



Regular Article

Effects of Desert Locust Plague on Disaster Management in the Subsistence Agriculture of Ethiopia: Do Ex ante or Ex post policy Measures are More Appropriate in Agricultural Risk Management? An Analytical Review

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Abstract The majority of African peoples rely on subsistence agriculture for a living. Because of the foregoing, any uncertainty in the agricultural sector endangers the lives and livelihoods of small-holder farmers in the countries, and disasters such as desert locust plague exacerbate the problem. The main goal of this research is to discuss the influence of desert locust plague, disaster risk management, and subsistence agriculture in Ethiopia. As a result, the effects of the desert locust plague are widespread and have long-term implications such as famine, health hazards, poverty, and food insecurity, among other things. As a result, selecting proper management methods, particularly ex ante measures, like early warning system, is strongly recommended in order to save lives and livelihoods throughout Africa, particularly Ethiopia.

Keywords: Desert locust plague, Disasters, Livelihoods, Africa, Ethiopia

1. INTRODUCTION

Subsistence agriculture is defined as agriculture that generates little or no profit for the farmer, allowing only a subsistence level of living (Ozdilek, 2017). Subsistence agriculture is closely associated with low levels of economic development; typically, subsistence agriculture is characterized by a low level of external input and low productivity (per land and/or per labor); the term subsistence agriculture is used synonymously with concepts such

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as traditional, small scale, peasant, low income, and resource poor, low-input or low technology farming (FAO, 2003). Despite the fact that Ethiopia adopted and practiced agriculture extremely early, the country has struggled to change smallholder subsistence agriculture (Gebrerufael, 2015).

Risk and uncertainty are inherent in agriculture; dangers represent the presence of susceptible elements in hazardous locations. Weather, climate, diseases, natural catastrophes, and market and environmental shocks are the most prominent causes of risk; other hazards concern logistics, infrastructure, public policy, the political situation, and institutions (IFAD, 2020). Furthermore, according to (Dohlman, 2020), risk is a major component of the farming business, and the uncertainties inherent in weather, yields, pricing, government regulations, global markets, and other farming-related events can produce large swings in farm income.

The USDA (2020) recognized five general forms of agricultural risks: - For starters, production risk stems from the unpredictability of crop and livestock growth processes. Weather, disease, pests, and other factors all have an impact on the amount and quality of commodities produced. Second, pricing or market risk relates to uncertainty regarding the prices at which producers will obtain commodities or must pay for inputs. Third, financial risk arises when the farm business borrows money and incurs a debt obligation. Fourth, institutional risk arises from uncertainties surrounding government actions such as tax laws, chemical use regulations, animal waste disposal rules, and the level of price or income support payments, all of which can have a significant impact on the farm business. Fifth, human or personal risk refers to variables such as problems with human health or personal relationships that might harm the farm business. Examples of personal crises that can threaten a farm business include accidents, illness, death, and divorce.

Furthermore, disaster risks hamper the livelihoods of smallholder farmers. According to the United Nations (UNOOSA, 2020), disaster is defined as "a serious disruption of society's functioning, resulting in widespread human, material, or environmental losses that exceed the affected society's capacity to cope using only its own resources." It was an appropriate interpretation that might be applied in agriculture. According to (FAO, 2018), climate-related and geophysical disasters killed 1.3 million people between 1998 and 2017 and left another 4.4 billion injured, homeless, displaced, or in need of emergency assistance. Direct economic losses totaled roughly USD 3 trillion, with climate-related calamities accounting for 77% of the total. Agriculture, the source of livelihood for over 2.5 billion people, is particularly vulnerable; between 2006 and 2016, the agricultural sector accounted for 23% of overall damage and loss caused by natural hazard-induced disasters in developing nations.

More importantly, the impacts of weather and climate-related disasters are increasing, and climate change can exacerbate many disasters, and some risks have become more severe in recent years (Parker et al., 2016). Smallholder farmers' livelihoods are especially vulnerable, because they may struggle to assess and manage risk, and they may miss out on investment

opportunities that could improve their farming businesses and strengthen household resiliency.

Furthermore, climatic factors are significant causes of vulnerability; for example, desert locusts require lush vegetation and damp soil to thrive, endangering lives and livelihoods throughout Eastern Africa, especially Ethiopia. Swarms of locusts are highly mobile and carried by the wind; swarms can travel up to 100 miles per day, and even a relatively small, 0.4 square mile-sized swarm can consume enough food to feed about 35,000 people in one day. As of late May 2020, nine East African countries were affected by the desert locust plague: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, Uganda, and Tanzania. Because of the plague, 2.5 million locust-affected people required emergency assistance as of late August 2020, 27.1 million estimated acutely food-insecure people as of late September 2020, 4.2 million acres of land targeted for rapid surveillance and control measures as of late May 2020, and as of late May 2020, a \$231.6 million FAO regional appeal was provided in response in East Africa and Yemen (FAO, 2020).

