

( 続紙 1 )

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論文題目	RISK ASSESSMENT, ADAPTATION STRATEGIES, AND RISK MANAGEMENT FRAMEWORK FOR HAILSTORMS IN NORTHERN BANGLADESH		
(論文内容の要旨)			
<p>The dissertation consists of the eight chapters. The summaries of each chapter are as follows.</p> <p><b>Chapter 1: Introduction</b></p> <p>The doctoral dissertation is briefly summarized in this chapter. Hailstorm is an extreme weather event (EWE) that occurs generally over a small scale; however, regardless of its localized occurrence, it is considered a significant natural hazard that leads to substantial economic losses to the agricultural sector, property, and livelihoods. Most of the existing research demonstrates the climatology of thunderstorms and hailstorms, and their causes and consequences. Still, there are significant research gaps in the community risk assessment of hailstorm, farmers' adaptation strategies, and risk management.</p> <p><b>Chapter 2: Hailstorm Issues and Concepts</b></p> <p>This chapter discusses the issues and concepts of hailstorm. The risk and vulnerability analysis of hailstorms and their management to the agricultural sector is highly overlooked globally and in developing countries like Bangladesh, known as a climate change hotspot. Thus, this research aims to assess the community level hailstorm risk and propose a risk management framework.</p> <p><b>Chapter 3: Assessment of Hailstorm Trends and Risks</b></p> <p>This chapter discusses the analysis of hailstorm trends and the risk of existing natural hazards, including hailstorms. The temporal and spatial distribution of hailstorms over Bangladesh and the study area showed significant increasing trends. Hailstorm was found to be the most prioritized hazard over droughts and flash floods, as perceived by the community. Moreover, hailstorm was recognized as a potential threat to the sustainable agriculture of the study area.</p> <p><b>Chapter 4: Determinants of Farmers' Risk Perceptions of Hailstorms</b></p> <p>This chapter aims to identify the determinants of farmers' risk perceptions to hailstorms. Hailstorm risk perceptions of farmers were embodied by subjective risk factors, such as their perceived control of hailstorm risk and personal circumstances. Their perceived resources for tackling hailstorm risk were the most significant predictor of hailstorm risk perceptions. Marginal and smallholder farmers were very vulnerable and perceived more risks than the medium- or large-holder farmers, owing to the lack of post-hailstorm compensation policies.</p> <p><b>Chapter 5: Farm Level Adaptation Strategies to Hailstorm and Factors Affecting Adaptation</b></p> <p>This chapter explores the existing adaptation strategies of hailstorm in the hailstorm-prone households of Bangladesh. Farmers adopted a variety of agricultural and non-agricultural measures to cope with the impacts. Positive correlations were found between the perception of hailstorm cognitive factors and the total number of adaptation practices adopted. Age, cognitive perceptions, household assets, and farm size of the respondents contributed mainly to the multiple regression model for adaptation of agricultural measures.</p> <p><b>Chapter 6: Identification and Prioritization of hailstorms Risk Management Measures</b></p> <p>This chapter deals with identifying the hailstorm risk management measures and analyzing their potential strengths, weaknesses, opportunities, and threats. We found 17 measures in total which could be adopted in all the phases of risk management. Through SWOT (Strengths, Weaknesses, Opportunities, and Threats) and cross-SWOT analysis of the risk management measures, we have found different alternative strategies. However, the non-structural measures which involved the community, local agriculture department, and local government (e.g., the recovery and rehabilitation, awareness-raising on the farmers, building community network for forecasting of hailstorm) received more prioritization than the agricultural management measures (e.g., early</p>			

harvesting, replantation, adjusting planting time, etc.).

### **Chapter 7: Development of Hailstorm Risk Management Framework**

This chapter has been divided into two sections. The first section summarizes the major findings from the preceding chapters. The crucial findings from the analytical chapters (Chapter 3, 4, 5, and 6) were subsequently used as substantial inputs for the development of hailstorm risk management framework (HRMF) in the second section. The HRMF consists of three main sections: assessment, strategy, and implication. The assessment section suggests the adjustment of the existing policy for hailstorm risk management, which is currently in an ignorant or retainment phase. In the strategy section, there are four support systems (institutional, financial, technical-technological, and community). Based on the support systems, several actions are proposed in the implication section. This research asserts that this framework's implication can help manage the hailstorm risks and bolster adaptation behavior of the people to mitigate such inevitable risks and crises.

