

## DEVELOPING A HISTORICALLY BASED “FAMINE VULNERABILITY ANALYSIS MODEL” (FVAM) – AN INTERDISCIPLINARY APPROACH

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With 1 figure and 2 tables

Received 21. November 2011 · Accepted 13. May 2012

**Summary:** This paper seeks to enhance the methodological and empirical basis of famine data analysis. It will focus on developing a new holistic, network model of famine analysis based on an understanding of vulnerability. This “Famine Vulnerability Analysis Model” will be derived from the study of historical famines of the 14th through the 21st centuries, primarily famines of the Little Ice Age. The model will help to answer questions on what drives famines, the direct impacts they have on affected groups or societies, how these cope and adapt. Using this modern vulnerability concept to analyse historical famines unpacks societal experience of the past for today’s regions at risk of famine worldwide and so can foster learning processes.

**Zusammenfassung:** Dieser Artikel zielt darauf ab, die methodische und empirische Datenbasis der Analyse von Hungersnöten zu erhöhen. Der Fokus wird darauf liegen, ein neues holistisches und netzwerkartiges Analysemodell für Hungersnöte auf dem grundlegenden Verständnis von Vulnerabilität zu entwickeln. Durch das Studium historischer Hungersnöte vom 14. bis zum 21. Jahrhundert, vor allem in Bezug auf Hungersnöte aus der kleinen Eiszeit, wird dieses „Famine Vulnerability Analysis Model“ entwickelt. Dieses Modell wird dabei helfen, Fragen nach den Auslösern einer Hungersnot und den direkten Einflüssen ebenso wie nach den Anpassungsstrategien der betroffenen Gruppe oder Gesellschaft zu beantworten. Die Analyse historischer Hungersnöte mit einem modernen Vulnerabilitätskonzept wie diesem macht gesellschaftliche Erfahrungen der Vergangenheit verfügbar für momentan hungersnotgefährdete Regionen weltweit und kann somit Lernprozesse fördern.

**Keywords:** Famine, vulnerability, driver, coping capacity, coping strategies, adaptation, Irish famine of 1740–1741

### 1. Introduction

Today, an estimated billion of the world’s people suffer from “chronic hunger” (FEED THE FUTURE 2011a, 1). In 2011, the African continent experienced repeated, severe famines. At least 12.4 million people at the Horn of Africa do not get enough to eat (cf. FEED THE FUTURE 2011b). Unfortunately, 2011 was the rule, not the exception. Several other African and developing countries elsewhere have had to cope with the problem of famine or deprivation for many years. 2009 was also a famine year; an extreme food shortage affected around 9.8 million people in Kenya alone (cf. EUROPEAN COMMISSION HUMANITARIAN AID 2009, 1). Describing these contexts, Wisner et al. state that “of all disasters, famine is perhaps the most damaging” (WISNER et al. 2004, 127). In the future, the number of years marked by severe food shortages is expected to exceed that experienced in previous decades, due to population growth, climate change, rising standards of living in some

parts of the world while needs grow in others, etc. (cf. FEED THE FUTURE 2011a, 1).

These examples underline the importance of current research into famines. This paper is intended as a contribution to the on-going interdisciplinary debate on the subject. So that we may learn to cope with, adapt to and hopefully mitigate famines and their effects in the future, it is important that we understand the processes that drive famine. We propose to expand the horizon of empirical famine studies back in time beyond the 20<sup>th</sup> century.

Given the agriculturally-based structure of the locally-affected groups in today’s Sub-Saharan Africa and in parts of Asia and of past agricultural societies in Europe, one can argue that they all experienced comparable impacts on a small geographical scale. People living in the period of the “Little Ice Age” (LIA) depended on agriculture to such an extent – in some cases, like Ireland’s, even on monoculture – that it made them vulnerable to famines (cf. HICKEY 2008, cf. WANNER 2000; cf. PFISTER and BRÁZDIL 2006; cf. MAUELSHAGEN 2010). MATTHES

originally coined the term „Little Ice Age” in 1939, but there are different time frames for dating the LIA (cf. MANN 2002, 1). MANN for example dates it between the 16<sup>th</sup> and mid 19<sup>th</sup> century (cf. MANN 2002, 1). Looking at the cooling temperature more closely others range the LIA between the 15<sup>th</sup> and 19<sup>th</sup> century. HICKEY goes more into detail by stating that the LIA “gripped Europe” between 1450 and 1850 (cf. HICKEY 2008, 36). Taking all the different approaches into account MAUELSHAGEN framed it between 1300 and 1900, which is the newest research LIA time frame (cf. MAUELSHAGEN 2010).

In order to develop a representative model, famines of the late medieval times and the 20<sup>th</sup> century of almost all continents, except Australia and Antarctica, will be covered in this study, in addition to LIA-famines, which are mostly dated in early modern times. This approach helps building a bridge to the field of historical climatology, the research discipline where history and climatology intersect (cf. MAUELSHAGEN 2010, 20). The major subjects of historical climatology are (1) the reconstruction of historic weather and climate, (2) the investigation of the vulnerability of past societies and economies to climate variations, climate extremes and natural disasters and (3) it studies past discourses on climate (cf. BRÁZDIL et al. 2005; BRÁZDIL et al. 2010). It extracts information from historical documents and natural proxies to analyse the previously mentioned “interaction between climate and society” (MAUELSHAGEN 2010, 20; cf. BRÁZDIL et al. 2005), of which a famine is a typical example.

Before turning to various famine analysis models and the newly developed “Famine Vulnerability Analysis Model” (FVAM), we need to examine what is meant by the term “famine”. While MOORE states that “everybody knows what a famine is” (MOORE 1990, 1), and even conceding that this is true, in fact a single definition eludes the scientific community.

Starting with the dictionary definition, a famine is an “(instance of) extreme scarcity of food in a region (...)” (OXFORD ADVANCED LEARNER’S DICTIONARY OF CURRENT ENGLISH 1989, 438). To this basic definition we need to add several other characteristics. WOLDE-MARIAM defines famine as “general hunger affecting large numbers of people in rural areas as a consequence of the non-availability of food for a relatively long time” (WOLDE-MARIAM 1984, 9). Expediently he underlines two factors in particular, the extensive spatial spreading of hunger as well as its duration. Thus WOLDE-MARIAM’S definition provides the basis for a time component for famines. DE WAAL also stresses this aspect when he

writes that an external observer “can only see a single year of drought, and that is not enough to cause famine” (DE WAAL 1997, 115). Here he ties the causation of a famine to a multi-year stressor. In addition, WOLDE-MARIAM writes about the non-availability of food, thus alluding to the Food Availability Decline (FAD) theory. This is a supply-side oriented theory and analyses food production and availability in a given region. Restating the FAD theory as an equation, famine occurs when:

$$\text{Food availability} < \text{basic needs (population)}$$

The theory describes natural drivers (see also Chapt. 2.2) as the main causes of famine. A shortcoming of WOLDE-MARIAM’S definition is its focus on famine-prone rural areas. While it is correct that famines strike rural areas more often and more severely than urban areas, deadly famines also strike urban areas today as well as in historical times; for example, there was the “Great Frost” that hit Dublin in 1740–1741 (cf. Ó GRÁDA 2009; POST 1984, 10; POST 1995, 241ff).