Desert locust swarms initially entered Ethiopia and Somalia in June 2019, after crossing the Gulf of Aden and the Red Sea from Yemen, and on November 18, 2019, U.S. Ambassador Raynor declared “a disaster” due to the impact of desert locust infestations in Ethiopia. In Ethiopia, desert locust infestations continue to affect food security and livelihoods, while hopper bands are gradually reducing in the northeastern Afar region due to control activities and fledging. However, numerous immature adult groups and swarms continue to form and are present in the northern Rift Valley on the western side along the edge of the Amhara/Tigray highlands as far north as Mekele and on the eastern side in the Harar Highlands to Jijiga, albeit slightly less than the previous week. Swarms have been spotted around Addis Abeba and in the Ogaden south of Degeh Bur. A couple of the swarms are mature and may reproduce. Ground and airborne control activities are now underway. More swarms are projected to migrate to Somalia, notably the Ogaden, where they will likely mature and lay eggs in favorable regions, while other immature swarms may continue south. Locusts have caused significant damage to sorghum and teff crops, as well as pastureland, in northeastern Ethiopia in recent months, damaging or destroying nearly 598,000 acres of crops and pasture in Afar and Tigray regions as of early September 2020.

What do empirical studies indicate about disaster risk? As various empirical studies have shown (for example, Bang et al., 2019; Costa and Mendes, 2017; Jin et al., 2016; Lazar et al., 2016; and Sánchez-Zapata et al., 2007), the issue of catastrophe risk and its management is not merely an immediate and one-time activity. Based on evidence from a household survey and field tests conducted in Yongqiao District, Suzhou City, Anhui Province, China, (Jin et al., 2016) explored the effect of farmers' risk preferences on their decisions to purchase agricultural weather index insurance. According to empirical findings, farmers' risk aversion considerably enhances the likelihood of their decision to purchase weather index-based crop insurance. Farmers' subjective judgments about the likelihood of crop losses, farming experience, education level, farm size, and household income are all important considerations

in weather index insurance participation decisions. Furthermore, a study by (Costa and Mendes, 2017) examined risk governance, assessment, and economic implications. As a result, climate change, increased urbanization, and population migration are among the social and economic variables that are exacerbating the effects of natural disasters.

Furthermore, Bang et al. (2019) evaluated resistance to the successful implementation of (disaster management) DM/ (disaster risk reduction) DRR within Cameroon's contemporary DM system using the Sendai Framework for Disaster Risk Reduction 2015-2030 as a benchmark. The findings revealed the presence of resistance factors that exacerbate communication, decision-making, and coordination of DRR activities, resource provision, aspects of international assistance, as well as DRR planning and policies, and such resistance factors contribute to Cameroon's DM system becoming more reactive and undermining risk reduction.

What is the purpose of this review? Smallholder livelihoods in East Africa, particularly Ethiopia, are currently threatened by the desert locust plague, which has been declared a disaster. However, catastrophe risk management in Ethiopia, particularly in agriculture, is underemphasized, owing to the fact that ex ante policy interventions are essentially non-existent. As a result, this seminar attempts to discuss the desert locust infestation and to provide some policy implications.

Thus, the primary purpose of this paper is to explore the effects of desert locust plague, catastrophe risk, and subsistence agriculture in Ethiopia, as well as to review different models and policies for agricultural risk management (ex ante or ex post). As a result, the following sections of the study explore important disaster models and empirical questions about the impact of the desert locust epidemic, and conclusions are reached.

2. DISASTER MODELS

This section provides some of the disaster models, such as comprehensive emergency management and the Incident Command System, which are primarily focused on management, whilst others, such as the pressure and release model, are more concerned with understanding the causes of disaster.

2.1 Comprehensive Emergency Management (CEM)

The Comprehensive Emergency Management (CEM), established in the 1980s, was one of the disaster models that quickly acquired widespread support in the field of emergency management. The fact that it expressly included mitigation and recovery in the emergency management cycle gave it a significant edge over other systems. CEM's four pillars are as follows: Long-term activities that minimize the danger of natural disasters, such as dam construction and barring people from building homes or businesses in high-risk locations, are

examples of mitigation. Preparedness entails anticipating calamities and putting in place the resources needed to deal with them when they occur. Stockpiling vital items and making emergency plans to follow in the case of a calamity are two examples. Response refers to actions made following a calamity. This category includes the actions of police, firefighters, and medical workers during and immediately following a disaster. Longer-term operations to rebuild and return the community to its pre-disaster state, or a state of functionality, are included in recovery. This is also an excellent moment to take steps to reduce susceptibility and mitigate future disasters, such as improving building rules or changing risky land-use laws. Prevention is sometimes considered a separate pillar (UK Resilience, 2004).

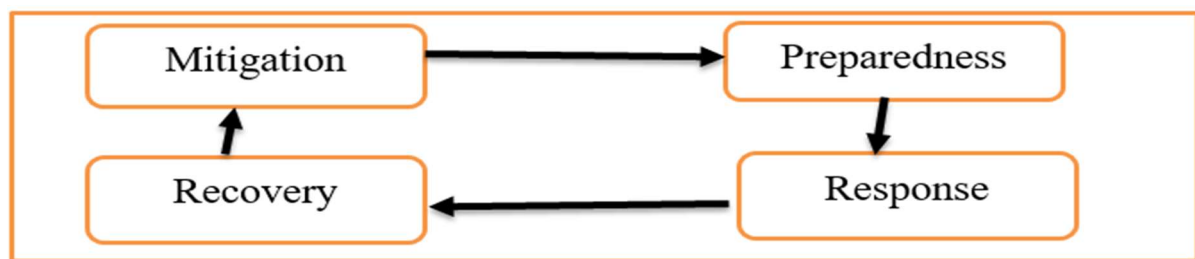


Figure 1. The four phases of CEM adopted from UK resilience (2004)

The CEM model described above, however, has been criticized for not explicitly addressing the relevance of capacity, resilience, informal networks, and formal arrangements, despite the fact that all emergency managers are aware of their significance.

