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WHAT CLIMATE CHANGE MEANS FOR FARMERS IN AFRICA: A TRIPTYCH REVIEW RIGHT PANEL: CLIMATE EXTREMES AND SOCIETY'S RESPONSES, INCLUDING MITIGATION ATTEMPTS AS PART OF PREPAREDNESS OF AFRICAN FARMERS

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ABSTRACT

In this paper in three parts, climate change is approached by dealing with the three sides from which the danger comes: (i) global warming, (ii) increasing climate variability, (iii) more (and possibly more severe) meteorological and climatological extreme events. These are the three panels of this triptych review and the right panel on climate extremes and society's responses, including mitigation attempts as part of preparedness of African farmers, is this part. The occurrence of more (and possibly more severe) extreme meteorological/climatological events, as another likely consequence of climate change, is discussed, reviewing the literature and dealing for Africa with recent droughts and famines. It appears that there is more than sufficient proof that the numbers of disasters have risen globally, and on average at an increasing rate, over the last half a century, with more evidence in the later decades. Extreme hazards have a shorter recurrence time but whether they also have become more severe cannot be easily determined. This is due to developments in observations, populations and vulnerabilities and lack of developments in climate models. Only for increased temperature related disasters, severity has clearly become larger. However, recent more realistic calculations appear to suggest that there has been little change in drought over the past 60 years. In physical terms, there is also little or no evidence of increased severity of floods over the past century. Increasing farmer preparedness will be an important part of better responses to these conditions. The traditional response farming as to droughts, floods (annual recession and recurrent occasional ones), strong winds and other serious disasters should be among starting points. At the end of this paper, the contributions that tropical agriculture can make to reduce greenhouse gases (GHGs) in win-win situations are also dealt with. Soil carbon sequestration has a higher mitigation potential than emission reductions in African agriculture, although both may be important. These are best achieved under management systems with higher carbon density, as well as improved soil conservation. Agroforestry, assisted natural regeneration, forest rehabilitation, forest gardens, and improved forest fallow projects should all be eligible under the Clean Development Mechanism. Throughout the paper text boxes are used that illustrate local conditions that must be taken into account to understand the impacts/consequences of climate change for African farmers and how they may cope with them.

Key words: Disasters, extreme events, famine, mitigation

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CLIMATE CHANGE, WHAT DOES IT MEAN FOR AFRICAN FARMERS?

***More (and possibly more severe) climate extremes* - Attributing events, counting hazards, understanding vulnerability**

Extreme atmospheric events are among the most devastating causes of food insecurity and poverty. Environmental catastrophes and the forces of nature they unleash are something to behold, fear and respect [1]. These incidents seem just another environmental disaster when seen individually, having local or country-wide consequences [2]. However, stepping back and taking in the big picture, the enormity of it all hits even more and they appear downright frightening [1]. The three panels of this triptych review are of course not set up as a traditional paper but in ways that are characteristic for a literature review combined with a review of our own experiences.

A recent editorial in "Nature" stated that "extreme weather and changing weather patterns - the obvious manifestations of global climate change - (……) usually have complex causes, involving anomalies in atmospheric circulation, levels of soil moisture and the like. Solid understanding of these factors is crucial if researchers are to improve the performance of, and confidence in, the climate models on which event attribution and longer-term climate projections depend. Event attribution is one of the proposed 'climate services' - seasonal climate prediction is another - that are intended to provide society with the information needed to manage the risks and costs associated with climate change. Advocates of climate services see them as a counterpart to the daily weather forecast. However, without the computing capacity of a well-equipped national meteorological office, heavily model-dependent services such as event attribution and seasonal prediction are unlikely to be as reliable" [3, 4].