Food Entitlement Decline (FED) theory – based on SEN’S ideas – focuses on a population’s food entitlements, i.e. the distribution of food, rather than its availability. According to SEN, “entitlement refers to the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces” (SEN 1984, 497). In his acclaimed work “Poverty and Famines – An Essay on Entitlement and Deprivation” he describes this distribution problem as “the group contrast” (SEN 1981, 43). He claims that, “while famines involve fairly widespread acute starvation, there is no reason to think that it will affect all groups in the famine-affected nation” (SEN 1981, 43).

SEN supports his hypothesis on unequal food entitlements by reporting on famines where there was no above-average decline in food availability. “For example, in the Bangladesh famine of 1974, a very large number died in a year when food availability per head was at a peak – higher than in any other year between 1971 and 1975” (SEN 1984, 498). SEN emphasizes the fact that during a famine only certain parts of the population suffer or die from hunger, while others have plenty. BOSE also dealt with this phenomenon in his 1990 analysis of famines in Bengal, Honan and Tonkin in 1942–1945 (cf. BOSE 1990). Not only does he show that food entitlement differs among people within the same regions, such as landowners and rural workers, but also between

genders and different age cohorts. Concerning the actual gender specific mortality rate of famines, Ó GRÁDA's studies disagree with BOSE's results on how famine burdens females. In the cases he investigated, Ó GRÁDA found that males actually starved at a higher rate than females (cf. Ó GRÁDA 2009, 99ff.) in contrast to BOSE's findings.

In the same study, Ó GRÁDA states that a "famine refers to a shortage of food or purchasing power that leads directly to excess mortality from starvation or hunger-induced diseases" (Ó GRÁDA 2009, 4). Ó GRÁDA's directly linking a famine situation to excess mortality is problematic. In his study on Darfur (Sudan) 1984/1985, DE WAAL showed that the main threat perceived by the Sudanese people was not the possibility of dying, but an upheaval of their traditional way of life (cf. DE WAAL 1989). Even though excess mortality and the fear of dying are not directly linked, an argument can be made for expanding Ó GRÁDA's definition.

Taking all the complex and diverse definitions of famine into account, we therefore define a famine as "an extreme scarcity of food or a drop in exchange entitlements in a certain region over a multi-year period that threatens the way of life of the already-vulnerable resident population and frequently leads to a higher mortality rate".

### Current famine analysis models

In modern famine research, dated explanatory models like FAD or FED theory alone are not complex enough to fully explain what causes famines. Newer, more holistic approaches that are based on the concept of vulnerability need to be included in famine analysis. This helps to explain and analyse the causation, process, and impact of famines and how populations adapt to them. Therefore, the starting point for any famine analysis model should be to gain an understanding of how susceptible a certain group or society is to famine by defining, describing and analysing the concept of vulnerability.

"Vulnerability describes a central concept in climate change research as well as in the research communities dealing with natural hazards and disaster management, ecology, public health, poverty and development, secure livelihoods and famine, sustainability science, and land change" (FÜSSEL 2007, 165). Thus, vulnerability approaches hold promise for interdisciplinary research that connects climate change, famines and migration. CHAMBERS defines vulnerability as "exposure to contingen-

cies and stress, and difficulty in coping with them. Vulnerability has thus two sides: an external side of risks, shocks and stress to which an individual or household is subject; and an internal side which is defencelessness, meaning a lack of means to cope without damaging loss" (CHAMBERS 1989, 1). TURNER et al. add a systems theoretical understanding to the definition of vulnerability by stating that "vulnerability is the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor" (TURNER et al. 2003, 8074).

Looking at the term from a population-based perspective, BANKOFF defines vulnerable populations as "those most at risk, not simply because they are exposed to hazard, but as a result of a marginality that makes of their life a 'permanent emergency'" (BANKOFF 2001, 25). Marginality, as a process by which a certain group is excluded from social and economic life, in BANKOFF's sense "affects people's entitlement and empowerment" (BANKOFF 2001, 25). A vital element in BANKOFF's definition of the term is his inclusion of both physical (hazard) as well as human geography (marginality) elements in it.

The following simple equation is widely accepted in the scientific community conducting research into risk and vulnerability, such as famine analysis (cf. SAPOUNTZAKI 2011 and WISNER et al. 2004, 51):

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability}$$

For our purpose, we narrow down the concept of risk to risk of a famine breaking out, as mentioned above. Hazard is a typical driver or stressor (cf. Chapt. 2.2) that is multiplied by vulnerability. Of course, this formula is too simple to describe a complex phenomenon like a famine (cf. DEVEREUX 1993, 8). To address this, we suggest modifying the formula by including the concepts of coping capacity and long-term adaptation strategies on the vulnerability side (cf. Chapt. 2.3 and 2.4) and so increase its complexity.

Keeping in mind the previously mentioned definitions and the concepts, current models of famine vulnerability analysis should fulfil several requirements, here adapted from COLLET (cf. COLLET 2012):

- The historicity of vulnerability;
- the dynamic rather than deterministic representation of famine processes;
- the entanglement of climatic, political and cultural factors;
- the scale-problem (from national to individual and from regional to local levels);

- the encouragement of diachronic and synchronic comparisons.

The climate-society interaction model by KRÄMER, his hunger analysis model and the conceptual framework by GLASER et al. are new holistic approaches that fulfil some of the previously mentioned requirements.

KRÄMER'S adapted climate-society interaction model, based on the ideas of KATES and PFISTER, is a well-known model that is often used to analyse impacts, such as famines, in historical climatology. It analyses famines through biophysical, socio-economic and cultural lenses. It does this by dividing the analysis into three lines of research, split among the physical, social and cultural sciences. Starting with an extreme weather event, it proceeds to a linear analysis of first, second, third and fourth order impacts along the abovementioned disciplinary lines (cf. KRÄMER 2011a, 4ff.). Although the climate-society interaction model includes various aspects of famine analysis, its utility is questionable because its linear structure is not adequate enough to fully describe famines. Weather/climate as a driver tends to dominate and steer the causation focus in that direction while it ignores others.