2.2 Pressure and Release (PAR) Model

The Pressure and Release (PAR) Model is an extremely valuable model for comprehending how social-economic and cultural pressures produce susceptible conditions. The model's central premise is that disasters occur when a hazard interacts with vulnerability (Etkin, 2009).

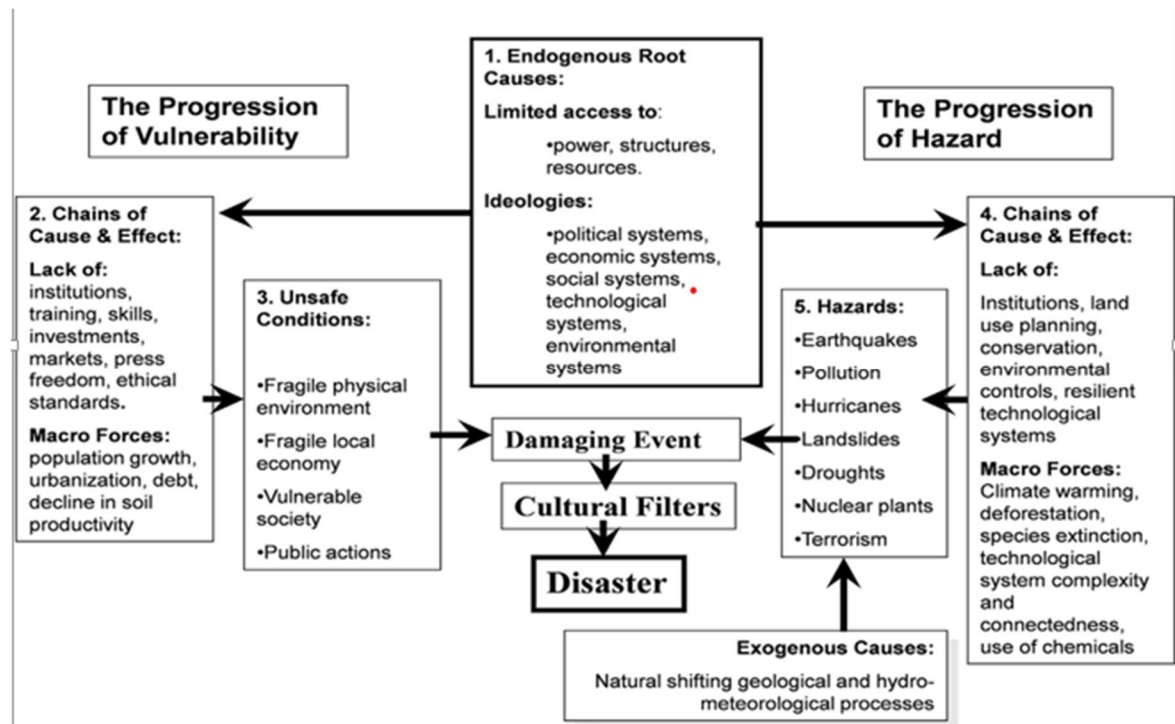


Figure 2. Modified pressure and release model adopted from Etkin (2009)

The PAR model has been widely adopted in disaster and emergency management and is a useful tool for developing a deeper understanding of why catastrophes occur from a social science standpoint. This PAR adaption has the advantage of presenting a more dynamic perspective of danger as well as a more formal relationship between hazard and vulnerability. It can also be used as a schematic depiction to show a standard concept of risk used in the natural hazards and disaster management communities (i.e., $\text{Risk} = \text{Vulnerability} \times \text{Hazard}$).

2.3 CARE Model

CARE is a non-governmental organization that works on humanitarian and development issues. Unlike the PAR model, which emphasizes a micro approach to disaster management, the CARE disaster model focuses on the household level (as embedded within broader scales) and considers catastrophes to be one of many external variables (shocks and stresses). It was created in order "to identify constraints to family and community livelihood security and design grassroots programs to overcome them" (Lindenburg, 2002).

