AMS Climate Studies and its Relationship to Research on Social, Behavioral and Economic Aspects of Adaptive Management: Smallholder Farmers Adaptation to Climate: A Conceptual Logic Model

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ABSTRACT

The American Meteorological Society (AMS) reported that our nation faces a serious challenge in attracting young people to science and science-related careers (including teaching). This is particularly true for members of groups underrepresented in science, technology, engineering, and mathematics (STEM) and is especially acute in the small number of minority college students majoring in the geosciences.

A formidable obstacle in attracting under-served students to the geosciences has been limited opportunity to enroll in introductory-level geosciences courses as reported by AMS. To help address this problem, the American Meteorological Society (AMS) developed an introductory climate science course, AMS Climate Studies, which can be added as a general education course and also educate those in the built environment (e.g. agricultural science, planning majors, etc. are expected to take the course. The purpose of this paper is to develop a logic model of farm household strategies and adapting agriculture to climate change based on review of the existing literature. The logic model comprises inputs, outputs (Activities and Participation), and outcomes (Short, Medium, Long). It is envisaged that this theoretical model provides a useful tool for all climate change agencies, practitioners and researchers in developing more comprehensive small farm household adaptation strategies.

Several recent studies have found that the impact of climate change on U.S. agriculture is likely to be adverse overall, though a northern tier of states will benefit. This finding is challenged by Deschenes and Greenstone, who link annual fluctuations in weather to reported profits and yields in the same year and conclude that the impact of global warming on U.S. agriculture is likely to be either insignificant or mildly beneficial overall.

Growing losses caused by extreme weather events and predictions of increasing frequency of extreme events in the future have brought adaptation to climate change into the center of both the scientific and political agendas. Climate change poses challenges in terms of availability of financial resources, technology, and knowledge. Along with these needs, adaptation practices also face difficulties connected with the perception of risks and adaptation. Some studies have focused on the perception of climate change risks

however, there is little known about perception of climate change adaptation among stakeholders.
Climate change is associated with a number of risks, such as flooding, heat stress, storms and vector- and rodent-borne diseases. While in most cases, climate change will amplify (mostly already existing) risks, in some cases, beneficial impacts are envisaged (e.g. reduced winter mortality due to higher temperatures. However, the general impression in the scientific community seems to be that, overall, climate change requires the timely development and implementation of adaptation plans. For example, Hurricane Katrina demonstrates how the economic consequences of not been prepared for changing weather patterns may be huge, in particular in densely populated, economic areas. In addition, exante evaluations have shown that planned adaptation to flood risk yields positive benefit-to-cost ratios.

It is therefore, concluded that there is need to educate farmers about climate change and design adaptation strategies that are cognizant of existing local level knowledge and practices on land and water management. There is also the need to avail agricultural research results relevant to smallholder farmers and train them on how to use the results to make informed on-farm investment decisions. AMS Climate Studies will provide students majoring in agriculture with an introductory-level survey of climate sciences and global change issues, thus informing adaptation strategies in their future careers.

Logic model implementation: The specific programs from the logic model can then implemented to address them so as to enhance the farmers' adaptive capacity to the current and future climate changes. The sustainability of adaptation strategies has to be erotized. The adaptation strategies should therefore, be considered in terms of farmers' location, livelihood systems and ecological setting so as to make them socially, economically and ecologically sustainable. There is need to increase smallholder farmers' productive capacity now so that they can improve their asset base which will place them on a strong footing take advantage of climate change and variability when it becomes more serious.

Introduction

Several recent studies have found that the impact of climate change on U.S. agriculture is likely to be adverse overall, though a northern tier of states will benefit. This finding is challenged by Deschenes and Greenstone (2007) [henceforth, DG], who link annual fluctuations in weather to reported profits and yields in the same year and conclude that the impact of global warming on U.S. agriculture is likely to be either insignificant or mildly beneficial overall.

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terms of availability of financial resources, technology, and knowledge. Along with these needs, adaptation practices also face difficulties connected with the perception of risks and adaptation. Some studies have focused on the perception of climate change risks (Lorenzoni and Pidgeon 2006); however, there is little known about perception of climate change adaptation among stakeholders (Klein et al. 2007; McEvoy et al. 2006, McEvoy et al. 2010.

