

Study on the Development of a Method Assessing the
Vulnerability to Famine in Each Country

世界各国の飢饉脆弱性評価手法の開発に関する研究

Misato Okaneya

37-126010

署名	日付	印
主査 :		
副査 :		

Department of Civil Engineering

Graduate School of Engineering, the University of Tokyo

March 2014

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1. Introduction

1.1 General background

Famine is one of the oldest and most catastrophic form of disaster in the world. The history of famine can be dated back to B.C. and the documentations of famine are found even in the history of Ancient Egypt and Ancient Rome (Filler 2013, Ó Gráda 2009). Many lives have been lost from lack of food.

The great paradox of famine is that it persists even in the contemporary world of food surplus. Fig.1 shows the theoretical availability of cereals per person (global cereal production divided by world population (FAOSTAT)). The amount showed steady growth and stabilized around 1970s at 350kg/year/person (=c.a. 3,500kcal/day/person), which is more than enough to provide sufficient calories for survival¹. Besides the increase in food production, social capability to avert famine has also improved. High-technology Early Warning Systems have been developed and installed (FEWS NET) and international humanitarian relief networks have been established and improved. Despite all these efforts, between 70 to 80 million people still died of famine in the twentieth century. This figure is far more than any of the previous centuries (Ó Gráda 2007). With the rising concerns towards food insecurity backed by population growth and climate/environmental changes, elimination of famine would still be a challenge even in the 21st century.

¹ Normal-weight adult with moderate actively level requires 1,200-2,000 kcal per day, according to FAO (FAO/WHO/UNU 2004).

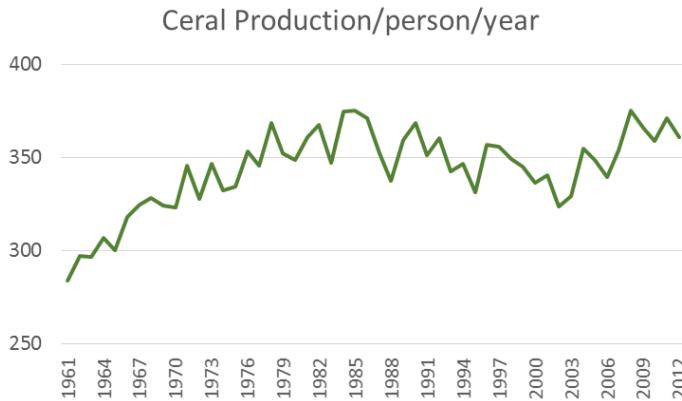


Fig.1 Cereal production per capita (kg/year)

Cereal production has been increased and per capita share was stabilized around 1970s. The amount is enough to provide sufficient energy to live.

1.2 Review of past famine studies

In this section, the knowledge from past famine studies and the evolutions of famine understanding were reviewed.

1.2.1 What is “famine”? – definitions of famine

General understanding of famine can be summarized as: severe shortage of food and large-scale death by hunger and starvation. However, it has proved difficult to provide a robust distinction between famine and other symptoms such as chronic malnutrition or starvation (Devereux 1993). Numerous definitions have been proposed from different study fields and have been discussed over the time, but most are ambiguous or descriptive, hence insufficient for operational use (Devereux 2007). Some analysts have even questioned the need to define the word at all, since one can easily “diagnose” famine even without being armed with a precise definition (Sen 1981). Here, I review common definitions and provide a rigorous definition under this study.

Food supply based definitions

Widespread food shortage leading to significant rise in regional death rates (Blix et al, 1971)

Sudden, sharp reduction in food supply resulting in widespread hunger(Brown & Eckholm, 1974)

A temporary, but severe local shortage of food ... the result of an almost complete crop failure in an area of subsistence or near subsistence farming (Ferris & Toyne 1970)

Definition based on the shortage of food supply would be the most conventional and easy-to-understand definitions of famine. They were proposed in earlier stages of famine studies.

Although they were widely taken for granted, they failed to explain why a localized food supply shortage is not compensated by food import or international aid. These statements also missed the point that food shortage is not necessarily a prerequisite of famine - famine can be caused by a failure of food *distribution* system rather than food *production* system.