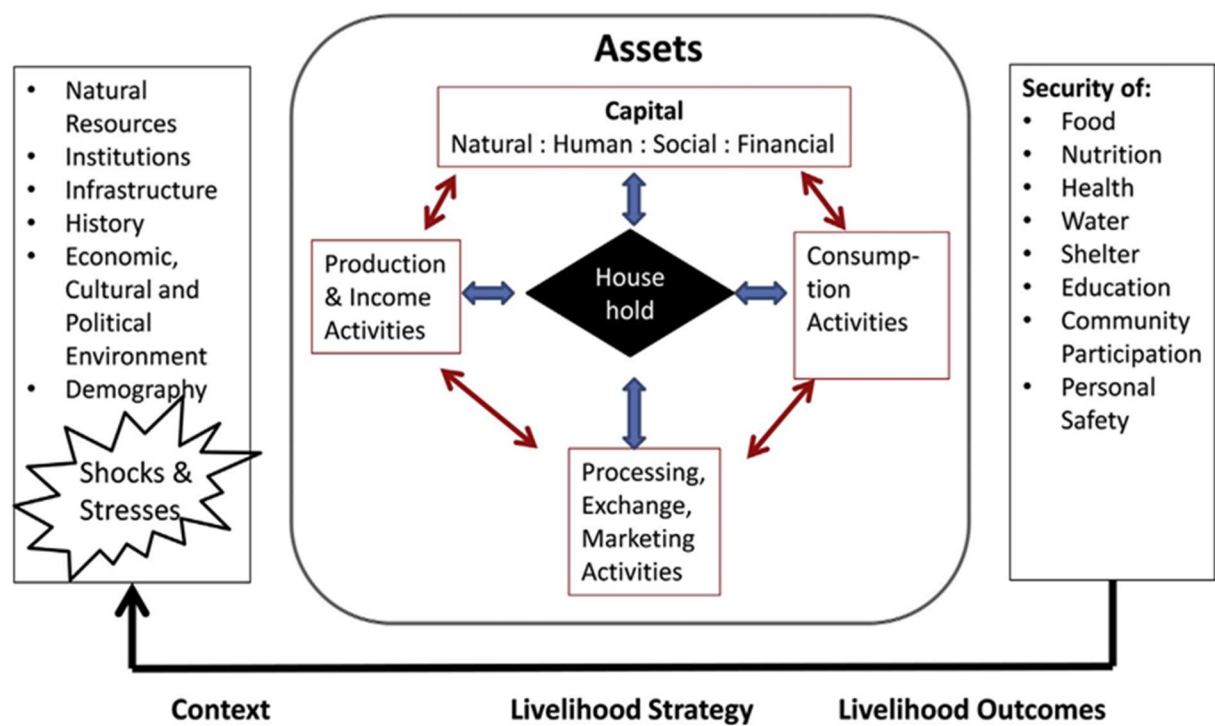


Figure 3. CARE household model adopted from Lindenburg (2002)

2.4 Linear Risk Management Model

According to Tarrant (2002), the linear risk management paradigm is depicted in the picture below:

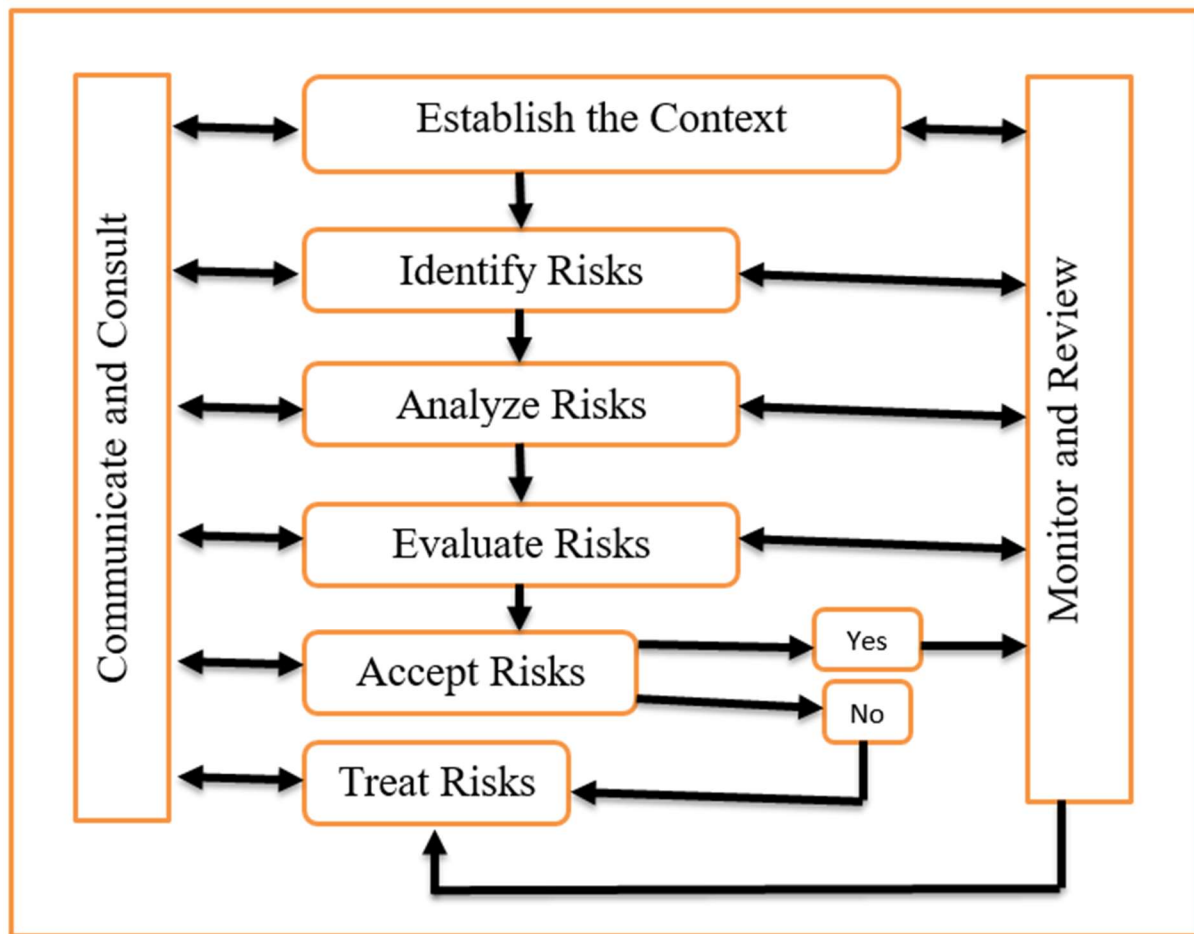


Figure 4. A traditional model of the ERM process adopted from Tarrant (2002)

When uncertainties are minor, hazards and vulnerabilities are well recognized and subject to known and available controls, and stakeholder buy-in to risk management techniques exists, this form of linear decision-making model works well. Linear models of this type have come under fire in recent years due to their top-down approach, deterministic nature, and reliance on expert judgment. As the complexities, chaos, and unpredictability of catastrophes have been better recognized, there has been a trend toward models that embrace alternative approaches such as the precautionary principle, social discourse, bottom-up strategies, and the involvement of emerging organizations.

2.5 Catastrophe (CAT) Models

Catastrophe (CAT) models are used to predict the amount of insured damage that would occur as a result of a catastrophic event such as a major storm, flood, or earthquake (Grossi and Kunreuther, 2005).

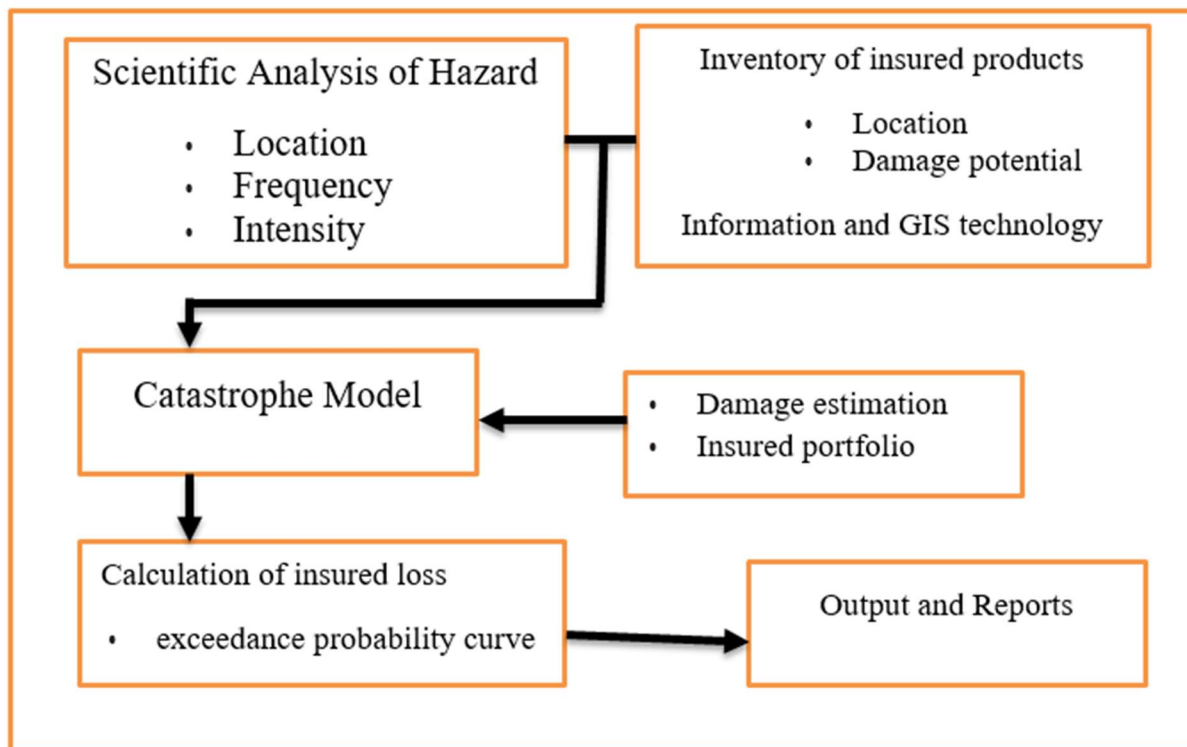


Figure 5. Catastrophe modeling adapted from Grossi and Kunreuther (2005)

2.6 Ecological Models

The ecological model views the natural environment as both a resource and a risk, as well as how humanity's relationship with nature might increase vulnerability (Etkin and Stefanovic, 2005).

