

Pei-An Liao¹, Jiun-Hao Wang², Chen-Yen Yao³SENSING AND RESPONDING TO A CLIMATE CHANGE:
EMPIRICAL EVIDENCE FROM RURAL SME IN TAIWAN

Taiwan is well known as a global disaster risk hotspot. However, there had been limited concern over the climate changes in business/economics literature in Taiwan, until the catastrophic damages by Typhoon Morakot in 2009. Given that the farmers' associations are not only the most important rural small and medium enterprises in Taiwan, but the ones that also provide vital links between the government, research institutions, and farmers, their sensing ability to a climate change should increase the efficiency of the response to the climate change and its impacts. The aim of this study is to examine how the level of sensing the climate changes affects the urgency of responding to the measures adaptive to climate variability among the farmers' association employees. Using the nationwide survey within the farmers' associations in Taiwan and the fixed-effect model, the authors have found the compelling evidence that sensing the current climate changes significantly increases the urgency of responding to the measures adaptive to climate variability. In addition, the employees of farmers' associations located in the previous typhoon disaster area show more sensing ability on the urgency of responding than their counterparts in other areas.

Keywords: climate change, sensing ability, responding ability, rural enterprises, farmers' associations, Taiwan.

JEL Classifications: Q12, Q13, Q16, Q54.

Пеї-Ан Ліяо, Джіюн-Хао Ванг, Чен-Йен Яо

ВІЯВЛЕННЯ ТА РЕАКЦІЯ НА ЗМІНИ КЛІМАТУ: ЗА ДАНИМИ
МАЛИХ ТА СЕРЕДНІХ ФЕРМЕРСЬКИХ ГОСПОДАРСТВ ТАЙВАНЮ

У статті продемонстровано, що Тайвань є зоною дії багатьох природних лих, однак до катастрофічного тайфуна Моракоат (2009 р.) даному питанню було приділено мало уваги з боку економічної науки та бізнесу. У контексті ефективної реакції на природні лиха важливою є роль асоціацій малих та середніх фермерських господарств, що є посередниками між урядом, НДІ та безпосередньо фермерами. Описано, яким чином сприйняття кліматичних змін впливає на термін прийняття відповідних заходів членами фермерських асоціацій. Дані національного опитування фермерів Тайваню було використано для побудови моделі з фіксованими ефектами. Отримано переконливі дані на підтвердження того, що сприйняття та відчуття змін клімату та погоди суттєво впливає на терміновість заходів. Відзначено, що фермери, які проживають у районах, постраждалих від Моракоату, демонструють значно вищу чутливість до кліматичних змін, ніж їх колеги з інших районів острова.

Ключові слова: зміни клімату, здатність до сприйняття, здатність до реагування, сільські господарства, асоціації фермерів, Тайвань.

Табл. 2. Форм. 1. Літ. 33.

Пеї-Ан Ліяо, Джіюн-Хао Ванг, Чен-Йен Яо

ВЫЯВЛЕНИЕ И РЕАКЦИЯ НА ИЗМЕНЕНИЯ КЛИМАТА:
ПО ДАННЫМ МАЛЫХ И СРЕДНИХ ФЕРМЕРСКИХ ХОЗЯЙСТВ
ТАЙВАНЯ

В статье показано, что Тайвань является зоной действия многих природных бедствий, однако до катастрофического тайфуна Моракоат (2009 г.) данному вопросу было уделено мало внимания со стороны экономической науки и бизнеса. В контексте

¹ Department of Economics, Shih Hsin University, Taipei, Taiwan.

² Department of Bio-industry Communication and Development, National Taiwan University, Taipei, Taiwan.

³ Department of Business Administration, Shih Hsin University, Taipei, Taiwan.

эффективной реакции на природные бедствия крайне важной является роль ассоциаций малых и средних фермерских хозяйств в качестве связующего звена между правительством, НИИ и непосредственно фермерами. Описано, каким образом восприятие климатических изменений влияет на срочность принятия соответствующих мер членами фермерских ассоциаций. Данные национального опроса фермеров Тайваня были использованы для построения модели с фиксированными эффектами. Получены убедительные данные о том, что восприятие и ощущение изменений климата и погоды существенно влияет на срочность мер. Следует отметить, что фермеры, проживающие в районах, пострадавших от Моракота, демонстрируют чувствительность к климатическим изменениям намного выше, чем у их коллег из других районов острова. Ключевые слова: изменения климата, способность к восприятию, способность к реагированию, сельские хозяйства, ассоциации фермеров, Тайвань.