In November 2011, the Special Report on managing Extreme events (the SREX Report) was approved by the International Panel of Climate Change (IPCC) [5, 6]. This report explored the challenge of understanding and coping with the risks of climate extremes to advance climate change adaptation. Extreme weather and climate events and hazards, interacting with exposed and vulnerable human and natural systems, can lead to hydrological and biological disasters. Changes in the frequency and severity of the physical events affect disaster risk, but so do the spatially diverse and temporally dynamic patterns of exposure and vulnerability. Some types of extreme weather and climate events have increased in frequency and/or magnitude, but populations and assets at risk have also increased, with consequences for disaster risk [5, 7]. This appears to confirm the relationship between climate change and more frequent disasters which also may be of a more violent nature. In many instances, however, the potential increases in extreme events due to climate change come on top of alarming rises in vulnerability, it was argued. Hence, the additional risks due to climate change should not be analyzed or treated in isolation, but instead be integrated into broader efforts to reduce the risk of natural disasters [7]. In this context, the human rights agenda was seen as a way of moving disaster reduction efforts forward [8].

Research by the World Meteorological Organization (WMO) over the years has clearly shown that record breaking extreme events of weather and climate are occurring throughout the world [9]. Historical data has traditionally been used for analysis of hazards patterns, but this is no longer sufficient, because hazard characteristics are changing as a result of climate change. For instance, a 100-year flood or drought may become a 30-year flood or drought or, simply said, more severe events could happen more frequently in the future [10]. Now it appears that there is more than sufficient proof that the numbers of disasters have risen globally, and on average at an increasing rate, over the last half a century, with more evidence in the later decades [11, 12]. Whether extreme hazards have not only a shorter recurrence time but also have become more severe, cannot be easily determined due to developments in observations, populations and vulnerabilities [12] and lack of developments in climate models [3, 4]. Only for increased temperatures related disasters, severity has clearly become larger. On the other hand, recent more realistic calculations, based on the underlying physical principles that take into account changes in available energy, humidity and wind speed, appear to suggest that there has been little change in drought over the past 60 years [13, 14].

For other disasters, it is presently difficult to prove whether they have become more severe but this would not influence policies. Model projections do indicate that over most land areas there will be a significant increase in the number of days with no rain [15]. At the other end of the spectrum, there is also projected to be an increase in the number of days with heavy precipitation [15]. Large portions of the world are predicted to have 30% more precipitation falling in those extreme events. Across much of the tropics and subtropics, increases of 100% or greater would be common [15]. However, in physical terms there is little or no evidence of increased severity of floods over the past century [16]. The story for wind speed is simpler: there were global increases in both average and extreme wind speeds, with the top 1% showing the biggest increases [17].

Recent serious droughts and resulting famine in Africa

For 2011, particularly serious were the East Africa drought and the Somalia famine (since June 2011) [1]. Weather conditions over the Pacific, including an unusually strong La Niña, interrupted seasonal rains for two consecutive seasons. The rains failed in 2011 in Kenya and Ethiopia and for the last two years in Somalia. The lack of rain led to crop failure and wide-spread loss of livestock from drying of grazing pasture, as high as 40 - 60% in some areas. This considerably decreased milk production as well as exacerbated a poor harvest. As a result, prices of grains and milk (where available) were pushed to record levels while livestock prices and wages fell, reducing purchasing power across the region [18].

For 2012, the Sahelian drought comes first and foremost [19]. The combined threat of drought, high food prices, displacement and chronic poverty affected millions of people in 2012 as a new food crisis emerged across the Sahel. Food insecurity and malnutrition are recurrent in the region with more than 16 million people directly at risk in 2012 [20]. Drought had reduced Sahelian cereal production by around 25 percent as compared to the previous year, Chad and Gambia were experiencing 50 percent decreases and other countries were suffering serious localized deficits. Severe fodder shortages were leading to early transhumance and changing livestock corridors, causing tensions to rise between communities and at border areas [20]. The situation was compounded by high food prices and a decrease in remittances owing to the global economic crisis and the return of migrants from Libya. The deteriorating security situation in Northern areas of the Sahel was further aggravating the situation [20].

