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## The adaptive capacity of smallholder farmers to climate change in the Northern Region of Ghana

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### ABSTRACT

Climate change is expected to adversely affect agricultural production, particularly in sub-Saharan Africa where the agricultural sector forms the backbone of most countries' economies. This thus holds true for the agriculture sector of the Northern Region of Ghana which is largely rain-fed and dominated by smallholder farmers with minimal livelihood alternatives. The main research question of this paper is how the adaptive capacity to climate change of smallholder farmers in the Northern Region of Ghana can be characterised? The paper proposes an indicator-based framework for assessing the adaptive capacity of smallholder farmers in the Northern Region of Ghana along six main determinants of adaptive capacity: economic resources, social capital, awareness and training, technology, infrastructure and institutions. Based on a thorough literature review and qualitative interviews with experts for rural livelihoods and agriculture in the study region, the determinants were ranked and three to five indicators per determinant were selected. The results of the expert interviews show that economic resources, awareness and training as well as technological capacities seem most relevant for smallholder farmers' adaptive capacity while infrastructure, social capital, and institutions were ranked least important. The study operationalized the indicators in a standardized survey questionnaire and tested it in two agrarian communities in the Northern Region of Ghana. The survey results show the aggregate adaptive capacity of respondents is low. However, disparities in adaptive capacity were recorded among respondents in terms of gender and education. Differentiating between the determinants women farmer show significantly lower capacities in fields of economic resources, technology and knowledge and awareness. This paper recommends resilience building interventions in the study area that target individuals with low adaptive capacities, especially women and farmers without formal education.

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### 1. Introduction

Over the past few decades, climate change has adversely affected both physical and biological systems in most continents across the globe (Rosenzweig et al., 2007). According to Porter et al. (2014), in the past 30 years climate change has contributed to global agricultural production declining by 1–5% per decade. Its effects are also predicted to manifest in severe consequences for the global agricultural sector, especially in tropical and sub-tropical regions (Dewi, 2009; Thornton, 2012).

Where the economies of a majority of countries are largely driven by the agricultural sector, such as in sub-Saharan Africa, the impacts of climate change are particularly severe. The rapid and uncertain changes in temperature and rainfall

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pattern in the subcontinent deepens the vulnerability of the agricultural systems, especially food production already today (AGRA, 2014). This trend is expected to intensify in the future with the predicted climate change in tropical regions as it is expected to cause a significant decline in the production of important and staple food crops in such regions (Nelson et al., 2009; Porter et al., 2014). In response to expected changes, governments supported by international cooperation have intensified their efforts to empower the agricultural sector to effectively adapt to climate change at both national and local levels.

This holds particularly true for the Northern region of Ghana, one of the driest savannah regions of Ghana, where an increasing number of droughts, floods and bushfires heavily affect nature and humans (Dazé, 2013; Akudugu and Alhassan, 2012). It is found to be one of the most vulnerable and exposed regions to climate change and variability in Ghana (Etwire et al., 2013; Stanturf et al., 2011). At the receiving end of these impacts are millions of poor smallholder farmers with minimal livelihood alternatives who are already marginalised, poor and largely rely on nature for food and income (Frank and Penrose Buckley, 2012; Morton, 2007). Their rain-fed agriculture, forming the dominant economic activity in the region (Antwi-Agyei et al., 2012), relies heavily on a single and already modified rainy season. Over the past decade, there have been growing number of studies on possible ways of increasing the resilience of these farmers against climate change impacts in the region. Most of these studies are largely centred on farm-level adaptation methods and strategies (Wossen et al., 2014; Al-Hassan et al., 2013; Kuwornu et al., 2013; Laube et al., 2012; Armah et al., 2011). There are only a few studies on the adaptive capacity of smallholder farmers towards the new climate variabilities in the region (Nantui et al., 2012). However, knowing who among those we expect to be the most vulnerable to climate change have a higher respective lower adaptive capacity to climate change and what the relevant determinants for these capacities are provides a basis to find more effective ways for supporting smallholder farmers in the Northern region of Ghana in their attempt to sustain their agricultural production and consequently the basis of their livelihoods and urban centres in the region. Therefore, the adaptive capacity assessments bring to the decision table fundamental information for the development of climate change adaptation policy (Adger et al., 2007; Juhola and Kruse, 2015). Thus, specific assessments focussing on the adaptive capacities of smallholder farmers deliver critical information in relation to key strengths and weaknesses and help to inform policy development and interventions on climate change adaptation.

Against this backdrop, this paper fills a fundamental knowledge gap related to a comprehensive and applicable framework for assessing the adaptive capacity of smallholder farmers in context Sub-Saharan Africa. It also applies the framework to the case of the Northern region of Ghana to explore the adaptive capacity of smallholder farmers to climate change and variability.

This paper answers the following research questions:

- How can the adaptive capacity of smallholder farmers in the Northern region of Ghana be characterised?
- What is the capacity level of smallholder farmers in the Northern region of Ghana to adapt to climate change and which are the specific determinants of higher or lower adaptive capacities?

To answer these questions we developed an indicator framework in a deductive and expert-driven way: a heuristic was developed grounded on a systematic review of scientific literature considering both previous approaches assessing generic adaptive capacity, specific adaptive capacity of farmers with particular focus on smallholder farmers as well as approaches focussing particularly on sub-Saharan Africa. Before applying the indicator based assessment to two communities in Northern Ghana, this deductive heuristic has been validated by expert interviews. The outcomes of this study are twofold: first, we developed a sector and region specific index for assessing the adaptive capacity of smallholder farmers in sub-Saharan context; and second, we explored the adaptive capacity of smallholder farmers in two rural communities in Northern Ghana and provide insights in the specific capacities' determinants and options for capacity building for smallholder farmers.

This paper is composed of six sections. The second section reviews literature on key concepts related to assessing adaptive capacity. The third section looks at the background of the study area and methods employed in collecting and analysing the data. Section four presents the developed Smallholder Farmers' Adaptive Capacity Index that has been revalidated by expert interviews. Section five includes results from the application of the developed indicator in the study area. The last section discusses the findings of this paper in the light of existing literature and presents a conclusive overview of the paper with recommendations for capacity building and further research.

## 2. Assessing adaptive capacity

The concept of adaptive capacity has been used differently in varying contexts. One of the most recently used definition in relation to climate change is taken from the Fifth Assessment Report of IPCC which defines it as "The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014, p118). The concept of adaptive capacity is highly used in relation to the vulnerability of socio-ecological systems. Vulnerability in this sense is often conceptualised as being composed of the exposure and sensitivity of a system to external stresses and the adaptive capacity (McCarthy et al., 2001; Adger, 2006; Smit and Wandel, 2006) or the coping capacity of the system to such stresses (Turner et al., 2003). The concepts of 'adaptive capacity' and 'coping capacity' are respectively used to denote long-term and short-term adjustments (Smit and Wandel, 2006; Gallopin, 2006).

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