1. Introduction

Taiwan is annually afflicted by several natural disasters, mainly typhoons and floods, and is identified as a relatively high-risk global disaster hotspot (Dilley et al., 2005). However, there had been limited concern over the climate change in business/economics literature in Taiwan, until the catastrophic damage induced by the Typhoon Morakot in 2009 (Environmental Protection Administration, 2010). On August 8, 2009, Typhoon Morakot lashed Taiwan with wind gusts as high as 150 km/h and copious amounts of rainfall. Particularly, the rainfall in Pingtung County in the southern Taiwan exceeded 2,600 mm (100 inches), surpassing all previous rainfall records in Taiwan induced by a single typhoon. The unprecedented amount of rainfall caused severe floods and enormous mudslides in the southern part of rural Taiwan. One mudslide crashed into the Shiao-Lin village, resulting in over 500 deaths under mud. Typhoon Morakot was the deadliest typhoon to impact Taiwan in the recorded history, leaving about 700 people dead and more than NT\$164 bln (5 bln USD) losses for the agricultural sector (Environmental Protection Administration, 2010).

With the global warming, weather patterns in the amount, intensity, frequency, and type of precipitation are greatly different from the past. Poor farming communities and rural small businesses are particularly vulnerable to climate change risks (IFAD, 2008; IPCC, 2007). In addition, most of adaptive measures to the climate changes require information, knowledge, facilities, and technology transfer. Hence, rural small business, especially resource-scarce smallholders, may not be sufficiently responsive to adapt to rapidly changing climate without an external support (Brondizio and Moran, 2008; FAO, 2007; Phillips et al., 2005).

Farmers' associations are essential cooperation organizations in rural Taiwan. They provide farming input goods and advisory services to farmers and improve their economic situation and livelihoods. During the time of global warming, farmers' associations, on the one hand, encounter great uncertainty of market conditions, caused by climate changes and extreme weather events. On the other hand, such association can play an important role in helping farmers be prepared for a greater climate variability and uncertainty, and to create preventive measures to cope with increasing climate change risks and unintended consequences (AEA Energy and Environment, 2007; Davis, 2009) Hence, given that farmers' associations are not only the most important rural small and medium-sized enterprises in Taiwan, but also the ones that

provide vital links between the government, research institutions, and farmers, their ability to sense the current climate changes and to respond readily plays a crucial role for both macro- and microlevel adaptations to climate changes.

The objective of this study is to examine how the level of sensing climate changes affects the urgency level of responding by the measures adaptive to the potential impact of climate variability among employees of farmers' associations. Several researches have investigated the extent of individual farmers' awareness and perceptions of climate variability and the behavioral adjustments they have made in farming practices in response to climate changes (Brondizio and Moran, 2008; Gbetibouo, 2009; Tarleton and Ramsey, 2008). However, to the best of our knowledge, no previous research has explored the relationship between the ability to sense and respond to climate changes among employees of rural SME in Taiwan. This study shifts attention from the focus on individual farmers to rural business organizations that facilitate and help farmers in their response to climate changes.

Taiwan is an ideal setting to reach our study goal. In addition to being a global disaster risk hotspot (Dilley et al., 2005), Taiwan is also well known as a smallholders agricultural country, characterized by a large proportion of family farms with the average farm size about 1 ha per household (Agricultural Statistics Yearbook, 2009; Birner and Resnick, 2010). Due to Taiwan's unique small farm structure, the farmers' associations have a long history of providing farmers services, such as joint procurement, technical support and management practices, finances, marketing etc. Given that the employees of the farmers' associations provide valuable agricultural services, their ability to sense the current climate changes and to respond readily plays a crucial role for farmers' well-being and influence the policy-making.

2. Literature review

2.1. Background of Taiwan's Farmers' Associations. Farmers' association in Taiwan is an important rural enterprise, which has a long history of developing cooperation with farmers (Mao, Schive, 1995). According to the Farmers' Associations Act (FAA), its primary organizational goal is safeguarding farmers' rights, enhancing farmers' knowledge and skills, modernizing farm business, and improving rural livelihood and economy (FAA, 2011). Farmers' associations function not only as an important rural business, but also as crucial intermediates between the government and farmers.