Responses to such disasters

Farmers face ever-increasing problems from such extreme events. Farmer organizations are blaming the local and central governments for being too slow in educating farmers on how to adapt to extreme weather shifts [21]. Following years of discussion, representatives from the Economic Community of West African States (ECOWAS) started to test joint disaster responses. Major efforts were underway for South-South cooperation between member states, including setting up an Emergency Flood Fund for disaster response which individual countries could tap into; a natural disaster reduction task force; and an Emergency Response team [22]. In December 2011, the Inter-Agency Standing Committee (IASC, the primary mechanism for inter-agency coordination of humanitarian assistance) launched a strategy to better respond to the risk of a new food and nutritional crisis in the Sahel in 2012 [23]. Within this broader IASC strategic framework, FAO started to prepare a Regional Response Programme to the Food and Nutrition Security Crisis in the Sahel to define FAO's priority response interventions in the sub-region, linking action in a continuum from emergency to recovery and development, focusing on protecting, restoring and building resilient livelihoods of vulnerable farmers and herders [20].

Farmer preparedness for adapting to disasters and related social issues

Although it should be complementary, such international support is often replacing what nationally should be organized. African farmers rely mostly on sitespecific traditional indicators to predict climate and make decisions on different farm operations [24, 25]. Therefore, farmer preparedness must be raised and established on-farm in a permanent way (BOX 01).

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BOX 01

CLIMATE-READY MAIZE GETS A BOOST: PHASE III OF THE "DROUGHT TOLERANT MAIZE IN AFRICA" PROJECT IS GOING TO REACH MORE FARMERS [26, 27]

Over the past five years, more than 34 new drought tolerant maize varieties have been developed and deployed to over 2 million smallholder farmers in sub-Saharan Africa, empowering them to cope with climate change impacts on their livelihoods and food security. (……). By testing maize varieties for drought tolerance from all over the world, CIMMYT, IITA and national scientists have been able to develop varieties adapted to African conditions and with increased drought tolerance. Cross-pollinating these varieties with others that feature farmer-valued traits such as high yield, good cooking qualities, and resistance to several important diseases such as maize streak virus, scientists have developed winning varieties—seed that can give African farmers a good harvest under both good rainfall and moderate drought conditions. Maize is 'life' to more than 300 million of Africa's most vulnerable people and the continent's top food staple. Most of this maize is grown under rain-fed conditions and with a probability of the region experiencing a drought once every ten years, maize farming is risky business. As temperatures rise there is an urgent need to grow maize that is able to thrive on less water. Experts at CIMMYT and Stanford University have shown that breeding efforts to produce drought tolerant crops are beneficial for managing current and future risks of drought and also likely to be important for the expected warming of Africa's maize lands; drought and heat tolerant maize is critical to Africa's ability to feed itself. (……). The project has made great strides toward its ten-year goal of increasing average maize productivity under smallholder farmer conditions by 20-30% on adopting farms. New funding should enable delivery of enough drought tolerant maize seed to benefit 30-40 million people in sub-Saharan Africa, adding grain worth an annual average of US$ 160-200 million in drought-affected areas. (……). The project has been working with both private and public seed producers to get quality certified seed of these new varieties to farmers, and will step up these efforts with new funding. There was also success with good rains in Zimbabwe [28].

A rural response to climate change should be generated and supported. Also here it is the traditional response farming to droughts [29], floods (annual recession ones (BOX02) and recurrent occasional ones [30]), strong winds [31], land degradation [32] and other serious disasters that should be among the starting points. One may, for example, wonder whether flood recession agriculture (BOX 02) has something to offer for those who do not have to cope with annual floods but have to be prepared for recurrent occasional floods. Dam designs should consider, for the sake of managing climate change and extreme rainfall conditions of flooding, factoring in controlled flood water releases, which can be used by farmers downstream for agricultural production, instead of the current devastating uncontrolled releases. An example is the Bagre Dam in Burkina Faso and downstream communities in the Upper East

Region of Ghana. Anytime there is a spill, farmlands are inundated and agricultural communities are impoverished. Flood water harvesting designs/structures/systems (such as sandbags) must be developed to trap floodwaters at levels possible to handle so that during the receding phase, enough water can be harvested and used for growing suitable crops (see also BOX 02).