For his PhD thesis, KRÄMER also developed a hunger analysis model for the “year without a summer”, in Switzerland, 1816 (cf. KRÄMER 2011b). Here, KRÄMER analysed the occurrences of hunger and malnutrition in a complex way, focusing on the structures, events and consequences of hunger. Even though this model is complex enough to describe hunger in the context of famines, KRÄMER seemingly did not address pre-famine or initial conditions in it.

In contrast to KRÄMER the conceptual framework by GLASER et al. is a geographical method for analysing famines. They do this by adding a “spatial dimension” and a “time scale” to their framework (GLASER et al. 2012, 5). Just as KRÄMER does in his climate-society interaction model, the GLASER et al. conceptual framework starts off by analysing the famine situation through “climatic hazards & stressors” (GLASER et al. 2012, 5). This offers an opportunity to provide the FVAM with a phase describing the general living conditions and other external circumstances before the famine and thereby enhancing current analysis models. Once the climatic hazard has started to affect the population, the GLASER et al. conceptual framework makes it possible to analyse the “regional biophysical and socio-economic vulnerability and resilience” (GLASER et al. 2012, 5) in a complex way.

In contrast to some of the previously mentioned models and conceptual frameworks, the FVAM fulfils requirements of famine theory and of concepts of vulnerability, such as the five requirements cited above from COLLET (cf. COLLET 2012). In view of famine's complexity, developing a multi-causal model based on a network structure of vulnerability is critical. Theoretical approaches, such as the FVAM, have important implications for the availability, handling and analysis of historical famine data and its use in drawing comparisons with more recent famines.

In addition to giving due weight to the underlying vulnerability concept, the FVAM assists in understanding how societies and environment interact to cause famines. We will apply a systems theoretical understanding in investigating this interaction. Generally speaking, systems theory is well suited for coming to grips with complex, interdisciplinary research topics like famines (cf. NÜNNING 1998, 521). Following OLIVER-SMITH'S socio-ecological system (cf. OLIVER-SMITH 2011), the “human-environment systems” of TURNER et al. (cf. TURNER et al. 2003, 8074) and MAUELSHAGEN'S and ENGLER'S sociosphere (cf. MAUELSHAGEN and ENGLER 2011) we consider a socio-environmental system as the basis for famine analysis. The environment influences society in all of its facets, and it is even truer in the reverse. In other words, the two spheres are deeply intertwined. By thinking in terms of a socio-environmental system, we can more easily attain a holistic perception of the processes involved.

The FVAM also introduces the concept of phases (cf. Chapt. 2) to famine analysis. We consider these famine-specific phases: (1) pre-famine vulnerability (cf. Chapt. 2.1), (2) an initiating driver (cf. Chapt. 2.2), (3) coping capacity and direct impacts (cf. Chapt. 2.3) as well as (4) an adaptation phase. Migration will play a significant role because it connects coping strategies and adaptation strategies on the individual level in the context of climate and famines (cf. Chapt. 2.4). These phases offer the opportunity to compare even complex impacts like famines at least in part by using qualitative and quantitative methods drawn from empirical social research. Such comparison will require analysing multiple famines with the FVAM. Consequently, only representative case studies of specific famines are conceivable in this preliminary stage of developing the FVAM.

Including pre-famine vulnerability in our model provides us with considerable advantages over other famine analysis models. It is a crucial stage of famine analysis. This is because it surveys the living

conditions of an affected group or society in the period before the initial driver or drivers of the famine come into play. A detailed pre-famine vulnerability analysis of the famine in Bern and Bohemia as well as Moravia in the 1770s by PFISTER and BRÁZDIL (cf. PFISTER and BRÁZDIL 2006) would lead to an even more sophisticated conclusion. It would shift the focus from better adaptations to the famine impacts in Bern to the superior pre-famine conditions there in comparison to the other two regions.

Initially, we will develop the FVAM from and for the further study of historic famine impacts. This will help to broaden its empirical basis, and it will also make it possible to describe the causation and processes of more recent famines and understand them better. The model has to be flexible and adaptable. On the one hand, this flexibility will be provided through the adaptable indicator system in the pre-famine vulnerability phase; on the other, the phase structure itself can be modified and improved. Given all these advantages, the FVAM model is both practical and still complex enough to evaluate real famine processes. In addition to the description and

development of the FVAM and its phases in chapter 2, a representative historical case study of Ireland’s famine of the “Great Frost” in 1740-1741 will be presented in chapter 3. The conclusion in chapter 4 offers a summary and perspectives for further research on this topic.

## 2 Famine Vulnerability Analysis Model

The term “vulnerability” is becoming more widespread in empirical social research. It seems that along with increased frequency comes a growing confusion about the term (cf. FÜSSEL 2007, 155f.). COLLET states that at least twenty different semiotic meanings of the word exist (cf. COLLET 2012). The FVAM, as discussed in chapter 1, incorporates several basic vulnerability concepts, such as the double structure of vulnerability by BOHLE, the Sustainable Livelihoods Approach (SLA), the conceptual framework by FÜSSEL and the BBC conceptual framework (cf. BOHLE 2001; FÜSSEL 2007; PAHS 2006; BIRKMANN 2006a,b).