Food consumption based definitions

Sudden collapse in level of food consumption of large numbers of people (Scrimshaw, 1987)

Lack of food over large geographical areas sufficiently long and severe to cause widespread disease and death from starvation (Chamber's Encyclopedia)

Definitions focused on the failure of demand side, rather than supply side, of food system. Distribution failure or other “created” famines could be taken into account under these definitions, but they still ignore the fact that most of the famine-related deaths are caused not by insufficient nutrition intake but by infectious diseases supported by deteriorated sanitation status.

Mortality based definitions / Mass starvation

Unusually high mortality with unusually severe threat to food intake of some segments of a population (Ravillion 1997)

Famine is a general and widespread, prolonged and persistent, extraordinary and insufferable hunger lasting for several months and affecting the majority of rural population over a more or less extensive area, resulting in total social and economic disorganization and mass death by starvation...

Famine is general hunger affecting large numbers of people in rural areas as a consequence of the non-availability of food for a relatively long time (Woldemariam 1984)

Definitions in this category focuses more on the outcome or phenomenon of famine rather than underlying factors. Famine is described in terms of inadequate food *intake* rather than inadequate food *availability*. Most of these definitions seem to have difficulty in distinguishing “malnutrition” and “undernutrition” from starvation and famine. Moreover, the major practical drawback of the definition is that they have limited diagnostic or predictive merit. They can detect famine only after long time has passed, and are therefore not very practical for the purpose of famine prevention. The role of the definitions as “pithy description” (de Waal 1987) is useful to focus on the past major famines and compare their magnitude.

“Behavioural” definitions

Famine might be more effectively defined as the community syndrome which results when social, economic and administrative structure are already under stress and are further triggered by one, or several, discrete disruptions which accelerate the incidence of many symptoms, or crisis adjustments, of which one is epidemic malnutrition. (Currey 1981)

This category of definition draws attention to the social and economic disruption which typically accompanies a famine. These definitions regard famine as a “community syndrome” rather than a “natural disaster”. The definition proposed by UNRISD (United Nations Research Institute for

Social Development) (1976) refers to three phases in a famine's "episodic career" and introduced a sense of dynamism and social context of how famines develop. The definitions have the advantage of emphasizing the nature of famine as a process rather than an event. However, they are more of descriptions after sometime rather than prediction of a coming disaster.

"Insider" definitions

During famines, many people choose not to consume food rather than sell vital assets... most famine mortality is not directly related undernutrition but is caused by outbreaks of disease (de Waal 1990)

Famine does not necessarily imply a massive death toll through starvation. In communities where it is recurrent, it is the process which may ultimately lead to a high death toll which is seen as defining famine, not the deaths per se. (Walker 1989)

Until this section, the perceptions of outsiders on the nature of famine were listed. In fact, there are only a few definitions proposed from the insiders' perspective. Unlike common understanding of "starvation by the lack of food" as a cause of famine, people under food shortage do choose to starve to a certain level to protect their property (de Waal 1989). A pastoralist from Niger stated about a famine in 1950s: "No one died, but the price of millet rose: when the sack of millet costs 6000 francs, isn't that a famine?" (Laya 1975).

It is true that starvation and death *are* common features of many famines, but it would be misleading if we solely focused on these two points and ignore the situation where people suffer from other elements of famine *except* death from starvation. All of the above-mentioned definitions focus on different aspects of famine, and none of them are able to capture every

feature of famine. Thus we should select the most suitable definition for our purpose (eg. Famine prediction to plan food aid program, famine analysis of the past).

1.2.2 Differences between terms concerned with food insecurity

The concepts of undernourishment, undernutrition, malnutrition, and famine are related to food insecurity and sometimes used interchangeably. It is important to understand the differences and how they are related to each other. Following are the definitions of the food insecurity concepts provided by FAO (FAO 2008).

Undernourishment is the status of persons, whose food intake regularly provides less than their minimum energy requirements. This is not a phenomenon or outcome, but a status of insufficient food supply.

Undernutrition is the physical syndrome associated with prolonged low levels of food intake (= undernourishment) and/or low absorption of food consumed. It is generally applied to energy (or protein and energy) deficiency, but it may also relate to vitamin and mineral deficiencies.

