Hassan, R. (2007). *Micro-level analysis of respondent adaption to climate change in Southern Africa*: Intl Food Policy Res Inst.

Nicholas S (2007). The Economics of Climate Change: The Stern Review, Cambridge University Press.

Nkondze, M. S., Masuku, M. B., & Manyatsi, A. (2013). Factors affecting households vulnerability to climate change in Swaziland: a case of

Mpolonjeni area development programme (ADP). *Journal of Agricultural Science, 5*(10), 108.

National Oceanic and Atmospheric Administration(NOAA, 2007),*Climate Change*. Retrieved from http://www.ncdc.noaa.gov/oa/climate/ globalwarming.html

Notenbaert, A., Karanja, S. N., Herrero, M., Felisberto, M., & Moyo, S. (2013). Derivation of a household-level vulnerability index for empirically testing measures of adaptive capacity and vulnerability. *Regional Environmental Change, 13*(2), 459-470.

Norouzian-Maleki, S., Bell, S., Hosseini, S.-B., & Faizi, M. (2015). Developing and testing a framework for the assessment of neighbourhood liveability in two contrasting countries: Iran and Estonia. *Ecological Indicators, 48*, 263-271.

NRS (2001). National response strategies to climate change. Ministry of Science, Technology and Environment, Malaysia

Nyang'au, W., Mati, B., Kalamwa, K., Wanjogu, R., & Kiplagat, L. (2014). Estimating rice yield under changing weather conditions in Kenya using CERES rice model. *International Journal of Agronomy, 2014*.

Nyatuame, M., Owusu-Gyimah, V., & Ampiaw, F. (2014). Statistical analysis of rainfall trend for volta region in Ghana. *International Journal of Atmospheric Sciences, 2014*. http://dx.doi.org/10.1155/2014/203245

O'Brien, K., Eriksen, S., Nygaard, L. P., & Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate policy, 7*(1), 73-88.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., . . . Nygaard, L. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change, 14*(4), 303-313.

Ompraksah , M., Rishi, P., & Mudaliar, R. (2010). *Behavioural mapping of Indian urban settlements towards changing climate: an empirical study*. Paper presented at the International Conference on "Human Security and Climate Change," Trondheim, Norway.

Önöz, B., & Bayazit, M. (2003). The power of statistical tests for trend detection. *Turkish Journal of Engineering and Environmental Sciences, 27*(4), 247-251.

Opiyo, F. E., Wasonga, O. V., & Nyangito, M. M. (2014). Measuring household vulnerability to climate-induced stresses in pastoral rangelands of Kenya: Implications for resilience programming. *Pastoralism, 4*(1), 1-15.

Paavola , J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environmental Science & Policy, 11*(7), 642-654.

Pandey, R., Jha, S. K., Alatalo, J. M., Archie, K. M., & Gupta, A. K. (2017). Sustainable livelihood framework-based indicators for assessing climate change vulnerability and adaptation for Himalayan communities. *Ecological Indicators, 79*, 338-346.

Parry , M., Rosenzweig, C., Iglesias, A., Fischer, G., & Livermore, M. (1999). Climate change and world food security: a new assessment. *Global Environmental Change, 9, Supplement 1*(0), S51-S67. doi:http://dx.doi.org/10.1016/S0959-3780(99)00018-7

Parry , M., Rosenzweig, C., & Livermore, M. (2005). Climate change, global food supply and risk of hunger. *Philosophical Transactions of the Royal Society B: Biological Sciences, 360*(1463), 2125-2138.

Parry, M. L. (2007). *Climate Change 2007: impacts, adaptation and vulnerability: contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel on Climate Change* (Vol. 4): Cambridge University Press.

Partridge, M. D., & Rickman, D. S. (1998). Regional computable general equilibrium modeling: a survey and critical appraisal. *International Regional Science Review, 21*(3), 205-248.

Patnaik, U., & Narayanan, K. (2009). Vulnerability and climate change: An analysis of the eastern coastal districts of India. Available Online at https://mpra.ub.uni-muenchen.de/22062/ MPRA Paper No. 22062, posted 14. April 2010 01:06 UTC

Philandras, C., Metaxas, D., & Nastos, P. T. (1999). Climate variability and urbanization in Athens. *Theoretical and applied climatology, 63*(1-2), 65-72.