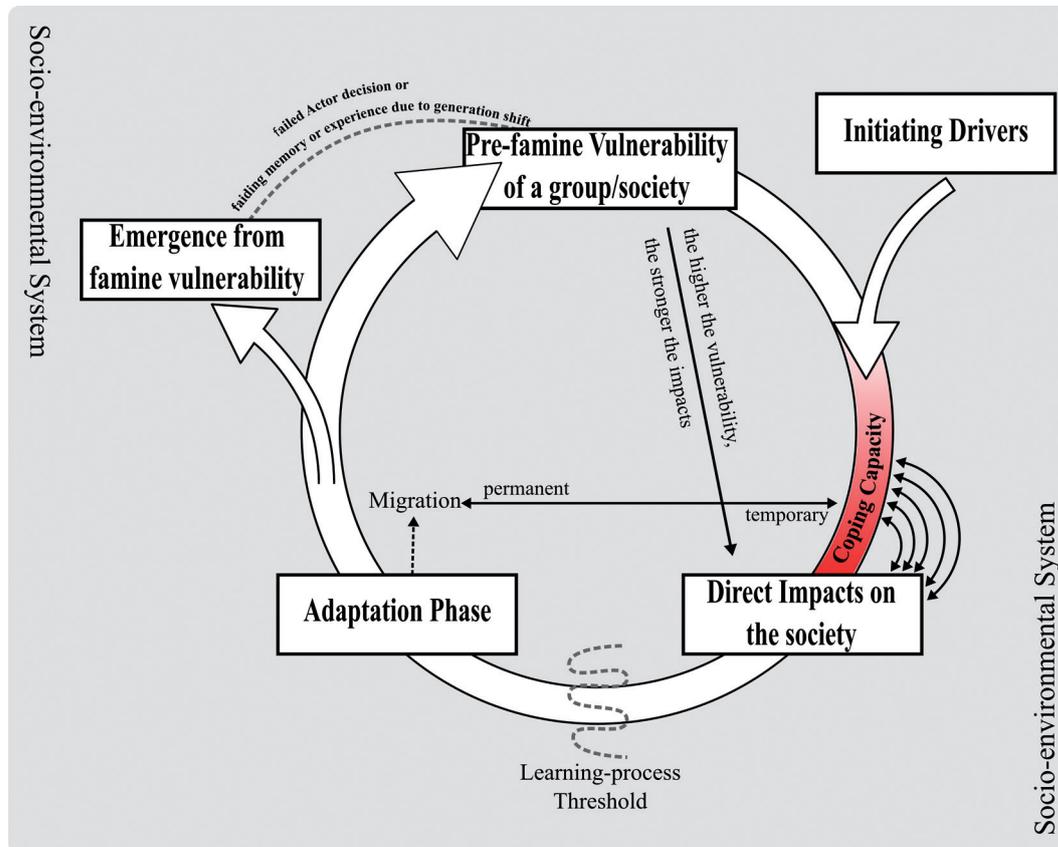


Fig. 1: Famine Vulnerability Analysis Model (FVAM)

Linking certain aspects of these approaches, concepts and analyses with famine and vulnerability theory will provide the basis for developing the FVAM. Taken as a whole, the FVAM's structure (cf. Fig. 1) encompasses a vulnerability analysis of the different phases of famines. The deepening red colour between the initiating driver and the direct impacts symbolises the onset of the acute famine situation (cf. Fig. 1). Once these direct impacts make themselves felt among the affected people, the famine is recognized as such. The different phases and their main contents were developed by analysing various historical famines worldwide. The time period covered by this analysis is the Little Ice Age as MAUELSHAGEN defines it (cf. MAUELSHAGEN 2010).

### 2.1 Pre-famine vulnerability

Demonstrating the relevance of the FVAM to historical famines, would seem to require *a priori* the inclusion of a type of vulnerability analysis that integrates both qualitative and quantitative empirical data drawn from archival material (documentary evidence). Traditionally, vulnerability analysis and approaches drew heavily on qualitative research methods, because they tend to provide deeper insight into complex social structures (cf. KROMREY 2006, 538ff).

In order to compare different famine situations, it is also crucial to quantify certain aspects/variables of a vulnerability concept and find specific indicators for the main factors. In this context, the already mentioned vulnerability frameworks and approaches of FÜSSEL (cf. FÜSSEL 2007), WHEELER (cf. WHEELER 2011), BIRKMANN (cf. BIRKMANN 2006b) and the SLA (cf. Chapt. 2) – even though they apply to current situations – seem to be helpful for historical events.

In keeping with the previously mentioned systems theory (cf. Chapt 1), social and environmental vulnerabilities have been singled out as major factors in pre-famine vulnerability analysis. Pre-famine vulnerability by definition exists in the period before the main driver starts to affect the specific region or group. Measuring it should not necessarily be based on years. Instead, if there was a previous famine in the affected area, its end could mark the beginning of the pre-famine analysis period. In our Irish case study, the pre-famine vulnerability analysis of the 1740–1741 famine mainly concentrates on the years following the famine of 1728–1729. Following the example of OLIVER-SMITH'S "Peru's

Five Hundred Year Earthquake" study, we will also take long-term developments and effects into account (cf. OLIVER-SMITH 1994, 31).

*Social vulnerability* (SV) displays a number of aspects that are useful for our purpose. First, it is about the social networks and backup systems human beings share in their societies or groups. Thus it usefully focuses on individuals as well as on the society. Second, it also accounts for basic elements, such as agricultural diversification and infrastructure, which help define the economic situation of the affected population. They play a major role in this context. Third, it provides insights into political indicators like power struggles, etc. Fourth, it has an economic and financial aspect. Market integration, transportation cost and the labour market situation all play a role, as do the financial resources available to a subject group or society.

*Environmental vulnerability* (EV) comprises all climatic elements as well as other important environmental variables that affect the population being analysed. The indicators of environmental vulnerability bear relation to social indicators. For example, it is vital to link climatic phenomena to growing periods of the staple foods specific to a group. FEBVRE describes the major role that plants play as food sources for agricultural societies, mainly referring to the medieval and early modern ages. "En d'autres termes, pour connaître l'action du climat sur l'homme, il faut d'abord connaître l'action du climat sur le milieu naturel dans lequel l'homme vit" (FEBVRE 1949, 151f).

In this context, we cannot just consider temperature and precipitation. The aim of historical climatology should be to expand research into historical climate systems. Other climate-related factors such as volcanic eruptions, land use or earth cover should also be analysed in the pre-famine vulnerability phase of the FVAM. Environmental limitations, such as access to natural resources by an affected society, will be included in addition to climatic factors per se.

Because of scarce data on historical famines we will classify the 34 vulnerability indicators (cf. Tab. 1) with a simple numerical index, assigning 0 when their role in vulnerability is neutral, -1, when it decreases vulnerability and 1 for when it increases it. Clearly, all indicators can be evaluated in both directions as they relate to famine vulnerability. For instance, temperatures can have a negative or positive effect on the amount of staple foods produced by a society, which can be evaluated as either lowering or raising vulnerability. If an indicator

cannot be evaluated because it is not documented sufficiently in the historical record, it will also be counted as 0, which is an acceptable mathematical method (cf. the indexation method in PFISTER and BRÁZDIL 2006). Overall, the pre-famine vulnerability analysis will range from -34 to +34 points.