Climate change is associated with a number of risks, such as flooding, heat stress, storms and vector- and rodent-borne diseases (Butler and Harley 2009; Huynenen Van Vliet 2009; PBL 2009). While in most cases, climate change will amplify (mostly already existing) risks, in some cases, beneficial impacts are envisaged (e.g. reduced winter mortality due to higher temperatures; Kabat et al. 2005; PBL 2009). However, the general impression in the scientific community seems to be that, overall, climate change requires the timely development and implementation of adaptation plans (e.g. Adger and Barnett 2009; Kabat et al. 2005; PBL 2009). Referring to the Katrina hurricane example, Kabat et al. (2005) claim that the economic consequences of not being prepared for changing weather patterns may be huge, in particular in densely populated, economic areas. In addition, exante evaluations have shown that planned adaptation to flood risk yields positive benefit-to-cost ratios (Tompkins et al. 2010).

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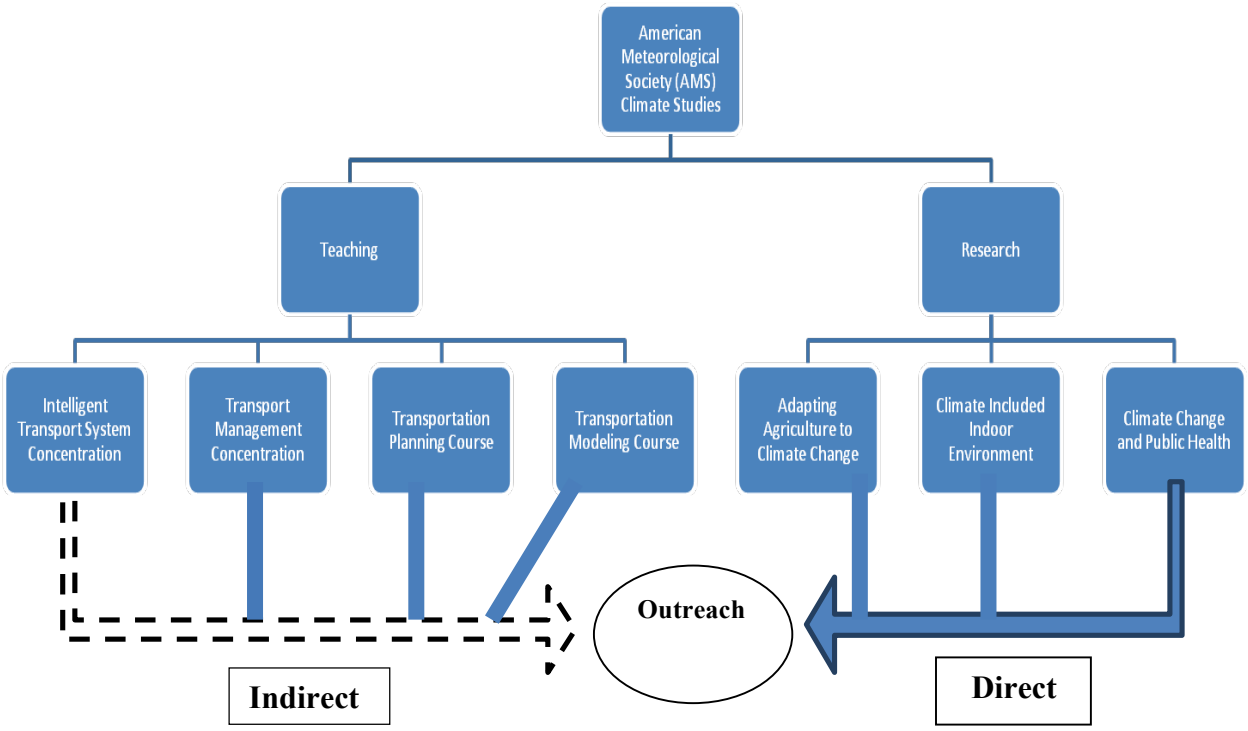
A formidable obstacle in attracting under-served students to the geosciences has been limited opportunity to enroll in introductory-level geosciences courses as reported by AMS. To help address this problem, the American Meteorological Society (AMS) developed an introductory climate science course, AMS Climate Studies, which can be added as a general education course. and also educate those in the built environment (e.g. agricultural science, planning majors, etc. are expected to take the course.. Figure 1 below is a conceptual framework of links between AMS climate studies, teaching, research and outreach..