Piya, L., Maharjan, K. L., & Joshi, N. P. (2012). *Vulnerability of rural households to climate change and extremes: Analysis of Chepang households in the Mid-Hills of Nepal.* Paper presented at the 2012 Conference, August 18-24, 2012, Foz do Iguacu, Brazil.

Polit, D. F., & Beck, C. T. (2004). *Nursing Research: principles and methods*. Lippincott: Williams & Wilkins.

Polit, D. F., & Beck, C. T. (2006). The content validity index: are you sure you know what's being reported? Critique and recommendations. *Research in nursing & health, 29*(5), 489-497.

Popham, W. J. ((1978)). As always, provative. *Journal of Educational Measurement, 15*(4), 297-300.

Pretty, J. (2003). Social capital and the collective management of resources. *Science, 302*(5652), 1912-1914.

Radin Firdaus, R. B., Abdul Latiff, I., & Borkotoky, P. (2013). The impact of climate change towards Malaysian Paddy respondent. *Journal of Development and Agricultural Economics, 5*(2), 57-66. doi:10.5897/JDAE12.105

Ramli, N. N., Shamsudin, M. N., Mohamed, Z., & Radam, A. (2012). The Impact of Fertilizer Subsidy on Malaysia Paddy/Rice Industry Using a System Dynamics Approach. *International Journal of Social Science and Humanity, 2*(3), 213-219.

Reid, S., Smit, B., Caldwell, W., & Belliveau, S. (2007). Vulnerability and adaptation to climate risks in Ontario agriculture. *Mitigation and Adaptation Strategies for Global Change, 12*(4), 609-637.

Reid, P., & Vogel, C. (2006). Living and responding to multiple stressors in South Africa—Glimpses from KwaZulu-Natal. *Global Environmental Change, 16*(2), 195-206.

Reidsma, P., & Ewert, F. (2008). Regional farm diversity can reduce vulnerability of food production to climate change. *Ecology and Society, 13*(1), 38.

Reidsma, P., Ewert, F., Boogaard, H., & van Diepen, K. (2009). Regional crop modelling in Europe: the impact of climatic conditions and farm characteristics on maize yields. *Agricultural Systems, 100*(1), 51-60.

Reidsma, P., Ewert, F., Lansink, A. O., & Leemansd, R. (2010). Adaptation to climate change and climate variability in European agriculture: The importance of farm level responses. *European Journal of Agronomy, 32*, 91-102.

Reilly, J. M., & Schimmelpfennig, D. (1999). Agricultural impact assessment, vulnerability, and the scope for adaptation. *Climatic change, 43*(4), 745-788.

Rezzoug, W., Gabrielle, B., Suleiman, A., & Benabdeli, K. (2008). Application and evaluation of the DSSAT-wheat in the Tiaret region of Algeria. *African Journal of Agricultural Research, 3*(4), 284-296.

Rimi, R. H., Rahman, S. H., Karmakar, S., & Hussain, S. G. (2009). Trend analysis of climate change and investigation on its probable impacts on rice production at Satkhira, Bangladesh. *Pak. J. Meteorol, 6*, 37-50.

Río, S. d., Herrero, L., Fraile, R., & Penas, A. (2011). Spatial distribution of recent rainfall trends in Spain (1961–2006). *International journal of climatology, 31*(5), 656-667.

Ritchie, J., Alocilja, E., Singh, U., & Uehara, G. (1987). IBSNAT and the CERES-Rice model. *Weather and rice*, 271-281.

Rodriguez-Puebla , C., Encinas, A. H., Nieto , S., & Garmendia, J. (1998). Spatial and temporal patterns of annual precipitationVariability over the Iberian Peninsula. *International journal of climatology, 18*, 299-316.

Rohde, R., Muller, R., Jacobsen, R., Muller, E., Perlmutter, S., Rosenfeld, A., . . . Wickham, C. (2013). A new estimate of the average Earth surface land temperature spanning 1753 to 2011. Geoinfor Geostat Overview 1: 1. *of*, *7*, 2.

Rosenzweig, C., Karoly, D., Vicarelli, M., Neofotis, P., Wu, Q., Casassa, G., . . . Seguin, B. (2008). Attributing physical and biological impacts to anthropogenic climate change. *Nature, 453*(7193), 353-357.

