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## SUMMARY OF DOCTORAL THESIS

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Title: Analysis of livelihood vulnerability and coping strategies to climate variability in rural villages of the northwestern Ethiopia

(エチオピア北西部の農村における気候変動に対する生計脆弱性の分析と対処戦略)

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In Ethiopia, agriculture employs 80% of workforce, contributes to 44% of the country's GDP, and accounts for 70% of the export revenue. As such, it is unarguably the mainstay of the economy. Ethiopian smallholder farmers produce 90–95% of the country's agricultural output. However, Ethiopia's smallholder farmers are over reliant on rain-fed agriculture and only cover half of rural households' annual food intake requirements. The productivity and sustainability of the smallholder farming sector is vulnerable to the adverse effects of climate variability and land degradation. To tackle this long-standing problem, the government and its partners have put in place policies and programs thus, billions of dollars have been outlaid. Despite all these efforts, poverty is still prevalent in the country. Evidences in Ethiopia have shown that livelihood vulnerability to climate variability often has resulted in prolonged poverty. Although climate variability is a shared global phenomenon, it could substantially be felt by the most vulnerable ones (smallholder farmers). Given the fact that the manifestations of poverty and vulnerability are context-specific, local adaptive or coping measures should be advised. However, little attention has been given to the smaller scale lived experiences of rural villages with climate variability/change, their coping capacity-or lack thereof. Moreover, albeit poverty has been well-studied in the country, efforts to measure from multidimensional perspective and making the indicators locally relevant is still lacking.

Owing to the above facts and to support efforts of addressing the negative effects of climate variability thereby reducing poverty and bringing out sustainable development, this study aimed to achieve the following objectives: First, this study analysed the livelihood vulnerability of households to climate variability; Second, it explored multidimensional poverty status of households as explained by multifaceted livelihood asset endowments and finally, it examined the covariates that shape rural livelihood coping strategies. The study was conducted in three rural villages with contrasting agro-ecologies (i.e. Dibatie [lowland]), Aba Gerima [midland], and Guder [highland]) of the northwestern part of Ethiopia. The study used the data collected during the period from 2017 to 2018 and combining household survey, focus group discussion, key informant interview and field observation. It uses the Sustainable Livelihood Approach (SLA) to conceptually build the interaction between vulnerability, climate variability and multiple dimensions of poverty.

This doctoral thesis is a compilation of 5 chapters where chapter one presents the backgrounds, introductory contexts, problem justification, objectives, conceptual framework and outline of the doctoral thesis.

Chapter two analyses the extent and sources of smallholder farmers' livelihood vulnerability to climate variability in the Upper Blue Nile basin. We conducted a household survey (n=391) across three distinct agroecological communities, and a formative composite index of livelihood vulnerability (LVI) was constructed. Indicators evaluation was carried out by the Shannon Entropy procedure as a function of IPCC constructs; adaptive capacity, sensitivity and exposure. The Mann-Kendall test and the standard precipitation index (SPI) were employed to analyse trends of

rainfall, temperature and drought prevalence for the period 1982-2016. The communities across watersheds showed a relative difference in the overall livelihood vulnerability to the effects of climate variability. Aba Gerima (midland) was found to be more vulnerable with a score of 0.37, while Guder (highland) had relatively lower LVI with 0.34 index score. Given similar exposure to climate variability and drought episodes, communities' livelihood vulnerability was mainly attributed to their low adaptive capacity and higher sensitivity indicators. Adaptive capacity was largely constrained by lack of participation in community-based organizations and lack of income diversification. This study will have practical implications to policy development in heterogeneous agroecological regions for sustainable livelihood development and climate change adaptation programs.

Chapter three analyses multidimensional poverty and inequality in three different agroecological settings of the Upper Blue Nile basin, Ethiopia. A participatory indicators selection and a structured survey were administered to 390 systematically and randomly selected households. The Alkire–Foster method was used to analyse multidimensional poverty. Multidimensional poverty incidence adjusted head count ratio and inequality were significantly different between study sites ( $P < 0.001$ ). Results indicated a high incidence (88%, 82% and 80%), intensity (52%, 55% and 56%), MPI (46%, 45% and 45%) and inequality (53%, 60% and 63%) of poverty in Aba Gerima, Guder and Dibatie study sites, respectively. The living standard and land and livestock ownership dimensions contributed the most to MPI. The case study signifies the importance of inclusion of land and livestock indicators for the national MPI. Besides, it implies that researchers and policymakers need to account for smaller scale contextualized indicators and location differences when studying and designing anti-poverty and climate vulnerability interventions and broader sustainable livelihood improvement programs.

Chapter four explores the covariates that shape rural livelihood diversification as climate variability coping strategies. Household-level data were collected from 270 households in three rural located in northwestern Ethiopia. We used the Herfindahl–Simpson diversity index to explore the extent of livelihood diversification. A stochastic dominance ordering was also employed to identify remunerative livelihood coping strategies. A multivariate probit model was employed to estimate the probability of choosing simultaneous livelihood coping strategies, and an ordered probit model was estimated to examine the effect of livelihood diversification on the adoption intensity of climate smart SLM practices. In addition to mixed cropping and livestock production, the production of emerging cash crops (e.g., *Acacia decurrens* for charcoal and khat) dominated the overall income generation of most farmers. Livelihood diversification at the household level was significantly associated with the dependency ratio, market distance, credit access, extension services, membership in community organizations, level of income, agroecology, shock experience and livestock ownership. We found evidence that having greater extent of livelihood diversification could prompt households not to adopt more climate smart SLM practices. Livelihood initiatives that focus on increasing climate related shock resilience, access to financial support mechanisms, improving livestock production, and providing quality extension services, while also considering agro-ecological differences, are needed. In addition, development planners should consider the livelihood portfolios of rural households when trying to implement SLM policies and programs.

The final chapter presents general conclusions, based on the main findings, and draws policy implications, which may help decision-makers and development practitioners. Some limitations and future research points are also reported. The findings from this study indicated that small scale farmers livelihoods are vulnerable to the negative effects of climate variability, mainly associated with their poor adaptive capacity and sensitivity and showed a remarkably high joint deprivation of wellbeing capability indicators. Their livelihoods portfolio entails significant diversification, but selected activities were remunerative (e.g. *Acacia decurrence* and Khat) and showed mixed relationship with climate smart SLM adoption. This study calls for integrated focus on climate resilient rural livelihood improvement to reducing poverty and vulnerability through sustainable coping measures.