Definition of adaptation

The Intergovernmental Panel on Climate Change (IPCC) defines climate change adaptation as "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities" (IPCC, 2001). This is probably the most authoritative definition. However, there are other definitions that are also often used. Below are a few more examples:
"A process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed and implemented" (UNDP, 2005).

Adaptation to climate change is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides (Burton, 1992, cited in Smit et al., 2000). Adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change (Smit, 1993, cited in Smit et al., 2000).

The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhiv, 1993, cited in Smit et al., 2000). Adaptation to climate

change includes all adjustments in behavior or economic structure that reduces the vulnerability of society to changes in the climate system (Smith et al., 1996, cited in Smit el al., 2000).

Purpose of the Paper

The purpose of this paper is to develop a conceptual AMS climate studies framework and its relationship to research on social, behavioral and economic aspects of adaptive climate change management and a logic model of farm household strategies and adapting agriculture to climate change based on review of the existing literature.

Literature Review (Rationale and Significance)

Agriculture is one of the few sectors of the modern economy directly exposed to climate and thus likely to be affected by climate change. It is also a sector where there exists considerable disagreement about the magnitude of potential impacts. Disagreement stems from differences in both methodology and empirical measurement. Over the past six decades world agriculture has become considerably more efficient. Improvements in production systems and crop and livestock breeding programmes have resulted in a doubling of food production while increasing the amount of agricultural land by just 10 percent. However, climate change is expected to exacerbate the existing challenges faced by agriculture. Farmers and researchers can breed new varieties of crops that are more resilient to droughts and floods, as well as diversify existing crops to adjust to changing temperature and rainfall patterns. Farmers and ranchers have always had to cope with variability in the weather.

Climate change poses significant challenges for the Fairtrade movement. It is expected that climate change will include more extreme events and slow onset impacts, such as changes in precipitation and temperature. Climate change is thought likely to have mainly negative impacts upon agricultural production, food security and economic development.

Many of the Fairtrade export crops, such as cotton, vegetables, rise, tea, bananas etc will be affected by climate change. Crops will respond in different ways to climate change: yields may increase or decrease and the places where crops can be cultivated may change. Assessing or predicting these changes, however, is difficult. Yields may be affected (possibly positively and negatively over different time frames and in different locations). The areas and the thresholds within which cultivation is feasible will also change as climate averages (temperature and precipitation) change. Counties in the Black Belt Region (BBR) of the U.S. are particularly vulnerable to climate change, given dependence on agricultural production and limited adaptive capacity.

The question now is “What does adaptation to climate change includes”? Adaptation to climate change includes many possible responses, such as changes in crop management practices (e.g., choice of fields, planting dates, planting densities, crop varieties, etc.), livestock management practices (e.g., feeding and animal health practices, transhumance timing and destinations, etc.), land use and land management (e.g., fallowing, tree

planting or protection, irrigation and water harvesting, soil and water conservation measures, tillage practices, soil fertility management, etc.), livelihood strategies (e.g., mix of crops or livestock produced, combination of agricultural and nonfarm activities, temporary or permanent migration, etc.).

Adaptation can greatly reduce vulnerability to climate change by making rural communities better able to adjust to climate change and variability, moderating potential damages, and helping them cope with adverse consequences (IPCC, 2001).

Different perceptions of adaptation to climate change

Several authors stress that perceptions about the environment and natural resources differ for individuals since their perceived world is subjectively constructed and is influenced by previous experience, type of education, and other socio-economic characteristics (Sudarmadi et al. 2001; Filip et al. 1983: 348; Feijoo and Momo 1991: 163). Irwin (1995) shows that different kinds of knowledge exist in the sphere of nature protection. Local and traditional knowledge is considered to be a supplement to abstract scientific expertise. Jennings (2009) presents a case of flood disaster management in Britain, where public participation reveals the coping capabilities of local communities. Excluding local knowledge and reducing flood disaster management to technical solutions usually leads to frustration and distrust. O'Brien (2009) notes a variety of worldviews in the context of climate change. She argues that both traditional values, connected with survival and satisfying the basic needs, and so-called post-materialistic (postmodern) values are involved in adaptation to climate change. Thus, adaptation is complicated by the need to address a spectrum of worldviews. O'Brien argues that the minimum task in adaptation is to identify the standpoint of each stakeholder. The importance of social values is acknowledged through adaptation to heat waves (Wolf et al. 2009). Perception of heat waves and an individual's assessment of coping with heat were revealed as crucial factors in decreasing mortality. Similarly, Ta`bara and Ilhan (2008) show that changes in water policies in Spain were driven by a coalition of sensitive agents, mostly from academia, NGOs, and local constituencies, who managed to articulate new identities and develop new values.