Rosenzweig, C., & Parry, M. L. (1994). Potential impact of climate change on world food supply. *Nature, 367*(6459), 133-138.

Rousseeuw, P. J., & Leroy, A. M. (1987) Robust Regression & Outlier Detection, John Wiley, Newyork, USA.

Sabzevari, A. A., Zarenistanak, M., Tabari, H., & Moghimi, S. (2015). Evaluation of precipitation and river discharge variations over southwestern Iran during recent decades. *Journal of Earth System Science, 124*(2), 335-352. doi:10.1007/s12040-015-0549-x

Sadoulet, E., & De Janvry, A. (1995). *Quantitative development policy analysis*: Johns Hopkins University Press Baltimore.

Salkind , N. j. (Ed.) (1977). *Exploring Research* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Sallu, S. M., Twyman, C., & Stringer, L. C. (2010). Resilient or vulnerable livelihoods? Assessing livelihood dynamics and trajectories in rural Botswana. *Ecology and Society: a journal of integrative science for resilience and sustainability, 15*(4).

Sanghi, A., & Mendelsohn, R. (2008). The impacts of global warming on respondent in Brazil and India. *Global Environmental Change, 18*(4), 655-665.

Sarker, M., & Rashid, A. (2012). *Impacts of climate change on rice production and respondents' adaptation in Bangladesh.* University of Southern Queensland.

Satake, T., & Yoshida, S. (1978). High temperature-induced sterility in indica rices at flowering. *Japanese Journal of Crop Science, 47*(1), 6-17.

Schimmelpfennig, D., & Yohe, G. (1999). Vulnerability of crops to climate change: A practical method of indexing. *GLOBAL ENVIRONMENTAL CHANGE*

AND AGRICULTURE: ASSESSING THE IMPACTS, Frisvold & Kuhn, editors, Edward Elgar Publishing Limited, 193-217.

Schipper, E. L. F. (2006). Conceptual history of adaptation in the UNFCCC process. *Review of European Community & International Environmental Law, 15*(1), 82-92.

Schlenker, W., & Roberts, M. J. (2006). Nonlinear effects of weather on corn yields. *Applied Economic Perspectives and Policy, 28*(3), 391-398.

Schubert, S. D., Suarez, M. J., Pegion, P. J., Koster, R. D., & Bacmeister, J. T. (2008). Potential predictability of long-term drought and pluvial conditions in the US Great Plains. *Journal of Climate, 21*(4), 802-816.

Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. Brighton: Institute of Development Studies.

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies, 36*(1), 171-196.

Sen, A. (1981). *Poverty and famines: an essay on entitlement and deprivation*: Oxford university press.

Sen , P. K. (1968). Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association, 63*(324), 1379-1389.

Seo, S.-N. N., Mendelsohn, R., & Munasinghe, M. (2005). Climate change and agriculture in Sri Lanka: a Ricardian valuation. *Environment and Development Economics, 10*(05), 581-596.

Shah, K. U., Dulal, H. B., Johnson, C., & Baptiste, A. (2013). Understanding livelihood vulnerability to climate change: Applying the livelihood vulnerability index in Trinidad and Tobago. *Geoforum, 47*, 125-137.

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika, 52*(3/4), 591-611.

Shukla, R., Sachdeva, K., & Joshi, P. (2016). Inherent vulnerability of agricultural communities in Himalaya: A village-level hotspot analysis in the Uttarakhand state of India. *Applied Geography, 74*, 182-198.

Siegel, S., & Castellan, N. J. (1988). *Nonparametric Statistics for the Behavioral Sciences* (2nd ed.). New York: McGraw-Hill, Book Company,

Singh, A. S., & Masuku, M. B. (2013). Fundamental of applied research and sampling techniques. *Int J Med Appl Sci, 2*(4), 123-124.

Singh , N. P., Bantilan, C., & Byjesh, K. (2014). Vulnerability and policy relevance to drought in the semi-arid tropics of Asia–A retrospective analysis. *Weather and Climate Extremes, 3*, 54-61.

Singh , S., Amartalingam, R., Wan Harun, W., & Islam, M. (1996). *Simulated impact of climate change on rice production in Peninsular Malaysia.* Paper presented at the Proceeding of National Conference on Climate Change.