At present, Taiwan has 304 farmers' associations at 3 levels: provincial (1), city/county (25), and township farmers' associations (278), respectively. The provincial and city/county farmers' associations mainly function to coordinate and supervise township farmers' associations. In principle, township farmers' association is the most important cooperative organization in nearly every township in Taiwan, and is also a private corporation operating in agricultural business. The average number of employees in township farmers' associations is usually about 50 persons (Taiwan Provincial Farmers' Associations, 2009). Thus, the township farmers' association is regarded as a typical small and medium enterprise in rural Taiwan.

Each township farmers' association consists of 4 departments to directly provide marketing, credit, insurance, and extension services to their members (FAA, 2011). Several previous researches related to the farmers' associations put emphasis on analyzing the performance and efficiency of credit departments of these associations (Liu

and Lin, 2007). In the face of larger-scale and permanent climate warming, this study is the first attempt to examine the relationship between the sensing and the responding ability to a climate change among the employees of farmers' associations.

2.2. Sensing and responding to a climate change. The sensing and responding capabilities are the main components of one organization's agility to cope with changes in its external environment. Sensing capability is the ability to gather information for, acquire knowledge about, and understand new environmental changes, which may influence upon organizational development (Dove, 2001; Zahra and George, 2003). Such intellectual ability can help an organization to scan actively for information about environmental predictable or unpredictable changes and their opportunities and threats, for instance, economic shifts, technological advancements as well as climate changes. The outcome of sensing a change is regarded as a matter of awareness and concern. In addition, a response depends on the ability to make sense of change. Hence, sensing capability can deeply increase the likelihood of being able to develop effective and efficient responses (Overby et al., 2006).

Responding capability means the ability to react to external stimulus, including identification, acting and recovering from changes (Dove, 2001; Zahra and George, 2003). Similarly, adaptation is a long-term response defined as an adjustment in natural or human systems in response to actual or expected long-term future of the environment, economies, and society (IPCC, 2007). With the preparedness for responding to changes in a proper manner, an organization can take advantages or reduce vulnerability associated with climate changes (Seo, La Paz, 2008).

This study pays special attention to proactive and reactive adjustments to climate changes. The former takes place before problems or hazards of a climate change occur while the latter takes place after the impact of the climate change is observed (IPCC, 2007; FAO, 2007). Because of the expressed concerns about catastrophic losses due to climate changes, there is a need for a deeper understanding of the differences between the proactive and reactive adjustment patterns. In this study, we analyse whether or not the farmers' association located in the Typhoon Morakot disaster area demonstrate either a proactive or reactive adaptation pattern to a climate change.

3. Methods

3.1. Data. The data used in this analysis were drawn from the 2010 research project "Perceptions and Adaptations to a Climate Change of the Farmers' Associations" sponsored by the Council of Agriculture in Taiwan. To ensure the nationwide representativeness, a two-stage random sampling design was employed in the survey. First, all the townships in Taiwan were assigned to 7 strata based on the degree of urbanization (Fu, 2009). Several townships' farmers' associations were then sampled from each urbanized area. Second, for each farmers' association chosen, depending on the organizational size, from 2 to 5 employees were randomly selected for face-to-face interviews. The sample comprised 120 townships' farmers' associations and 393 respondents. After deleting those with missing values in terms of sensing or responding scores, 325 respondents' replies were used for further analysis.

3.2. Measure for responding score to a climate change. The dependent variable in this analysis is the urgency level of responding to the measures adaptive to a climate variability among the employees of farmers' associations. In the survey, 10 questions in 2 categories (micro- and macrolevels) were asked to reflect the respondents' prior-

ity level on the climatic adaptation measures to be taken by farmers' associations or government. The example items were: "Adopt stress-resistant new crop varieties adaptive to climate changes (e.g., crops with drought tolerance, heat resistance and resistant to plant disease and insect pest)" for the microlevel of climate adaptation (farm management practices); and "Build up the special fund in agricultural sector adaptive to extreme climate events and relevant disasters (e.g., climatic risk fund)" for the macrolevel adaptation (agriculture policy). The complete list of the survey questions is available upon request.