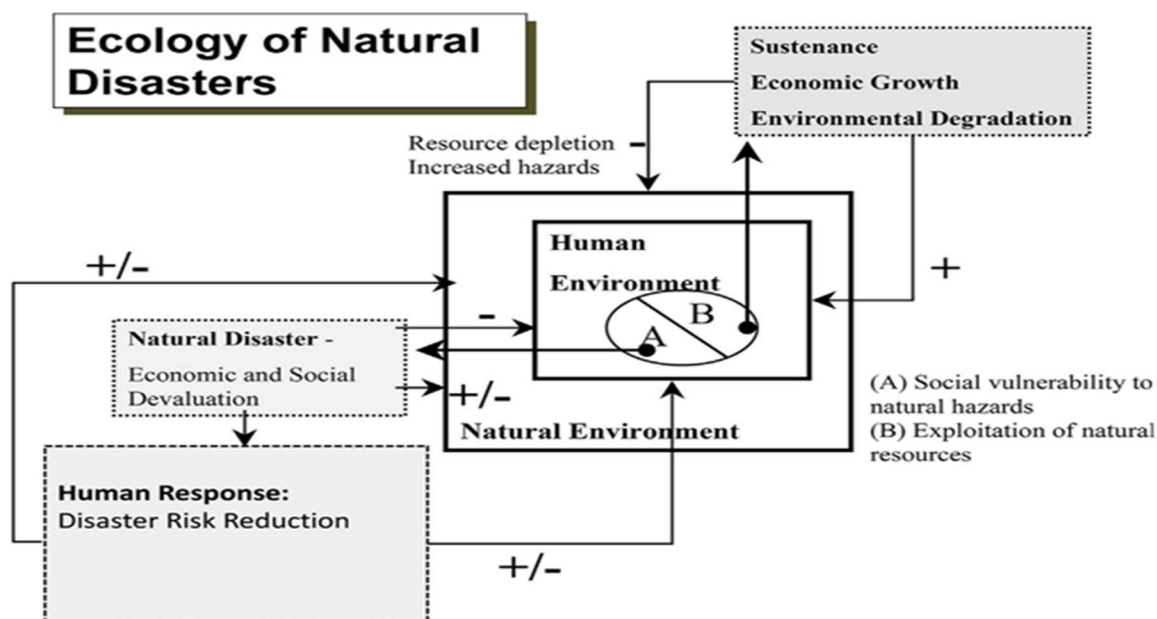


Figure 6. Adopted from Etkin and Stefanovic (2005). An ecological model of disaster

Ecological paradigms are classified into two types: equilibrium and non-equilibrium. Because the environment is constantly changing, equilibrium models of the world are too basic to adequately portray the complexity of environmental interactions. A non-equilibrium model considers significant disturbances as part of the dynamic of change, whereas an equilibrium model regards disasters as destructive aberrations to be avoided (Reice, 2003).

2.7 Disaster Risk Reduction

Disaster Risk Reduction (DRR) is defined as "the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development" (UNISDR, 2004). It is a "concept and practice of reducing disaster risks through systematic efforts to analyze and reduce disaster causal factors." Disaster risk reduction includes reducing exposure to risks, reducing vulnerability of people and property, prudent land and environmental management, and enhancing readiness for adverse events." It fits nicely within the PAR model approach to catastrophe analysis due to its emphasis on causal variables.

DRR strives to increase livelihood security by bridging the gap between development and humanitarian programs. It stresses community resilience, vulnerability reduction, and bottom-up community-driven programming. These initiatives are critical during non-emergency situations, but they should also be integrated into response and recovery operations.

3. DISASTER MANAGEMENT IN ETHIOPIA

As previously noted, Ethiopia is extremely vulnerable to a variety of disasters, including the locust plague. There was no established disaster management institution prior to 1973, hence crisis response was haphazard. The Relief and Rehabilitation Commission (RRC) was founded in 1973 as the first formal government disaster management entity, with the aim of providing relief aid to drought-affected people in Wollo and Tigray. In 1978, the RRC was reorganized and integrated with settlement and Awash Valley Development Authorities, with a mandate of relief and rehabilitation, including settlement initiatives. The National Policy on Disaster Prevention and Management (NPDPM) was published in 1993. Following the policy's passage, RRC was reorganized and renamed DPPC in 1995, with a fundamental shift in its mandate (relief supplies and disaster prevention through tying relief to development). The Disaster Prevention and Preparedness Commission (DPPC) was renamed again as the Disaster Prevention and Preparedness Agency (DPPA), with a new mandate focusing on disaster response. The system had been designed for immediate relief and hence was extremely effective in saving lives, but its contribution to reducing vulnerability to disaster risks and poverty reduction initiatives was minimal. It was necessary to reengineer the way the country controls disaster risks and vulnerabilities. This BPR-based framework has

brought about. Disaster Risk Management Food Security Sector (DRMFSS) 2008 combines the Early Warning and Response Directorate and the Food Security Coordination Directorate under one roof. For improved coordination and implementation, the same structures are reproduced in other regions of the country (Muluneh, 2013).

In general, we can state that catastrophe risk management is a relatively young and underdeveloped concept in Ethiopia. Ex ante policy measures, in particular, can be called into doubt. Because, as shown in the figure 7 below, the majority of parts of the national disaster management framework are primarily concerned with post-disaster situations.