### **Chapter 8: Conclusion**

One of the significant findings of this research is the potential threat of hailstorms to agricultural sustainability, which requires urgent attention from policymakers and the authorities. The study found evidence of the lower adaptive capacity of farmers, which has a broader range of implications in hailstorm risk management and managing other potential hazards. The research strongly urges introducing a crop insurance model for farmers living in hailstorm-prone areas of northern Bangladesh. The proposed framework for hailstorm risk management can be implemented on a pilot basis to measure the efficacy and practice on a larger scale.

(論文審査の結果の要旨)

降雹雷雨は極端気象現象の一種であり、被害地域の農業生産、生活、資産、そして人的資源に深刻な損害をもたらしてきた。しかしながら被害範囲が局所的であることから、他の自然災害と比べて社会的な認知度が低く、研究蓄積も少ない状況にある。特に経済が脆弱な発展途上国においては、雹害に対して政策的にも十分な対策が取られてきたとは言いがたい。

本論文は、従来、比較的マイナーな自然災害として認識されていた雹害を取り上げ、同災害が頻発するバングラデシュ北部農村を対象にして、PRA (Participatory Rural Appraisal)、アンケート調査、半構造化インタビューなどの手法を駆使してデータを収集・分析し、農家のリスク認知、適応行動とその要因、リスク管理方策の抽出と推進戦略とその体系化を試みたものである。本論文で学術的に評価できる点として、以下の4点が挙げられる。

1. 雹害は空間的に限定された地域に集中して発生し、かつ対象地域においては発生頻度が増加傾向にあることを明らかにするとともに、SMUG (Seriousness, Manageability, Urgency, Growth) モデル及びFEMA (Federal Emergency Management Agency) モデルを適用して自然災害危険度を比較し、対象地域においては干ばつ、射流洪水(鉄砲水)などの主要な自然災害よりも危険性の高い自然災害であることを明らかにした。このことは、雹害に対する従来の認識に変更を迫るものである。
2. 二項ロジット分析を用いて雹害の農作物へのリスク認知を左右する要因を探索し、雹害への対処能力に対する主観的評価(雹害に対して効果的に対処できるか、十分な知識を持っているか、対処に必要な資源を保有しているか)と個人属性(若年、高学歴)がリスク認知を高めていることを明らかにした。この成果は、リスク認知の向上施策への示唆を与えるものである。
3. 雹害に対する農民の様々な適応行動を農業分野と非農業分野に分けて指標化し、線形回帰モデルを用いて農業的適応行動の影響要因(年齢、雹害に対する認知、財産、経営規模、農業技術研修)と非農業的適応行動の影響要因(経営規模)をそれぞれ明らかにした。この成果は、適応行動を促す方策を検討する際に有意な示唆を与えるものである。
4. 災害リスク管理の7つのフェーズにそって、延べ17の雹害リスク管理方策を抽出し、それぞれに対してクロスSWOT分析を適用し、方策ごとに適応戦略を明らかにした。更に、対象地域の雹害リスク管理のフレームワークに集約し、提案している。この成果は、雹害に対する農民のリスク管理能力を体系的に強化する上で、関係者に極めて有益な情報を提供するものである。

以上のように、本論文は、研究としてはまだ草創期にある雹害を取り上げ、そのリスク評価、適応戦略およびリスク管理の枠組みについて考究した先駆的研究である。これらの成果は、雹害常襲地域の農民および対策を担う実務担当者に有益な知見をもたらすとともに、地球環境学、持続的農村開発論、災害リスク管理論の学術的発展に寄与するところが大きい。

よって本論文は博士(地球環境学)の学位論文として価値あるものと認める。なお、令和3年8月12日、論文内容とそれに関連した事項について試問を行った結果、博士(地球環境学)の学位を授与される学力が十分あるものと認めた。