BOX 02

TRADITIONAL FLOOD RECESSION AGRICULTURE AS AN EXAMPLE TO DEAL WITH FLOODS [33]

For river basins and their populations, floods are an essential part of the natural and human cycle, revitalizing land, restoring groundwater, nurturing fish and plants. In dry areas, for example in sub-Saharan Africa, the retreat of floodwaters is the signal for 'recession agriculture' to begin. Farming families living near the Senegal River traditionally harvest two crops a year, one during the rainy season, on the sandy uplands (millet and beans), and a second on the floodplain once the annual floods have retreated (maize, watermelons and potatoes). Seasonal floods bring not only water, but also much needed sediment, a rich source of nutrients to maintain fertility. Many communities depend for food and income on fish which spawn and feed on the flooded land. And the floodplain grasses and trees that have evolved to cope with the high water levels provide nutritious grazing for livestock, and timber, fuel and an incredible variety of other products for people. No wonder that the whole social and cultural framework of floodplain communities is linked to the annual floods. Damming of large rivers, whether for hydropower or irrigation projects, has major impacts on downstream floodplains. (……). In addressing the problems faced by downstream communities, some dam authorities have attempted to simulate the effects of the annual rains, by deliberately releasing large amounts of water during the normal flooding period. (……). [Quite some] river basins have shown clear benefits from flood releases. (……). One difficulty facing the engineers is how to allow sediment as well as water to be released.(……). Future dam building projects should, agrees the World Commission on Dams, pay more attention to the needs not just of displaced communities on the upstream side, but also to those on the downstream side whose lives depend on the ebb and flow of the flood.

What climate change brings is not new but it is more serious, so the response should be more seriously as well (BOX03). Strengthening preparedness must be a joint effort of governments, extension services backed by scientists and farmer facilitators selected from among the farmers for their wide understanding and critical ideas on what the communities can handle themselves. In some circles the extension services are thought to be almost redundant, and can be done without, if farmer facilitators can be well organized [34]. Some Indonesian farmers are also thinking that way. Others believe in extension training, backed by scientists, to support farmers in their decision making [25, 35, 36, 37]. In the example of BOX01 other support systems were in place.

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BOX 03

IMPLICATIONS OF CLIMATE CHANGE FOR AGRICULTURAL SECTOR PERFORMANCE IN AFRICA [38]

(……). Results provided evidence that African agriculture and the welfare of its rural population are vulnerable to climate change. The highest risk of future climate change damages is associated with specialized crop and livestock farming (mono systems) particularly under dryland conditions in arid and semi-arid regions. This indicates how difficult it is to achieve an African green revolution under the current high reliance on dryland systems (more than 95% of the land) given predicted harsh future climates (warmer and dryer projections) for most of the dryland areas in Africa. It will require substantial public and private investments in expanding irrigation and development of crop varieties and animal breeds that are tolerant to heat, water and low fertility stresses, and in building roads and marketing infrastructures that will improve access to critical inputs (e.g., fertilizer) and output trade. This essentially requires mainstreaming climate sensitivity as an integral component of all agricultural and broader economic development planning and policy design. Policies aimed at promoting farm-level adaptation need to emphasise the critical role of farmers' education, provision of improved climate, production and market information and the means to implement adaptations through affordable credit facilities. Other needed public interventions to help promote adaptation measures and reduce vulnerability include insurance against climate risks to farmers and provision of safety nets.

Contributions from African agriculture in diminishing Green House Gases (GHGs)

Early in the previous century, agricultural expansion was by far the leading cause of increases in greenhouse gases at a global scale, whether through forest conversion for permanent cropping, cattle ranching, shifting cultivation or colonization agriculture [39]. These days it has been superseded by the energy and transportation sectors [40]. Most prominent underlying causes of deforestation and degradation are economic factors, weak institutions and inadequate national policies. Mitigation techniques such as improved feed quality, improved manure management, improved fertilizer use and greater applied nitrogen efficiency (BOX 04), as well as improved water management in rice paddies, all have to be considered in order to minimize the impact of agriculture on climate, but in win-win situations only. Such win-win situations are conditional, because it seems unfair to overly pressure farmers to compensate for the larger sources of greenhouse gases elsewhere [21].