**Tab. 1: Major factors and pre-famine indicators**

Social Vulnerability (SV)	1	Relief systems
	2	Education systems
	3	Infrastructure
	4	Agricultural diversification
	5	Population size
	6	Social classes
	7	Dependence structure
	8	Power struggles (internal or external)
	9	Political systems
	10	Health system
	11	Agricultural techniques
	12	Market integration
	13	Financial structure (e.g. transportation costs)
	14	Grain prices or prices of staple foods
	15	Labour market situation
	16	Low exchange entitlements
	17	Law-structure
	18	Tax-structure
	19	National borders
	20	Economic opportunity
	21	Governance structure
	22	Urbanisation rate
	23	Marginalisation or inequality
	24	Famine history or memory
	25	Climate perception of the population
Environmental Vulnerability (EV)	26	Geographical position
	27	Annual mean temperature
	28	Annual mean precipitation
	29	Mean temperature during the growth period
	30	Mean precipitation during the growth period
	31	Influence of other forcings
	32	Fresh water availability
	33	Fresh water accessibility
	34	Diversity of species

## 2.2 Initiating drivers of a famine situation

The case study literature on historic famines reveals that they are driven by numerous factors. First of all, we will briefly explain why we use "driver" instead of "trigger". Scientists often use the term "trigger" to describe the factor or factors that initiate an impact, such as a famine. What is easily misunderstood is that "trigger" tends to refer to short-term and sudden actions. In analysing multi-year events like famines, we rarely encounter such precipitate action (cf. the definition of famine in chapter 1). Therefore we need another term to describe this initiating phase. Two concepts, used in similar contexts, are 'stressor' and 'driver.' The difference between them is minor. Both 'stressor' and 'driver' express a long-term process or phase instead of a short-term impact like "trigger" does, making them more suitable for describing this phase in a famine's course. We choose driver because of its prevalence.

Regarding the historical drivers of famines, we will present each driver in isolation from the others, even though in most famines combinations of drivers are at work. Hence they should be considered the most prominent among the drivers introduced in this study. For example, in analysing the "Great European Famine" of 1315–1317 (cf. LUCAS 1930) or Ireland's "Great Frost" in 1740–1741 (cf. DICKSON 1997), climatic variability is obviously one of those drivers.

### Climate

In discussing the impact of climate on historical famines, it is vital to analyse the effect of temperature and precipitation phenomena on agricultural processes which, in turn, impact civil societies. This again emphasizes the importance to the analysis of understanding a socio-environmental system. We will also consider other climatic forcings in our analysis of this driver. Chapter 3 offers a more detailed description and analysis of this driver.

### Political failure

Failed policies are one of the most obvious causes of famines. According to BOSE, failure by the state to act or to intervene is the predominant cause of recent or 20<sup>th</sup> century famines (cf. BOSE

1990, 701). Even in historical times, the failure of politics affected groups, societies and whole states in Europe. PFISTER and BRÁZDIL discuss this in their analysis of the social vulnerability to climate in Bern (Switzerland), Bohemia and Moravia (regions in today's Czech Republic) (cf. PFISTER and BRÁZDIL 2006).

This driver correlates strongly with other drivers like climate or wars. It could also be argued that wars in themselves are policy failures. Because of the numerous examples from the past we understand them as a driver in their own right (cf. KELLER 1992 or Ó GRÁDA 2009).

### Wars

Observing the African famines in the 1970s (cf. KELLER 1992) it is quite evident that wars can also drive population groups or whole societies into famine. As Ó GRÁDA writes “civil war alone was enough to trigger a major famine in Nigeria in 1968-70” (Ó GRÁDA 2009, 20f.). This is just one example in a long series of famines driven by wars. In Somalia and Eritrea, political unrest lasted for decades and subjected people into deadly, recurring famines (cf. KELLER 1992, 609ff.). One could safely argue that they still continue in some areas today.

Going back farther in time, the Bengal Famine of 1943–1944 was also heavily influenced by the state of war and by the British presence in the region. States of siege also led to many famines during World War I (1914–1918) and the Thirty-Years War (1618–1648).

### Microbial shocks

Microbial shocks, defined as bacterial activity that pushes populations into famine situations, are another type of famine driver. The best-known example is the “Great Irish Famine” of 1845–1852, a disastrous famine that was caused by *Phytophthora infestans*, a fungus-like microbacterium, more commonly known as “potato blight”, that devastated potato crops, the mainstay of the Irish diet. The population had never seen this blight before, so they had no adequate coping strategies for it. Kinealy quotes one contemporary witness, who describes it as “a blight of unusual character” (KINEALY 2006, 31), reflecting the helplessness that the Irish felt when forced to confront it.

## 2.3 Coping capacity and direct impacts

When these drivers start to affect a specific region, they put a given group's or society's coping ability on trial. By coping we mean “the potential of a system to forestall (prevent) and reduce the impacts from stresses or perturbations” (IFEJIKI SPERANZA 2006, 26). Hence, coping or “coping strategies”, to use a familiar concept, in our context comprise all short-term or temporary actions that a group or society undertakes in order to avoid famine. Famine-specific coping strategies are “the bundle of producers' [and consumers'] responses to declining food availability and entitlements in abnormal seasons or years” (DAVIES 1996, 45).

A typical coping strategy in a famine situation is a change in food habits. Not only does the affected population eat less in order to save increasingly scarce food products, but what food products they eat also changes. Ó GRÁDA for example, calls them the ‘famine foods’ (Ó GRÁDA 2009, 73ff.). In protracted famines, the nutritional content of food becomes much more important than its taste. The affected population also eats “things” they normally would not consider as being edible: at the height of an Indian famine of the 1860's, the affected people started to eat mango stones (Ó GRÁDA 2009, 74).

Another specific coping strategy is saving money or barter articles. This is achieved not only by eating less but also by reducing expenditures on clothing, hygiene products, etc. (cf. Ó GRÁDA 2009, 73).

At the governmental or political leadership level, changed import and export policies are a standard reaction to famines. A common response is to ban the export of grain products while simultaneously trying to increase grain imports (cf. ABEL 1974). Another strategy by the authorities is to provide the affected regions with financial relief structures (cf. BOSE 1990, 719). The church in Europe often started or initiated this kind of relief to the poor.

The coping capacity concept takes these and other coping strategies of affected people into account. The UNISDR defines coping capacity as “the ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters” (UNISDR 2009, 8).

If the coping capacities/strategies of a group or society are low or weak or the pre-famine vulnerability is high, the initial driver leads to famine-specific direct impacts. BRÁZDIL and PFISTER highlight this with the previously mentioned examples in Bern, Bohemia and Moravia. While typical, similar climate

conditions caused a famine in the Czech provinces, the city of Bern was able to cope better (cf. PFISTER and BRÁZDIL 2006). On the one hand this shows the different vulnerability of these regions, but it also reveals that when a certain coping capacity threshold is crossed, it leads to famine impacts directly affecting a group or society. In the following passages we will illustrate those direct impacts on the socio-environmental system.

Direct impacts on the society can be pronounced in famine situations. Riots (cf. BOSE 1990, 725), outbreaks of diseases (cf. LUCAS 1930, 357ff.) and increasing mortality rates are the most obvious and frightening effects. Apart from these characteristic consequences, other (related) direct impacts demonstrate how deeply interconnected societies and environments are.