Conceptual Logic Model of Farm Household Strategies and Determinants of Adapting Agriculture to Climate Change

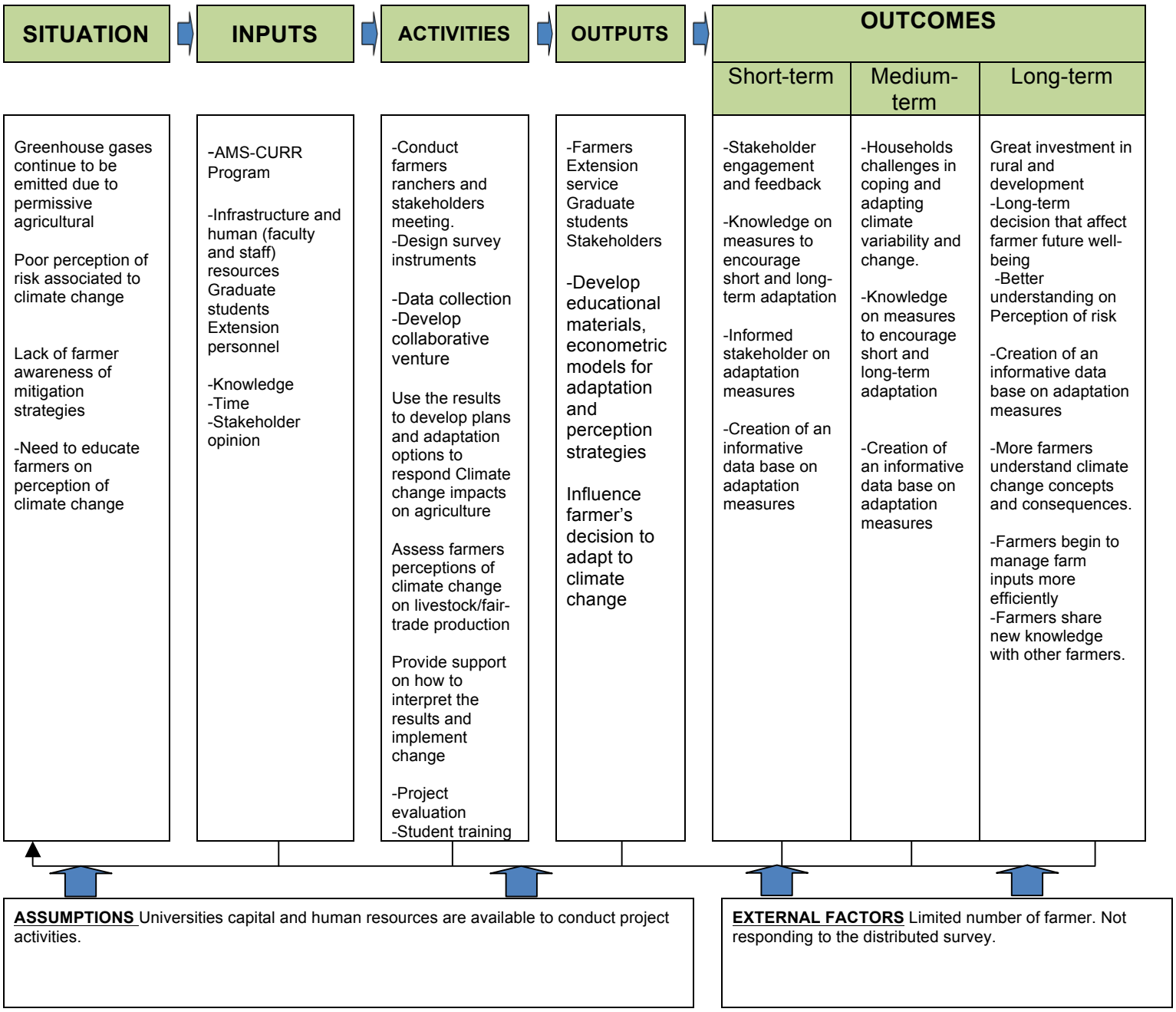
A better understanding of farmers' perceptions of climate change, ongoing adaptation measures, and the decision-making process is important to inform policies aimed at promoting successful adaptation of the agricultural sector. Adaptation will require the involvement of multiple stakeholders, including policymakers, extension agents, NGOs, researchers, communities, and farmers.