Sink, C. A., & Mvududu, N. H. (2010). Statistical power, sampling and effect sizes: Three keys to the research relevancy. *Counseling Outcome Research and Evaluation, 1*(2), 1-18.

Siwar, C., Alam, M. M., Murad, M. W., & Al-Amin, A. Q. (2009). A review of the linkages between climate change, agricultural sustainability and poverty in Malaysia. *International Review of Business Research Papers, 5*(6), 309-321.

Siwar, C., Idris, N. M., Yasar, M., & Morshed, G. (2014). Issues and Challenges Facing Rice Production and Food Security in the Granary Areas in the East Coast Economic Region (ECER), Malaysia. *Research Journal of Applied Sciences, Engineering and Technology, 7*(4), 711 - 722.

Smit, B., Burton, I., Klein, R. J., & Street, R. (1999). The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change, 4*(3-4), 199-213.

Smit, B., & Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustainable Development, 8*(9), 9.

Smit, B., & Skinner, M. W. (2002). Adaptation options in agriculture to climate change: a typology. *Mitigation and Adaptation Strategies for Global Change, 7*(1), 85-114.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change, 16*(3), 282-292.

Smith, B., Burton, I., Klein, R. J., & Wandel, J. (2000). An anatomy of adaptation to climate change and variability. *Climatic change, 45*(1), 223-251.

Steffen, W., Sanderson, R. A., Tyson, P. D., Jäger, J., Matson, P. A., Moore III, B., . . . Turner, B. L. (2006). *Global change and the earth system: a planet under pressure*: Springer Science & Business Media.

Steinman, B. A., Mann, M. E., & Miller, S. K. (2015). Atlantic and Pacific multidecadal oscillations and Northern Hemisphere temperatures. *Science, 347*(6225), 988-991.

Stocker, T., Qin, D., Plattner, G., Tignor, M., Allen, S., Boschung, J., . . . Midgley, P. (2013). Intergovernmental panel on climate change, working group I

contribution to the IPCC fifth assessment report (AR5): Cambridge University Press: New York.

Suhaila, J., Deni, S. M., Zin, W. Z. W., & Jemain, A. (2010). Trends in Peninsular Malaysia rainfall data during the southwest monsoon and northeast monsoon seasons: 1975–2004. *Sains Malaysiana, 39*(4), 533-542.

Suhaila, J., & Yusop, Z. (2017). Trend analysis and change point detection of annual and seasonal temperature series in Peninsular Malaysia. *Meteorology and Atmospheric Physics*. doi:10.1007/s00703-017-0537-6

Sumarto, S., Toyamah, N., Usman, S., Sulaksono, B., Budiyati, S., Widyanti, W. D., . . . Sodo, R. J. (2006). *A rapid appraisal of the implementation of the 2005 direct cash transfer program in indonesia: A case study in five kabupaten/kota*. Retrieved from http://www.smeru.or.id/en/content/rapid-appraisal-implemen-tation-2005-direct-cash-transfer-program-indonesia-case-study-five

Tabachnick, B. G., & Fidell, L. S. (2007). Using multivariate statistics, 5th. *Needham Height, MA: Allyn & Bacon*.

Tabari, H., & Talaee, P. H. (2011). Recent trends of mean maximum and minimum air temperatures in the western half of Iran. *Meteorology and Atmospheric Physics, 111*(3-4), 121-131.

Tan, M. L., Ibrahim, A. L., Cracknell, A. P., & Yusop, Z. (2017). Changes in precipitation extremes over the Kelantan River Basin, Malaysia. *International journal of climatology, 37*(10), 3780-3797.

Tangang, F., Juneng, L., & Ahmad, S. (2007). Trend and interannual variability of temperature in Malaysia: 1961–2002. *Theoretical and applied climatology, 89*(3-4), 127-141.

Tesso, G., Emana, B., & Ketema, M. (2012). Analysis of vulnerability and resilience to climate change induced shocks in North Shewa, Ethiopia. *Agricultural Sciences, 3*(06), 871.

Thornton, P.K., Jones, P.G., Ericksen, P.J. & Challinor, A.J. (2011) Agriculture and food systems in sub-Saharan Africa in a 4 C+ world. *Philosophical Transactions of the Royal Society,* 369(1934): 117-136.