The respondents were asked to rate the urgency of the demand to the statement in each question, with the scores from 0 (the lowest urgency) to 10 (the highest one). The responding score was constructed as the total score of these 10 questions and then standardized ranging from 0 to 1 (0 to 100%) for the ease of interpretation, with a larger value of the score indicating a larger degree of response to the measures adaptive of agriculture to climate changes.

3.3. Measures of sensing score to a climate change. The independent variable of particular interest in this analysis is the level of sensing of the climate changes. The sensing score is defined by the objective measures of climate change knowledge. In the survey 4 true/false questions were asked to evaluate the respondents' knowledge level to the overall climate variability. According to the Scientific Report of Taiwan Climate Change (Hsu, 2010), the authors presented several climate change facts in Taiwan for the past decade which reflect the key climate variability, including temperature, precipitation, and extreme weather events. The example item was: "Total annual rainfall does not vary too much, but the number of rainy days decreases significantly". The sensing score was constructed as % of correct answers, and thus ranging from 0 to 1 (0 to 100%). A larger value of the sensing score indicated a more correct level of sensing to the overall climate variability conditions in Taiwan.

In addition, we used two indicators to measure the respondents' climate change awareness: the level of worrying and the level of concern about the climate changes. The level of worrying was measured by the question: "To what extent do you worry about extreme weather events occurring in your working/farming area in the near future? The level of concern was measured by the respondent's self-reported level of concern about the climate change related issues and information. The level of worrying and concern about the climate change were ranged from 0 to 1 (0 to 100%), with a larger value of the score indicating higher degree of worry and concern about the climate change.

3.4. Measures of other independent variables. Recognition of a climate change from different information sources may be also associated with the responding score. Several information and knowledge sources of a climate change were identified, such as television, newspaper, magazines or books (printed media), Internet, relatives or friends, and attending related conferences and/or workshops. We employed dummy variables indicating whether the respondents learned climate change matters from the abovementioned sources (= 1 if they are positive).

The sociodemographic variables, including gender (= 1 for male), age (in years), educational level (in years), job position (= 1 if a supervisor), and working experience in farmers' associations (in years) were identified as well. Detailed definitions and sample statistics of all the independent variables are presented in Table 1.

Table 1. Definitions and summary statistics of regression variables

Variable	Definition	Mean	SD
Responding score to a climate change	Urgency level on adaptive measures to a climate change. The responding score was constructed as the total score of 10 questions and the standardized ranging from 0 to 100% (0 = lowest and 1 = highest)	0.726	0.145
Sensing score to a climate change objective knowledge	4 true/false questions were asked to evaluate the knowledge level to the overall climate variability. The sensing score was constructed as % of correct answers, ranging from 0 to 1 (0% = lowest and 100% = highest).	0.719	0.230
Awareness			
Level of worry	The level of worrying about extreme weather events occurring in one's working/farming area in near future (self-rating, 0 = lowest and 1 = highest)	0.762	0.200
Level of concern	The level of concern about climate change related problem and information (self-rating, 0 = lowest and 1 = highest)	0.757	0.189
Information/Knowledge source			
TV	If receive climate change related information via television (= 1)	0.872	0.335
Printed media	If receive climate change information via newspaper, magazines or books (= 1)	0.652	0.477
Internet	If receive climate change related information via Internet (= 1)	0.771	0.421
Relatives and friends	If receive climate change related information via relatives (= 1)	0.159	0.366
Conference	If receive climate change related information via conferences (= 1)	0.482	0.500
Workshop	If receive climate change related information via local workshops (= 1)	0.021	0.145
Sociodemographic variables			
Male	If the interviewee is male (= 1)	0.534	0.450
Age	Age of the interviewee (year)	44.817	9.741
Education	Years of education	14.201	1.767
Supervisor	If the interviewee is the supervisor (= 1)	0.265	0.442
Experience	Years of working experience in farmers' association	8.617	8.360

Notes: 141 townships' farmers' associations and 328 employees are included.

Source: Developed by the authors.

As shown in Table 1, the average objective knowledge score is 0.719 (71.9% of the correction). The level of worry about future extreme weather events occur in the respondent's working area and the level of concern about the climate change information are 0.762 and 0.757, respectively. Television is the most widely used source (87.2%) for the respondents to obtain climate change information while workshop is the least used one (2.10%). Among 328 respondents: 53.4% are male, with the average age of 44.817 and 14.201 years of education, 26.5% are supervisors, with 8.617 years of working experience in farmers' associations.