Cross-sectional observations across different climates can reveal the climate sensitivity of agriculture. The advantage of this empirical approach is that it does not only capture the direct effect of climate on productivity but also reflects farmers' adaptation to local

climate. This farmer behavior is important as it mitigates problems associated with deviations from optimal environmental conditions.

Evidence from the above suggests that climate, in addition to responding to natural phenomena, is also changing as a result of human activities. However, effective development of mitigation and adaptation strategies will require the engagement of stakeholders, research and education institution, policy-makers, and governmental agencies. The challenge is to provide diverse stakeholders with trusted, useful, science-based information to aid them in making informed decisions. The potential adaptation options of the agricultural sector to climate change are not well understood.

Based on the relevant literature review, a logic model of farm household strategies and determinants of adapting agriculture to climate change is derived as shown in Figure 2.



Analysis of Conceptual Logic Model

This section discusses the five determinants to adapting agriculture to climate change. It analyses the relevance of these factors by drawing on existing research work.

Figure 2 below is a conceptual tool for planning and evaluation which displays the sequence of actions that describes what the science-based program is and will do to

social, behavioral aspects of adaptive management agriculture to climate change.. The logic model in fig2

- Clarifies the linkages between investments and activities, outputs and expected outcomes of the policy, program or initiative;
- Communicates externally about the rationale, activities and expected results of the policy, program or initiative;
- Tests whether the policy, program or initiative "makes sense" from a logical perspective; and
- Provides the fundamental framework on which the performance measurement and evaluation strategies are based (i.e., determining what would constitute success).

As one can see from the above conceptual model of many variations on the specific composition of a logic model. For its purposes,

- Situation is a description of the challenge or opportunity. The problem or issue to be addressed, within a complex of socio-political, environmental, and economic conditions.
- Inputs are an issue of what is invested, such as resources, contributions, and investments that are provided for the program.
- Activities are what the program does with its inputs to services it provides to fulfill its mission.
- Outputs are products, services and events that are intended to lead to the program's outcomes.
- Outcomes are planned results or changes for individuals, groups, communities, organizations or systems. Types of outcomes include:
    - Change in knowledge - Occurs when there is a change in knowledge or the participants actually learn.
    - Change in behavior - Occurs when there is a change in behavior or the participants act upon what they have learned.
    - Change in condition - Occurs when a societal condition is improved.
- External factors are variables that may have an effect on the portfolio, program, or project but which cannot be changed by the managers of the portfolio, program, or project.
- Assumptions are the premises based on theory, research, evaluation knowledge, etc. that support the relationships of the elements of the logic model and upon which the success of the portfolio, program, or project rests.

Conclusion

It is therefore, concluded that there is need to educate farmers about climate change and design adaptation strategies that are cognizant of existing local level knowledge and practices on land and water management. There is also the need to avail agricultural research results relevant to smallholder farmers and train them on how to use the results to make informed on-farm investment decisions. AMS Climate Studies will provide

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Implementation

Logic model implementation: The specific programs from the logic model can then implemented to address them so as to enhance the farmers' adaptive capacity to the current and future climate changes. The sustainability of adaptation strategies has to be erotized. The adaptation strategies should therefore, be considered in terms of farmers' location, livelihood systems and ecological setting so as to make them socially, economically and ecologically sustainable. There is need to increase smallholder farmers' productive capacity now so that they can improve their asset base which will place them on a strong footing take advantage of climate change and variability when it becomes more serious.

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