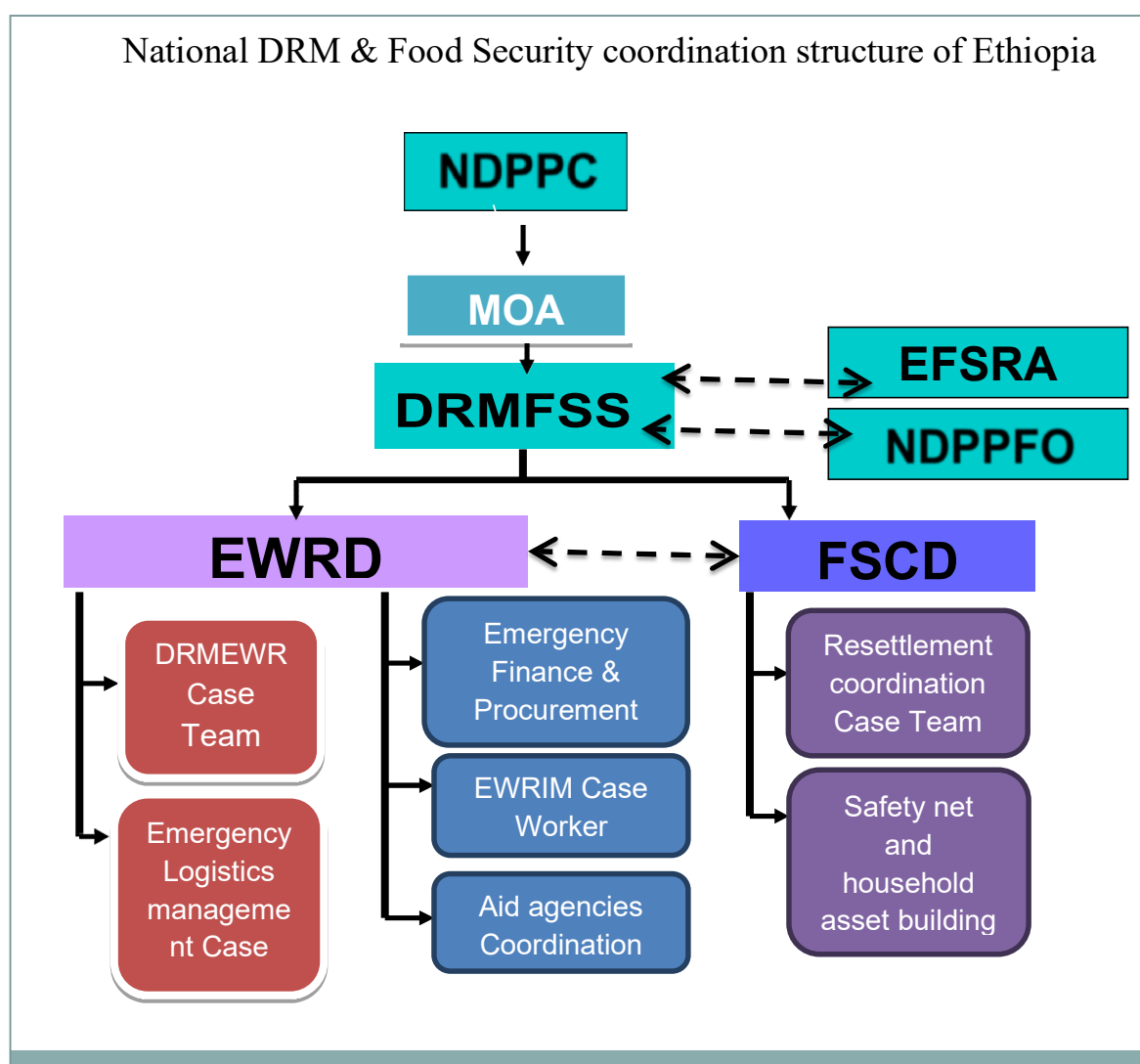


Figure 7. National DRM and Food Security coordination structure of Ethiopia. Adopted based on Muluneh (2013)

4. REVIEW OF EMPIRICAL LITERATURES ON DESERT LOCUST PLAGUE AND DISASTER MANAGEMENT

This section discusses various empirical investigations on the influence of desert locust plague and disaster management in agriculture. Despite the fact that empirical research on this topic is restricted, every attempt has been made to provide relevant literature.

Table 1. Summary of empirical literatures related to impacts of desert locust plague and agricultural risk management