We will analyse this relationship by looking at the impact of food scarcity. One could argue that food shortages arise due to societal problems such as failed food distribution, low exchange entitlements of the poor or by choosing the wrong staple foods. It could be argued further that food shortages originate from harvest failures due to environmental factors, such as climatic anomalies, barren soils or soil erosion. In fact, food shortages and malnutrition occur because of a complex of intertwined societal and environmental reasons. The massive soil degradation in the Sahel crises of the 1970s and 1980s, which lowered the agricultural output drastically, argues effectively for socio-environmental system coherence. Here, climatic conditions decimated the grasslands while simultaneously individual decisions by numerous herders led to overgrazing. More socio-environmental impacts are analysed in the case study of the Irish famine of 1740–1741 in chapter 3.

In the context of the FVAM, the coping capacities/strategies and direct impacts should not be viewed as linear processes, but rather as feedback loops characterised by consecutive responses reinforcing one another.

## 2.4 Adaptation phase

Adaptation in connection to climate change is defined as “the adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC 2007, 6). The difference between coping and adaptation is that adaptation strategies involve more far-reaching and systematic changes.

Before a society or certain groups can adapt to famine or its aftereffects, a learning process needs to take place. We suggest that there is a certain learning process threshold describing the point when groups or societies start to adapt. Even though this paper does not attempt to define this threshold, the mortality rate, the emigration rate and the financial insecurity of the famine-affected group or society would seem to be promising avenues to explore in this regard. Ireland, for example, has a long history of famines. A historical benchmark for adapting to a famine is found in response to the “Great Irish Famine” in 1845–1852. The estimates differ, but the consensus is that while about 1 million people died, another 1.5 million people emigrated (MOKYR and Ó GRÁDA 1984, 487). As a consequence, economic stability deteriorated and thus all three previously mentioned factors came together. The earlier Irish famines regularly had either high mortality rates or high migration rates. The impacts of the “Great Irish Famine” therefore seem to be strong enough to result in structural adaptations.

In the Ireland of 1845, potatoes made up 25% of the value of all agricultural products (cf. MOKYR and Ó GRÁDA 1984, 485). This kind of monoculture increases the vulnerability of a group or society (cf. OLIVER-SMITH 2011) and exposes them to famines, as was the case with the “Great Irish Famine”. One adaptation strategy is therefore to change agricultural practice by cultivating a greater diversity of crops and cease relying on just one food staple. A second adaptation strategy also connected with food is its storage. Expanding the size and number of grain storage facilities is a useful strategy for helping to solve problems of food availability. In addition to improved food storage, innovation in agricultural technologies aids in adapting to famines. For example, windmills in the Netherlands certainly lowered social vulnerability in rural areas.

However, it remains that migration is the most important adaptation strategy. Temporary or short-term internal migrations occurring directly after the initiating phase of a famine belong among the coping strategies. Typical examples are rural-urban migrations by families due to complete harvest failures and imminent food shortages. In the context of the adaptation phase, migration is defined as a movement of people – in most cases, emigration – across longer geographic distances in search of better living conditions. We will consider this form of migration to be of a permanent nature. Hence, migration links two different phases (coping capacity and direct impacts on the society with the adaptation phase).

Migration is not only the most important and often the most effective adaptation, but also a risky one. The migrating people leave their familiar but unliveable environment in search of a better albeit unfamiliar place. Therefore, migration should not be considered a failed adaptation, but rather an adaptation of last resort. Many past and present ethnic groups migrate as a strategy for securing food availability. For example, the male Raikas, a group of herders in India's Rajasthan state, in the past engaged as they still do today in seasonal migration to feed their animals, while the women remain at a permanent base (cf. SINGH 2011, 8ff.). Another example is the Fulani ethnic group in northern Nigeria and southern Chad, whose members migrated over the "porous" borders between the two countries after the 1970s Sahelian famine to save their lives (cf. OKORAFOR NDUBUISI 2011). This division of ethnic groups brings with it a host of other problems, in that it tends to tear apart social networks, which in turn leads to a higher social vulnerability (cf. OLIVER-SMITH 2010). If people have to leave their homes due to a disaster, be it a sudden one such as an earthquake or a slow one such as a famine, they grieve for their lost place as much as for a lost person (OLIVER-SMITH 1996, 308f.). These are just two reasons among many why migration and resettlement should be regarded as adaptations of last resort.

This raises another question: who defines who a "migrant" is? This is essential for counting a migrating group or people. We cannot answer this question, at least for the moment. In the context of this paper and the following case studies, we define climate migrants as people leaving their home temporarily or permanently due to famine-inducing climatic changes.

If the adaptation strategies were/are to be successful, they should include cross-societal, legal or formal adaptations as a permanent way out of the vicious famine cycle for a group or society. However, due to generational shifts or failed decision-making processes, it is possible to drift back into the cycle. There is no way out of the famine cycle without successful adaptation strategies.

### 3 Representative case study

This case study of the Irish famine of 1740–1741 puts the FVAM to the test, using work previously published by other researchers as well as documentary/archival sources. Ireland offers a rich historical panorama of famines and their causes. Because it is

also an island state, hence geographically well-defined, it is a perfect subject for investigation. Given the need for further research, the pre-famine vulnerability analysis presented here is a preliminary study and does only attempt a precise evaluation of vulnerability. Nevertheless, it is thought that taking the FVAM as an analysis model will provide us with a more holistic view of the famine in Ireland 1740–1741. Furthermore the FVAM will augment a modern vulnerability concept with compiled historic data and in doing so make it partially available for comparisons.

The Irish famine of 1740–1741 was one of the deadliest famines in history measured by the proportion of its casualties. Still, this famine has not been investigated as extensively as other Irish famines. It should be noted here that a lot of authors describe the island in the era before the "Great Irish Famine" as "pre-famine Ireland" (MOKYR and Ó GRÁDA 1984, 480). This obscures the fact that Ireland in fact experienced numerous famines before 1845.

#### 3.1 Pre-famine vulnerability of the Irish population

In the early 18<sup>th</sup> century and at the time of the famine of 1740–1741, Ireland was "lightly governed, materially poor, and socially polarized" (DICKSON 1997, 16). This social polarization reflected the disparities between the rural population and the higher, mostly urban classes.

Prior to the famine, the Irish Parliament passed a series of punitive laws (called penal laws) that mainly affected the Irish catholic population (cf. CRUISE O'BRIEN and CRUISE O'BRIEN 1985, 77ff.). It also influenced the Irish economy by curtailing trade, for example by the "simple device of prohibiting imports of foreign hops (1731)" (SALAMAN 1985, 245).