3.5. Statistical analysis. The primary purpose of this study is to understand how the level of sensing climate changes affects the urgency level of responding to the measures adaptive to climate variability among the employees of farmers' associations in Taiwan. The corresponding ordinary least squares (OLS) regression equation is specified as:

$$response_i = \alpha + \beta \times sense_i + \gamma \times X_i + v_{fa} + \varepsilon_i, \quad (1)$$

where $response_i$ is the individual i 's responding score; $sense_i$ is the sensing score for the individual i ; X_i is a set of independent variables; v_{fa} is fixed-effect of the farmers' association (where the individual i employed), which controls for unobservable heterogeneity across farmers' associations. The random error term ε_i is assumed to be normally distributed. α , β , and γ are the coefficients to be estimated, of particular interest is β which measures how the sensing climate change ability affects the urgency of responding by the measures adaptive to climate variability.

In order to distinguish between proactive and reactive adaptive ability among the employees of the farmers' associations, we estimate Eq. (1) separately for the Morakot and non-Morakot disaster areas. By doing this, we can understand if the previously natural disaster experience leads the level of sensing a climate change heterogeneously affect the urgency level of responding to measures adaptive to climate variability. The econometric estimations are performed with the STATA 10.0 software (StataCorp, 2007).

4. Results

The OLS estimated results by the Morakot and non-Morakot disaster areas are given in the columns (1) and (2) of Table 2, respectively. The results are remarkably different. In general, the impacts of sensing ability and other independent variables as well on the responding score are significantly larger for the farmers' associations located in the Morakot disaster area than those in the non-Morakot areas. For instance, the 1% increase in the correctness of objective knowledge about the current climate change situation in Taiwan significantly increases the responding score by 0.132% among the employees of farmers' associations in the Morakot disaster area, while that is not significant among those in the non-Morakot counterpart. In other words, if the knowledge level increases by 255% (with an extra true/false correction), then the urgency level of responding to measures adaptive to climate variability increases by 3.3% among the employees of farmers' associations in the Morakot disaster area. This result implies that for the employees of the farmers' associations in the disaster area have a higher level of climate change knowledge are able to adapt to and respond readily in rapidly changing environments.

In addition, for the Morakot experienced respondents, a 1% increase in the level of worrying about future extreme weather event occurs in the respondent's working/farming area and the level of concern about the climate change information increase the responding score by 0.204 and 0.130%, respectively. These findings are consistent with the previous studies (Hasan and Akhter, 2011; Jones et al., 2010; Oruonye, 2011) and suggest that raising awareness can play an important role in encouraging adaptive actions to deal with climate changes and their impact. Compared to proactive adaptation to climate change threats, the reactive adaptation model is more appropriate to explain the responding readiness to climate variability among the farmers' associations in Taiwan.

Furthermore, this study looks into the role of information sources in facilitating changes in the responding level with regard to adapting to the climate change

impacts. Using printed media, internet, and workshops as climate change information sources increases the responding score for the respondents employed in the Morakot disaster area by 4.4, 4.5, and 27.4 %, respectively. The sociodemographic characteristics also matter. Female employees and supervisors in the Morakot disaster area show a more ready responsiveness for taking the measures adaptive to climate variability. Compared to the numerous significant results derived from the Morakot disaster area samples, none of the variables mentioned above significantly affects the responsiveness to the measures adaptive to climate variability among those in the non-Morakot counterpart. Our differential results are consistent with the previous studies that a more significant environmental change simulates organizations and individuals respond more quickly and extensively (Bledaa and Shackley, 2008; Grothmann and Patt, 2005; Prabhakar et al., 2009).

Table 2. Estimation of OLS Regression Equation (Dependent Variable: the Responding Score)

Explanatory variables	Morakot disaster area (1)	Non-Morakot disaster area (2)
Objective knowledge	0.132*** (0.050)	-0.022 (0.069)
Awareness		
Level_worry	0.204*** (0.064)	0.155 (0.114)
Level_concern	0.130* (0.066)	0.050 (0.110)
Information/Knowledge source		
TV	-0.004 (0.031)	-0.009 (0.074)
Printed media	0.044* (0.023)	-0.014 (0.032)
Internet	0.045* (0.025)	0.058 (0.043)
Relatives or friends	-0.007 (0.028)	-0.070* (0.038)
Conference	0.003 (0.023)	0.047 (0.031)
Workshop	0.274*** (0.070)	0.177 (0.148)
Sociodemographic variables		
Male	-0.034* (0.020)	-0.018 (0.030)
Age	-0.000 (0.001)	-0.001 (0.002)
Education	0.002 (0.006)	0.008 (0.010)
Supervisor	0.054** (0.024)	0.046 (0.033)
Experience	-0.002 (0.002)	-0.000 (0.002)
Constant	0.312** (0.129)	0.504** (0.192)
Observations	216	109
Number of farmers' associations	76	38
R-squared	0.367	0.224

Source: Developed by the authors.