Thornton, P. K., Jones, P. G., Owiyo, T., Kruska, R. L., Herrero, M., Orindi, V., . . . Bekele, N. (2008). Climate change and poverty in Africa: Mapping hotspots of vulnerability. *African Journal of Agricultural and Resource Economics, 2*(1), 24-44.

Tilman D, Cassman KG, Matson P, Naylor R, Polasky S (2002). Agricultural Sustainability and Intensive Production Practices. Nature, 418(6898): 671–677.

Timberlake, A. M. (2011). Sample size in ordinal logistic hierarchical linear modeling. Retrieve from https://search.proquest.com/openview/91852edc06bc4b1f6e60b1b558bc5b68/1?pq-origsite=gscholar&cbl=18750&diss=y

Timsina, J., & Humphreys, E. (2006). Application of CERES-rice and CERES-wheat for research, policy and climate change studies. *International Journal of Agricultural Research, 1*(3), 202 -225.

Tiwari, K., Rayamajhi, S., Pokharel, R., & Balla, M. (2014). Determinants of the climate change adaptation in rural farming in Nepal Himalaya. *International Journal of Multidisciplinary and Current Research, 2*, 2321-3124.

Toner, A. (2003). Exploring sustainable livelihoods approaches in relation to two interventions in Tanzania. *Journal of International Development, 15*(6), 771-781.

Trenberth, K. E., and D. A. Paolino, (1980), The Northern Hemisphere sea-level pressure data set:Trends, errors and discontinuities. *Mon. Wea.Rev.,* **108,** 856–872.

Tsuji, G. Y., Hoogenboom, G., & Thornton, P. K. (1998). *Understanding options for agricultural production* (Vol. 7): Springer Science & Business Media.

Tubiello, F. N., & Rosenzweig, C. (2008). Developing climate change impact metrics for agriculture. *Integrated Assessment, 8*(1).

Turco, M., Palazzi, E., Hardenberg, J., & Provenzale, A. (2015). Observed climate change hotspots. *Geophysical Research Letters, 42*(9), 3521-3528.

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., . . . Martello, M. L. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences, 100*(14), 8074-8079.

Uddin, M. N., Bokelmann, W., & Entsminger, J. S. (2014). Factors affecting respondents' adaptation strategies to environmental degradation and climate change effects: a farm level study in Bangladesh. *Climate, 2*(4), 223-241.

UNDP. (2006). *Global partnership for development*. Retrieved from

UNFCCC. (1992). United Nations Framework Convention on Climate Change. (FCCC/INFORMAL/84 GE.05-62220 (E) 200705). Retrieved 1st April, 2017 https://unfccc.int/resource/docs/convkp/conveng.pdf

UNFCCC, (2007). *Impacts, vulnerabilities and adaptation in developing countries.* Paper presented at the United Nations Framework Convention on Climate Change (UNFCCC), Germany.

UNFCCC,(1999)United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its Fourth Session, FCCC/CP/1998/16. http://www.unfccc.de downloaded on 19 February 1999.

UNISDR, M. (2009). UNISDR Terminology for Disaster Risk Redution. *United Nations International Strategy for Disaster Reduction (UNISDR) Geneva, Switzerland*.

Van Nguyen, N., & Ferrero, A. (2006). Meeting the challenges of global rice production. *Paddy Water Environ.*, 4: 1-9 Springer.

Vaghefi, N., Shamsudin, M. N., Makmom, A., & Bagheri, M. (2011). The economic impact of climate change on rice production in Malaysia. *International Journal of Agricultural Research, 6*(1), 67-74.

Vaghefi , N. S. (2013). *Economic Impact of Climate Change on Malaysian Rice Production* (PhD), University Putra Malaysia, Unpublished.

Varikoden H, Preethi, B., Samah, A. and Babu, C. (2011), Seasonal variation of rainfall characteristics in different intensity classes over Peninsular Malaysia, *Journal of hydrology*, 404(1):99-108.

Vergni L. and Todisco, F. (2011), Spatio-temporal variability of precipitation, temperature and agricultural drought indices in Central Italy. *Agricultural and Forest Meteorology*, 151(3): 301-313.

Villafuerte, M. Q., Matsumoto, J., Akasaka, I., Takahashi, H. G., Kubota, H., & Cinco, T. A. (2014). Long-term trends and variability of rainfall extremes in the Philippines. *Atmospheric Research, 137*, 1-13.