At that time, the whole society's actions were tied to the crop cycle. This appears to be true even in agricultural societies today. Agriculturally, Ireland relied heavily on potatoes. After the failure of the oat crops in 1727, which caused a subsequent famine, it "was a sequel of dominance of the potato in the economy of the people, and persisted till some time after the Great Famine" (SALAMAN 1985, 252). Dickson underlines this argument by stating that "the Great Frost had played havoc with one of the two main sources of food in rural Ireland – the potato" (DICKSON 1997, 19). In Munster County, the role of the potato was even greater because the people produced potatoes for commercial and not only

subsistence reasons (cf. DICKSON 1997, 21). This dependence on one or two staple foods made them and the rest of the Irish population vulnerable before the famine of 1740–1741.

They were not just extremely vulnerable socially, but environmentally as well, because the three decades before the famine were generally characterised by mild winters (cf. RUTTY 1770, 78) and thirty years cover nearly a full generational shift (cf. SCHELLEKENS 1996, 29). BRIFFA and JONES especially highlight the big temperature difference between the mild 1730s and 1740–1741 (cf. BRIFFA and JONES 2006, 362ff.). This mild climate "perhaps lulled people into a sense of false security as regards their food supply" (DICKSON 1997, 21). They were not prepared for failing potato harvests and the extreme food shortages that they would entail. The harsh climate of 1739–1741 revealed another vulnerability in Ireland's agricultural production: technology. The mills, which were also very important for pre-industrial towns, stopped turning and production came to a halt due to the frost (cf. DICKSON 1997, 22 and 33).

During 1739, the politically already tense situation between Ireland and Spain deteriorated dramatically as the year progressed. As 1739 ended, imports and exports with Spain were severely curtailed. Ireland's political relations with France were indirectly (England) also strained in those days (cf. DICKSON 1997, 29).

Ireland as a whole was therefore highly vulnerable before the famine. Indexing shows that Ireland's pre-famine vulnerability was +21 on a scale from -34 to +34 (cf. pre-famine vulnerability score, Tab. 2). This is a high pre-famine vulnerability score and means that Ireland was caught up in a vicious cycle of famine (cf. Fig. 1).

"To give particular dates as the occasions of famine years is, to some extent, to create a wrong impression of the Irish situation, the truth being that the country lived in a chronic state approaching famine, and that the particular years which are mentioned by historians as famine years were simply the years in which the chronic symptoms became acute" (O'BRIEN 1918, 102).

### 3.2 Climate as initiating driver

The external initiating driver influencing the Irish social-environmental system was primarily climatic. Temperatures dropped throughout Europe between the end of 1739 and 1741. LUTERBACHER et al. (2002), MAUELSHAGEN (2010, 67f.) and XOPLAKI

**Tab. 2: Major factors and according indicators (vulnerability score in brackets)**

Social Vulnerability (SV)	1. Relief systems (1)
	2. Education systems (1)
	3. Infrastructure (1)
	4. Agricultural diversification (1)
	5. Population size (0)
	6. Social classes (1)
	7. Dependence structure (1)
	8. Power struggles (internal or external) (1)
	9. Political systems (1)
	10. Health system (1)
	11. Agricultural techniques (1)
	12. Market integration (1)
	13. Financial structure (e.g. transportation costs) (1)
	14. Grain prices or prices of staple foods (-1)
	15. Labour market situation (0)
	16. Low exchange entitlements (1)
	17. Law-structure (1)
	18. Tax-structure (1)
	19. National borders (0)
	20. Economic opportunity (1)
	21. Governance structure (1)
	22. Urbanisation rate (0)
	23. Marginalisation or inequality (1)
	24. Famine history or memory (0)
	25. Climate perception of the population (1)
Environmental Vulnerability (EV)	26. Geographical position (-1)
	27. Annual mean temperature (1)
	28. Annual mean precipitation (1)
	29. Mean temperature during the growth period (1)
	30. Mean precipitation during the growth period (1)
	31. Influence of other forcings (1)
	32. Fresh water availability (-1)
	33. Fresh water accessibility (-1)
	34. Diversity of species (1)

et al. (2005) identify 1740 as one of the coldest years over the past centuries in Europe. The Central England Temperature (CET) series (cf. MANLEY 1958, 1974) confirms 1740 as the century's coldest year in north-western Europe. This is probably why DICKSON called it the famine of the "Great Frost" (cf. DICKSON 1997).

HICKEY describes the effects of this harsh climate, which lasted for two years, writing that it "caused the Liffey, the Lagan, and Lough Neagh to freeze over" (HICKEY 2008, 37). The temperature of

1740 according to the CET shows an annual mean of 6.84 degrees Celsius. Compared with the reference period of 1961–1990 the annual mean temperature of 1740 was -2.64 degrees Celsius lower.

Looking at it on a monthly and seasonal basis RUTTY, a contemporary medical scientist from Dublin, described the winter of 1739/40 as severely cold and frosty (cf. RUTTY 1770). The newspaper portrayed the weather situation in January 1740 as follows: “The frost continues most severe and intense, so that there are tables and forms on the Liffey and selling liquors, and it’s said they intend to roast an Ox on it. The thermometer is four degrees lower and colder since our last, and is now 7–9 degrees colder than ever has been know” (*The Dublin Gazette* 1740a). RUTTY went on to write: “The Spring [was] six weeks more backward than usual” (RUTTY 1770, 80). In May of 1740 he registered “frost and snow at the beginning” of the month (RUTTY 1770, 80). These harsh climatic conditions lasted for months and caused the potato tubers to freeze in the ground, once again demonstrating the link between environment and society (cf. SALAMAN 1985, 603ff.). The summer of 1740 was mostly dry, whereas the autumn was again “unusually frosty” (RUTTY 1770, 84) with frequent cold spells during October and November. “We hear from Belfast, that there has been for these several days last past, the coldest weather and the greatest fall of snow and sleet, that hath been know in that part of the world at this time of the year; the snow was so deep on the road between that place and Ballymena, that a person coming from thence with a horse, was in much danger of perishing, he often sunk out of sight in the snow and was oblig’d to turn back again” (*The Dublin Gazette* 1740b).

The winter of 1740/41 was again icy, which further exposed the Irish people. The spring of 1741 was dry and cold and afterwards turned into a hot and rainy summer. Nevertheless the extreme food shortage lessened by July of that year (cf. DICKSON 1997, 57ff.).