Malnutrition is a broad term for a range of conditions that hinder good health, caused by inadequate or unbalanced intake of macro- and/or micro- nutrients. Malnutrition may be an outcome of food insecurity, but it can also be relate to non-food factors, such as insufficient health services and unhealthy environment.

Famine is a wide-ranging crisis rather than a chronicle condition or simple biological syndrome and thus not a continuation of any of the above-mentioned term.
Undernourishment is usually measured by the amount of energy intake and malnutrition is measured by biological features of stunting (i.e. weight-for-age, height-for-age and weight-for-height), to describe chronicle reality of food insecurity, while famine is a sharp sudden event and

measured by social as well as biological features (e.g. loss of social assets and the number of death). Famine is different from hunger (an individual's perception of the need to eat (Devereux 1993)) or starvation (continuation of hunger to the point where life is threatened (Devereux 1993)), although the separation between starvation and famine could be a blurred, if the perception of famine as a crisis of mass starvation is valid.

1.2.3 Review of famine theories

Famine has been studied for a few centuries (Malthus 1798) and the theories of famine have evolved along with the social changes. At the early stages of famine studies, when societies were vulnerable to external forces, famine was explained by reduced availability of food such as destruction of agricultural production (Devereux 2006). This is called Food Availability Decline (FAD) famine, and natural disasters or wars² were pointed out as the major contributors (Devereux 2006, Wisner 1994).

The FAD approach had been almost the only theory to explain the mechanism of famine until 1981, when Amartya Sen proposed the “Entitlement Approach” (Sen 1981). That was the time when cereal production became sufficient to feed people and the amount was stabilized but famine still persisted (Fig.1). Rapid development in transport network reduced vulnerability to harvest failure, besides rapid development of transport network, which integrated rural area to wider economy (Iliffe 1987) and enabled prompt response to emerging food crises (Mallory 1926; Dando 1980). Through close observations of contemporary famines that reflect those social changes, Sen concluded that the crucial factor of famine is the lack of accessibility to food, rather than definitive insufficiency of total amount of food. He argued that loss of production is

² In this paper, the word “war” includes conflict and civil war as well

only one type of the entitlement failure (“direct entitlement failure”) and suggested other types such as “trade entitlement failure”, which is typically caused by the loss of purchasing power.

The Entitlement Approach does not rule out the FAD hypothesis but subsumes it.

At the end of the 20th century, theories showed great expansion, taking in various implications from different study fields. Democracy was suggested as a key factor for prevention of famine (Sen 1999, Banik 2007). The New Variant famine (NVF) theory refers to HIV/AIDS as a supplement factor; HIV/AIDS affects demographic pattern by attacking adults³ and leaving long-lasting damage to the society as well as the household (de Waal and Whiteside 2003). Von Braun et al. (1998) advanced a notion that “famine is largely a function of institutional, organizational, and policy failure, not just one of generalizable market- and climate-driven production failure”. At the age of globalization, in addition to local government or internal political issues, international factors should also not be neglected (Devereux 2006). Based on the notion that famine is generated from the interaction of various concerns and priorities, Howe (2007) proposed the “priority regimes⁴” theory, which focuses on the relationship between priority regimes and famine. Relationships were summarized into six categories and creation of famine was explained by the decision making process under each category (Table.1 and Fig.2). It is

³ Conventional drought-induced famine attacks vulnerable population such as children and elderly people.