Author(s)	Objective of the study	Approach of the study	Major findings
Rahaman et al. (2020)	Evaluated overlapping of locust swarms with COVID-19 pandemic: a cascading disaster for Africa	Descriptive approach	The study indicated that the current locust swarm, which began in July 2019, has become endemic in Africa, and alongside the COVID-19 pandemic, it is a disaster with a cascading risk. It is presumed that with the world's attention on COVID-19, the locust-endemic is perceived as a relatively overlooked hazard risk. This has been borne out due to the failed control of the locust infestation in countries which first saw locusts, including Somalia, Kenya, and South Africa. Both catastrophes resulted in a disaster escalating toward famine, health-hazards and poverty in the regions at risk.
Bang et al. (2019)	Investigated resistance to the effective implementation of (disaster management) DM/ (disaster risk reduction) DRR within Cameroon's contemporary DM system.	Used a qualitative, case study based research strategy	The findings indicated the existence of resistance factors that particularly complicate the communication, decision making, and coordination of DRR activities, the provision of resources, aspects of international assistance, as well as DRR planning and policies. The authors argue that such resistances factors contribute to making Cameroon's DM system more reactive and further undermine risk reduction.
Foster (2015)	Investigated the 1915 Locust Attack in Syria and Palestine and its Role in the Famine During the First World War.	Systematic trend analysis	Accordingly, major foodstuffs and sources of livelihood, including fruits, vegetables, legumes, fodder and a small but not insignificant amount of the cereals, were devoured by the locusts. As a result despite the huge distraction of food supply the middle classes sunk into poverty, the poor became totally impoverished, with the death count due to starvation still remaining (relatively) low, perhaps in the high hundreds to low thousands. From November 1915 to November 1916, the situation deteriorated extremely rapidly, such that as many as 100,000-200,000 people died from starvation or starvation-related causes throughout the region in this 12-month period.
Topaz et al. (2012)	Locust Behavioral Change Swarming Dynamics: Phase and	Quantitative framework	Results indicated that locust plague in West Africa (2003–2005) severely disrupted agriculture, destroying 2.5 USD billion in crops destined for both subsistence and export.

Lazar et al. (2016)	Investigated importance of solitaires desert locust population dynamics: lessons from historical survey data in Algeria	Quantitative approach, based on archive data collected in Algeria from 1980 to 2011	The results confirm previous empirical observations on solitaires' population dynamics. First, a clear difference could be documented between the northern and southern Saharan regions of Algeria concerning the locust dynamics and the impact of environmental conditions. The importance of runoff was clear to create suitable habitats over a long period and to very distant places from rainy areas. Second, a link, on an annual basis, between green vegetation and presence of solitaires' locusts was found. Third, statistical relationships between various locations demonstrated a clear regional dynamics. Our study confirmed the importance of migrations of solitaires' populations among Algerian regions and more generally within the recession area of this species.
Sánchez-Zapata et al. (2007)	Evaluated desert locust outbreaks in the Sahel: resource competition, predation and ecological effects of pest control	Both qualitative and quantitative approaches were employed	Stable isotope analyses revealed that little trophic overlap exists between desert locusts that feed on trees and shrubs and nomadic livestock that feed on grasses in the Sahelian savanna grasslands. In addition, during an outbreak, desert locusts were consumed by resident and long distance migrant birds. This accounted for significant changes in the diet and foraging strategies of wintering generalist predators such as the black kite <i>Milvus migrans</i> .
Ralf (2005)	The paper addressed the question how do obligations translate into the reality of locust control? "We believe what we see and vice versa: evidence versus perception in locust control"	Qualitative approach	Accordingly, three pillars of decision-making were represented for sustainable development: capacity, understanding and willingness. The study concludes that substantial progress has been made over the last decade in improving the technological capacity for more target-specific control (application technology, biological control, barrier treatment). However, despite all evidence, these innovations are often perceived with suspicion by locust control practitioners and the public.
Lecoq (2005)	Examined desert locust management: from ecology to Anthropology	Qualitative approach	The paper observed new concepts gradually being introduced in locust control. The old locust control concepts are based on "phases", "outbreak areas", "ecological conditions", "crop protection", "preventive control", "emergency planning", etc. New concepts are being introduced, involving "natural risk management systems", "stakeholder strategies", "governance", "regional public assets", "strategic analysis", etc. They consider that these new concepts highlight the recent development of what could be called a truly new locust-control paradigm. The old paradigm was focused on the locust and its ecology, studied with the aim of gaining insight. The new paradigm is more focused on humans and the interactions between them and locusts.

5. CONCLUSIONS AND THE WAY FORWARD

When subsistence is combined with disasters such as the desert locust infestation that Ethiopia is facing this year, life is not simple for marginal livelihood producer farmers. The impact of the desert locust plague is extensive and has long-term consequences, which can be described by starvation, health hazards, poverty, and food insecurity. Without foreign support, most underdeveloped countries, such as Ethiopia, are unable to control and manage disasters such as locust plagues. Not only that, but they lack proper ex ante policies in place to manage disasters inside the ministry of agriculture's framework. However, the many models provided above highlight the significance of catastrophe preparedness and ex ante policy initiatives in disaster management.

Smallholder farmers are obviously more vulnerable and immediately affected by disasters such as desert locus infestations than other sectors. This is due to a lack of livelihood assets, a poor institutional framework, a lack of access to knowledge, and other factors.

As a result, rather than focusing on ex post possibilities, proper ex ante policy actions should be implemented, as preventive measures are more crucial. Further, a greater understanding of the socioeconomic consequences of these outbreaks is being researched, as is an evaluation of desert locust control methods in the country. Most critically, Ethiopian policymakers should reassess the national disaster risk management framework and incorporate research and early warning departments into the structure.

Furthermore, multi-disciplinary future research findings are expected to understand the clear and full picture of the impact of the desert locust plagues in the area.

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