### 3.3 Coping capacity and direct impacts

Once the unusually cold climate started to threaten the Irish population’s survival, they resorted to characteristic coping strategies. First and foremost, the government banned the export of grain because of the harvest failures, high grain prices and an imminent food shortage. The only truly accepted export partner throughout this period was

Britain. RUTTY remarked on the high grain prices in November 1740, stating: “the potatoes having failed, whilst other provisions bore double or treble their usual price” (RUTTY 1770, 83).

On a more micro scale perspective “there were those town authorities who decided to intervene in the food markets to try and control prices” (DICKSON 1997, 18). All these actions were targeted at stopping the further rise of grain prices and so to ease the people’s hardship. The Church of Ireland was another major actor, performing as a large-scale relief organisation in several national crises. During the Great Frost, it distributed money, food and clothes to the poor. Hugh Boulter, archbishop of Armagh, was prominently involved in both the famine of 1728–1729 and 1740–1741 (cf. DICKSON 1997, 30).

On a personal level, people switched to eating famine foods (cf. Chapt. 2.3), which, according to DICKSON, included “sour milk”, “nettles”, “charnock” and the “rotten potatoes” (DICKSON 1997, 26). This lowered their immune resistance and made them more susceptible to diseases. RUTTY described how the “dysentery raged greatly” among the already famine-affected population of Dublin in March 1741. At its peak, dysentery caused 21 deaths per week, even “though it was less mortal than in the country” (RUTTY 1770, 85).

Facing death by starvation, some of the poverty-stricken people started rioting or stealing. DICKSON writes that the “atmosphere in the towns was more explosive” than in the countryside (DICKSON 1997, 26). Food riots increased rapidly. “Last Saturday in the evening, Sunday and yesterday, we had very great tumults, occasioned by the great dearness of bread, meal, &c. Several bakers shops were broke open, and their goods sold at a low price to the poor; great damages have been done on this occasion, many persons being wounded and some killed” (GEORGE FAULKNER, *The Dublin Journal* 1740). Simultaneously the numbers of those imprisoned and the severity of the penalties for such infractions rose. Because this led to overcrowded jails, the number of persons “transported” to North America increased rapidly (cf. McDONNELL 1992). A further impact from the climatic driver, was the outbreak of severe urban fires in April and May 1741 due to extremely dry conditions (cf. DICKSON 1997, 57).

Even though coping strategies were implemented, the percentage death toll was unusually high. Thirteen per cent of the population died during the famine of the Great Frost (cf. Ó GRÁDA 2009, 23f.). This high mortality rate was directly or indirectly connected to the extreme climatic impacts.

### 3.4 Adaptation phase

One of the first adaptations after the famine was to expand old food storage facilities and to build new ones to ensure that more food could be kept on hand.

"The best course to guard against scarcity, is to encourage farmers to raise large quantities of corn yearly, that the redundancy of plentiful crops may be sufficient to answer the deficiencies of bad ones. And this can no other ways be done, than by affording them a constant and reasonable price for the quantities of corn they shall raise. [...] It will easily occur to everyone, that granaries under proper regulations would answer all those intentions" (THOMAS 1741, 3). Despite the good motives, granaries at times created a false sense of security, because not everybody shared equal access to their contents (cf. COLLET 2010).

As previously mentioned, many diseases, such as smallpox, dysentery, flu and debilitating fevers spread during the famine. This motivated many towns to set up or improve their health systems. For instance, the city of Cork, with help from charitable people, set up a kind of clinic, in which ten physicians and four surgeons attended the poor inhabitants three hours every day (cf. SMITH 1774). "Some years above 2,000" (SMITH 1774, 390f.) patients were treated there.

For many, the preferred personal adaptation strategy was migration. FITZGERALD and LAMBKIN consider 1741 as a "migration landmark" year (cf. FITZGERALD and LAMBKIN 2008, Chapt. 13, without a page number). Smyth even assumes that the migration rate in 1741 equalled that of the Great Irish Famine of 1845–52 (cf. FITZGERALD and LAMBKIN 2008, 120). Although his estimates may be a bit high and cannot be verified, they at least let us suspect a high migration rate. Cullen also suggests a high migration rate in his case study, concluding that most of the one-third drop in tax collections in Sligo and Kerry was due to out-migration and not to deaths (cf. CULLEN 1981, 90f.).

Even though most of the migration took place within Ireland, emigration was also part of the set of adaptation strategies during and after 1740–1741. For example a great number of the Irish emigrated to Philadelphia, in the United States. WOKECK states that the number of immigrants arriving in Philadelphia in 1740 was five times the rate in 1730. In 1740, an estimated 1,000 Irish men and women crossed the Atlantic Ocean (cf. WOKECK 1989, 140). ROBERT J. DICKSON summarises his analysis of the Ulster emigration to colonial America, by saying that "the terrible winter caused many to emigrate" (DICKSON 2010, 52).

The outflow would have been even higher but "mostly Irishmen (were) too poor to pay for the transatlantic passage" (WOKECK 1989, 139). Other circumstances, including the possibility of war with Spain, also heightened the risk of a transatlantic emigration.

Because of the almost non-existent cross-social and formal (legal) adaptations, Ireland continued to experience recurring famines, following the course illustrated with the FVAM in chapter 2, for the next 110 years.

## 4 Conclusion

We have argued in this paper that the analysis of famines – given all of their diversity today and throughout historic time – requires a model based on a socio-environmental system. In addition, it should allow us to compare complex phenomenon's, such as famines, to each other. The FVAM's vulnerability approach, building on the phases of pre-famine vulnerability, initiating drivers, coping capacity and direct impacts as well as adaptation, can help with this, especially when combined with empirical, quantitative and qualitative social research methods. It is also of value that the FVAM is multi-causal and network-like, which means it takes into account the feedback loops within the phases and linkages between different phases in a more realistic way. Migration, with its different subdomains, is a perfect example of such a linkage. As demonstrated by the case study on the Irish famine of 1740-1741, changing or, as it were, widening the focus to include analysis of pre-famine vulnerability will bear fruit.

Because of the growing problem of famines in the future it is vital to address this subject even more in scientific research. Scientists need to develop new and sufficient theories, models and practices to avoid or at least mitigate the effects of famines.

## Acknowledgements

The BMBF research project "Climates of Migration: Klimawandel und Umweltmigration in historischer Perspektive" by Christof Mauch, Franz Mauelshagen and Uwe Lübken was a valuable aid in this research project. Thanks also to Jürg Luterbacher, Andreas Dittmann, Johannes Werner, Anne Schindler (all University of Gießen), Eleonora Rohland (Institute for Advanced Study in the Humanities Essen), Dominik Collet (University of Göttingen) and Johannes Köster (University of Duisburg-Essen) for their help in bringing this study to fruition.

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