BOX04

FERTILIZER USE IN AFRICAN AGRICULTURE [41]

The inherent lack of fertility of many African soils, which has been and continues to be exacerbated by widespread nutrient mining, has led to expansion of the agricultural frontier and the opening up of less favorable soils for cultivation. This is a scenario for disaster over the long run, given the difficulty of restoring tropical soils to productive capacity. In many tropical soils, the restoration of organic matter (a key component in soil fertility) is a very long-term proposal, and in lateritic soils such as those found throughout large parts of Africa, restoration may even be impossible. Without nutrient replenishment, many African farmers risk taking their soil resource base beyond a point of no return. Mainly for this reason, there is widespread agreement that the improvements in soil fertility needed to boost agricultural productivity growth, improve food security, and raise rural incomes will require substantial increases in fertilizer use, in combination with accelerated adoption of improved land husbandry practices. (……). Policies and programs therefore are needed to encourage fertilizer use in ways that are technically efficient, economically rational, and market-friendly. At the same time, it is important to recognize that fertilizer is not a panacea for all of the problems that afflict African agriculture and that promoting fertilizer use in isolation from other needed actions can have little lasting impact. (……). In recent years, expectations have increased regarding the role that fertilizer can play in the economic development process. (……). But the size and the sustainability of the contribution that fertilizer can make will be limited as long as underlying structural problems in the economy remain unaddressed. (…..). The following additional needs were mentioned: (i) Policy reforms; (ii) Institutional reforms; (iii) Investment in infrastructure; (iv) Strengthening agricultural research and extension services; (v) Capacity building; (vi) Improvement in the agricultural research base. (……).

Significantly, agriculture has an important role because of the large land areas involved, and also because of the many already available technologies and opportunities in agriculture to contribute to the global mitigation effort, many of which can be implemented at minimal cost [39]. Soil carbon sequestration has a higher mitigation potential than emission reductions in African agriculture, although both may be important (BOX 05). These are best achieved under management systems with higher carbon density, as well as improved soil conservation [39, 42].

BOX 05

SOIL CARBON SEQUESTRATION IN SUB-SAHARAN AFRICA [43]

Restoration of degraded soils is a development strategy to reduce desertification, soil erosion and environmental degradation, and alleviate chronic food shortages with great potential in sub-Saharan Africa (SSA). Further, it has the potential to provide terrestrial sinks of carbon (C) and reduce the rate of enrichment of atmospheric CO_2. Soil organic carbon (SOC) contents decrease by 0 to 63 per cent following deforestation. There exists a high potential for increasing SOC through establishment of natural or improved fallow systems (agroforestry) with attainable rates of C sequestration in the range of 0·1 to 5·3 Mg C ha^{-1} yr^{-1}. Biomass burning significantly reduces SOC in the upper few centimeters of soil, but has little impact below 10 to 20 cm depth. The timing of burning is also important, and periods with large amounts of biomass available generally have the largest losses of SOC. In cultivated areas, the addition of manure in combination with crop residues and no-till show similar rates of attainable C sequestration (0 to 0·36 Mg C ha^{-1} yr^{-1}).

The lack of an effective carbon price is currently one of the most significant detriments to collective global action. However, some key constraints still need to be overcome, namely: how to mobilize the large and highly diverse global farm populations, and how to certify their sequestered carbon increases and GHG emission reductions, given the high variability inherent in small-scale agricultural production environments [21].

Clean Development Mechanism (CDM) rules should encourage the participation of smallholder farmers and community forest and agroforestry producers. Such rules should protect them against major livelihood risks, while still meeting investor needs and rigorously ensured carbon off-set goals [39]. Agroforestry, assisted natural regeneration, forest rehabilitation, forest gardens, and improved forest fallow projects should all be eligible under CDM. This is because they offer low-cost approaches to carbon sequestration, while offering fewer social risks and significant community and biodiversity benefits [39]. Africa centered agroforestry deserved the UK Climate Week prize that it just got in March 2013 [44]. Short-duration tree growing activities should be permitted, with suitable adaptations. Unfairly favoring large plantations should be avoided. The successful promotion of livelihood enhancing CDM sequestration projects will require investment in capacity-building and advisory services for potential investors, project designers and managers, national policy makers, and leaders of local organizations and federations [39, 45, 46].

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See Paper ...[47].

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