Vincent, K. (2004). Creating an index of social vulnerability to climate change for Africa. *Tyndall Center for Climate Change Research. Working Paper, 56*, 41.

Voldoire, A., & Royer, J. (2004). Tropical deforestation and climate variability. *Climate Dynamics, 22*(8), 857-874.

Wai, N. M., Camerlengo, A., Khairi, A., & Wahab, A. (2005). A study of global warming in Malaysia.

Walker, R. (2004). *Social Security And Welfare: Concepts And Comparisons: Concepts and Comparisons*: McGraw-Hill Education (UK).

Waltz, C. F., Strickland, O. L., & Lenz, E. R. (2005). Content Analysis. *Measurement in nursing and health research, 3*, 239-245.

Wan, Z., W.Z., Suhaila, J., Deni, S. M. &Jemain, A.A. (2010). Recent changes in extreme rainfall events in Peninsular Malaysia: 1971–2005. *Theoretical and applied climatology, 99*(3-4), 303-314.

Watson, R., Zinyowera, T., Marufu, C., & Moss, R. H. (1996). *Impacts, adaptations and mitigation of climate change: Scientific-technical analysis*: Cambridge University Press.

Wilding, L. (1985). *Spatial variability: its documentation, accommodation and implication to soil surveys.* Paper presented at the Soil spatial variability. Workshop.

Willmott, C. J. (1982). Some comments on the evaluation of model performance. *Bulletin of the American Meteorological Society, 63*(11), 1309-1313.

Willmott, C. J., Ackleson, S. G., Davis, R. E., Feddema, J. J., Klink, K. M., Legates, D. R., . . . Rowe, C. M. (1985). Statistics for the evaluation and comparison of models. *Journal of Geophysical Research: Oceans (1978–2012), 90*(C5), 8995-9005.

Willroth, P., Diez, J. R., & Arunotai, N. (2011). Modelling the economic vulnerability of households in the Phang-Nga Province (Thailand) to natural disasters. *Natural Hazards, 58*(2), 753-769.

Winters, P., Murgai, R., Sadoulet, E., De Janvry, A., & Frisvold, G. (1996). *Climate change, agriculture, and developing economies*: Department of Agricultural and Resource Economics, Division of Agriculture and Natural Resources, University of California at Berkeley.

Wiréhn, L., Danielsson, Å., & Neset, T.-S. S. (2015). Assessment of composite index methods for agricultural vulnerability to climate change. *Journal of environmental management, 156*, 70-80.

Xiong, W., Holman, I., Conway, D., Lin, E., & Li, Y. (2008). A crop model cross calibration for use in regional climate impacts studies. *Ecological Modelling, 213*(3), 365-380.

Yamane, Taro (1967). Statistics An introductory Analysis. 2nd ed. New York: Harper Press. p. 886.

Yaro, J. A. (2004). Theorizing food insecurity: building a livelihood vulnerability framework for researching food insecurity. *Norsk Geografisk Tidsskrift-Norwegian Journal of Geography, 58*(1), 23-37.

Yohe, G., & Tol, R. S. (2002). Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. *Global Environmental Change, 12*(1), 25-40.

Yoshida, S. (1981). *Fundamentals of rice crop science*: Int. Rice Res. Inst.

Yusuf, A. A., & Francisco, H. (2009). Climate change vulnerability mapping for Southeast Asia. *Economy and Environment Program for Southeast Asia (EEPSEA), Singapore*, 10-15.

Zainal, Z., Shamsudin, M. N., & Mohamed, Z. (2013, 04-05 March, 2013). *Economic Impact of Climate change on the Malaysian Paddy Production.* Paper presented at the 4TH International Conference on Business and Economic Research (4TH ICBER 2013), Golden Flower Hotel, Bandung, Indonesia.

Zhou, P., Ang, B., & Zhou, D. (2010). Weighting and aggregation in composite indicator construction: A multiplicative optimization approach. *Social IndicatorResearch, 96*(1), 169-181.

Zumbo, B. D., & Chan, E. K. (2014). *Validity and validation in social, behavioral, and health sciences* (Vol. 54): Springer.

Žurovec, O., Čadro, S., & Sitaula, B. K. (2017). Quantitative Assessment of Vulnerability to Climate Change in Rural Municipalities of Bosnia and Herzegovina. *Sustainability, 9*(7), 1208.