5. Conclusion and discussion

Climate change is expected to have serious adverse impacts on the agricultural sector. Given that farmers' associations are the most important rural small and medium enterprises in Taiwan and provide critical services to bridge the government, research institutions, and farmers, their organizational sensing ability to a climate change can increase the likelihood of being able to develop effective and efficient adaptation patterns in response to climate change and its impacts. This study examines the determinants of responsiveness to measures adaptive to climate variability among the farmers' associations in Taiwan. Special attention was paid to understanding the role of the sensing ability to current climate change conditions. By using a unique national survey of the farmers' association employees and fixed-effect model, several findings are revealed.

First, sensing an actual climate change and its impacts significantly increases the urgency of responding to the measures adaptive to climate variability. Secondly, the responding level to the measures adaptive to climate variability is significantly associated with the climate change awareness (including the level of worrying and concern), information sources, gender, and supervisor position.

Most importantly, those respondents located in the Typhoon Morakot disaster area show larger impacts of the sensing ability on the urgency of responding than their counterparts do. A 1% increase in the knowledge level to the current climate change significantly increases the urgency of responding to the measures adaptive to climate variations by 0.132% among the employees of the farmers' associations in the Morakot disaster area while that is not significant among those in the non-Morakot counterpart. The reactive adaptation evidence could be justified as those who have experienced the climate disaster are more likely to take adaptation measures in responding to climate changes.

The main policy implications of our findings are relatively straightforward. The face-to-face training workshops or discussion group can dramatically increase the urgency of responding via the measures adaptive to climate variability among the employees of farmers' associations. To increase the likelihood of being able to respond readily to a climate change, the administrative authorities have to take farmers' organization employees' sensing ability to current climate change conditions into account. The administrative authorities should organize and implement more educational programs or workshops for training their employees to address the challenges of communicating, learning, and teaching about the climate changes and their impacts on the agricultural sector. In addition, the government should develop systematized educational and public awareness materials on climate changes and their effects on the web, and create easily visible Internet access to climate change information as well, since Internet is one of the most important and widely used information sources on a climate change and agricultural issues by the employees of farmers' associations. The dissemination of climate change information through various information sources has to be delivered particularly to those who work in the risky areas without any previous experience of extreme weather events in an effort to prepare them for danger for the sake of safety and reduce future extreme weather damages.

References:

- AEA Energy and Environment (2007). Adaptation to climate change in the agricultural sector. UK: Harwell International Business Centre.
- Birner, R., Resnick, D.* (2010). The political economy of policies for smallholder agriculture. *World Development*, 38(10): 1442–1452.
- Bledaa, M., Shackley, S.* (2008). The dynamics of belief in climate change and its risks in business organizations. *Ecological Economics*, 66: 517–532.
- Bron dizio, E.S., Moran, E.F.* (2008). Human dimensions of climate change: The vulnerability of small farmers in the Amazon. *Philosophical Transactions of the Royal Society*, 363: 1803–1809.
- COA (2009). Agricultural statistics yearbook. Taipei: Council of Agriculture (COA).
- COA (2011). The Farmers' Associations Act (FAA). Taipei: Council of Agriculture (COA).
- Davis, K.* (2009). The important role of extension systems. In: 15th conference of parties (COP15) of the UN framework convention on climate change. Washington, DC: International Food Policy Research Institute.
- Dilley, M., Chen, R.S., Deichmann, U., Lerner-Lam, A.L., Arnold, M., Agwe, J., Buys, P., Kjekstad, O., Lyon, B., Yetman, G.* (2005). Natural disaster hotspots: A global risk analysis. Washington, DC: The World Bank.
- Dove, R.* (2001). Response ability: The language, structure, and culture of the agile enterprise. New York: John Wiley and Sons, Inc.
- Environmental Protection Administration (2010). Extreme events and disasters are the biggest threat to Taiwan: Typhoon Morakot. Taipei: Environmental Protection Administration.
- FAO (2007). Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities. Rome, Italy: Food and Agriculture Organization (FAO).
- Fu, Y.C.* (2009). Report for the 2008 Taiwan social change survey. Taipei: Academia Sinica, Institute of Sociology.
- Gbetibouo, G.A.* (2009). Understanding farmers' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa. IFPRI Discussion Paper, No. 00849. Washington, DC: The International Food Policy Research Institute (IFPRI).
- Grothmann, T., Patt, A.* (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, 15(3): 199–213.
- Hasan, Z., Akhter, S.* (2011). Determinants of public awareness and attitudes on climate change in urban Bangladesh: Dhaka as a case. *European Journal of Social Science*, 21(1): 154–162.
- Hsu, H.H.* (2010). The scientific report of Taiwan climate change. Taipei: National Science Council.
- IFAD (2008). Challenges and opportunities for smallholder farmers in the context of climate change and new demands on agriculture. Rome, Italy: International Fund for Agricultural Development (IFAD).
- IPCC (2001). Climate change 2001: Impacts, adaptation and vulnerability. International Panel on Climate Change (IPCC) third assessment report. Cambridge: Cambridge University Press.
- IPCC (2007). Climate Change 2007: Impacts, adaptation and vulnerability. International Panel on Climate Change (IPCC) fourth assessment report. Geneva, Switzerland: IPCC.
- Jones, L., Jaspars, S., Pavanello, S., Ludi, E., Slater, R., Arnall, A., Grist, N., Mtisi, S.* (2010). Responding to a changing climate: Exploring how disaster risk reduction, social protection and livelihoods approaches promote features of adaptive capacity. London: Overseas Development Institute.
- Liu, C.C., Lin, H.C.* (2007). Applying data envelopment analysis in analyzing the organizational change for credit departments of Farmers' Associations in Taiwan. *Applied Economics*, 39(21): 2797–2805.
- Mao, Y.K., Schive, C.* (1995). Agricultural and industrial development of the Republic of China. In: J.W. Mellor (Ed.), *Agriculture on the road to industrialization* (pp. 23–66). Baltimore: Johns Hopkins University Press.
- Oruonye, E.D.* (2011). An assessment of the level of awareness of the effects of climate change among students of tertiary institutions in Jalingo Metropolis, Taraba State Nigeria. *Journal of Geography and Regional Planning*, 4(9): 513–517.
- Overby, E., Bharadwaj, A., Sambamurth, V.* (2006). Enterprise agility and the enabling role of information technology. *European Journal of Information Systems*, 15: 120–131.
- Phillips, J.G., Krantz, D., Lyon, B.* (2005). Farmer climate risk management: Insights into climate change adaptation capacity. Virginia: US Climate Change Science Program workshop.
- Prabhakar, S.V.R.K., Srinivasan, A., Shaw, R.* (2009). Climate change and local level disaster risk reduction planning: Need, opportunities and challenges. *Mitigation and Adaptation Strategies for Global Change*, 14: 7–33.

Seo, D., La Paz, A.I. (2008). Exploring the dark side of IS in achieving organizational agility. *Communications of the ACM*, 51(11): 136–139.

StataCorp LP (2007). *Stata survey data reference manual*—release 10. Texas: Stata Press.

Taiwan Provincial Farmers' Associations (2009). *Farmers' associations yearbook in Taiwan district*. Taichung: Taiwan Provincial Farmers' Associations.

Tarleton, M., Ramsey, D. (2008). Farm-level adaptation to multiple risks: Climate change and other concerns. *Journal of Rural and Community Development*, 3(2): 47–63.

Von Braun, J., Pandya-Lorch, R. (2009). *Agriculture and climate change: An agenda for negotiation in Copenhagen*. Washington, DC: The International Food Policy Research Institute.

Watson, R.T., Zinyowera, M.C., Moss, R.H. (Eds.) (1997). *The regional impacts of climate change: An assessment of vulnerability*. Cambridge: Cambridge University Press.

Zahra, S.A., George, G. (2003). Absorptive capacity: A review, reconceptualization and extension. *Academy of Management Review*, 2(27): 185–203.

Стаття надійшла до редакції 25.03.2013.