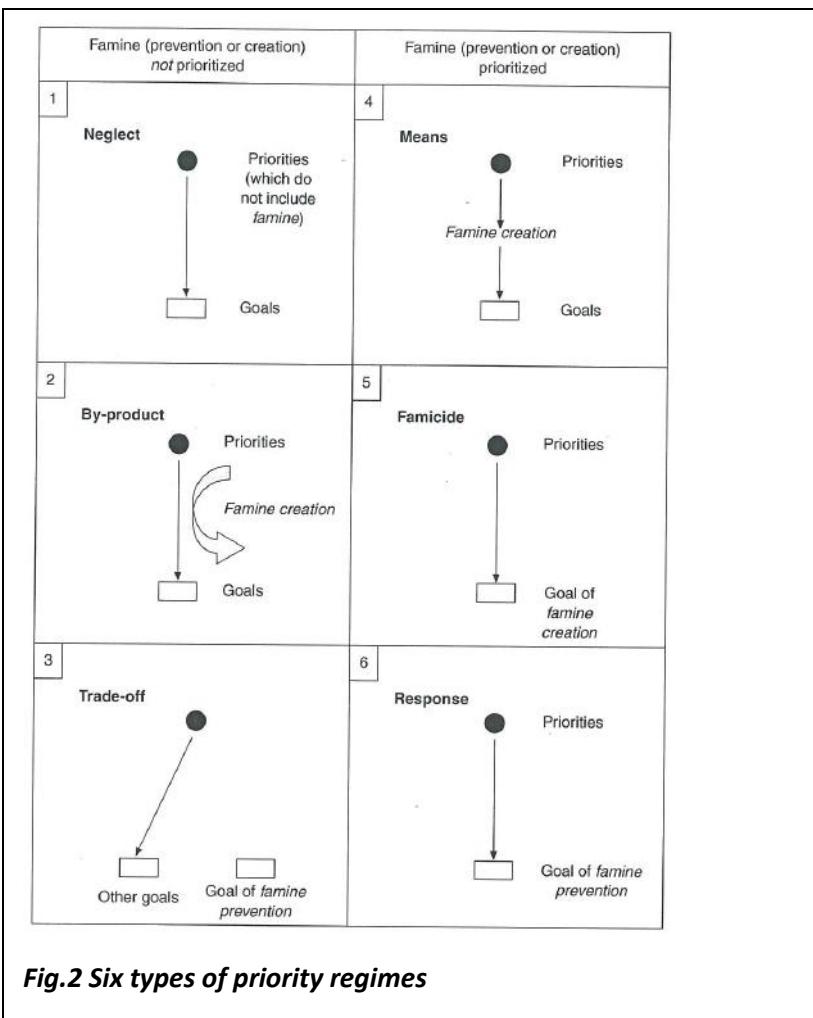
⁴ Priority regimes was defined as the set of concerns that are privileged in the decision-making and actions of institutions and individuals (Howe 2007)

worth emphasizing that the theory takes into account the famine *created* by political will, not just

<i>Relationship</i>	<i>Description</i>
Neglect	Famine is not considered in the decision-making process
By-product	Famine is an inadvertent by-product of another higher priority
Trade-off	An explicit decision is made to prioritize other goals instead of famine prevention
Means	Famine is a necessary means to a larger priority
Femicide	Famine is prioritized as an actively sought occurrence
Response	Famine is prioritized as an actively fought against occurrence

Table.1 Six types of priority regimes

a *failure* of prevention. Such examples include famine as a tool of economic sanctions or as a weapon of wars (Charlton 1997, Howard 1993). As international politics become one of the major factors in determining the vulnerability to famine, this theory can provide useful perspective in understanding recent famines.



Numerous theories on famine have been proposed and discussed over the decades. However, most of the researches are descriptive than analytical (Devereux 2006) and there are few studies that quantitatively testify those theories against the global reality over time and space.

Although it is widely acknowledged that famine is an outcome of complex interaction of political, social, economic and environmental factors, not simply a consequence of quantitative insufficiency of food, it remains to be unclear to what extent can famine be explained only by considering supply factors.

1.3 Objective of this study

The aim of this study was to represent the essential structure of famine by simple model that is useful to assess the vulnerability to famine. Past famine cases were analyzed and famine database was developed to summarize their contributing factors. Based on the understanding from the developed database, famine structure was developed and applied for the assessment of vulnerability in each country.

In this study, famine was defined by mortality based definition (Ravallion 1997, famine-related death > 10,000). Although it is admitted there are immense suffering and disruption to livelihoods and communities that did not result in excess mortality or large-scale death (Devereux 2006), those sufferings were excluded from the scope due to the insufficient availability of data.

1.4 Thesis outline

This study consists of two parts: analysis of past famines and development of famine vulnerability assessment method.

In Chapter 2, past famine theories and case studies were reviewed to understand the structures and mechanisms of famine since 20th century. Literature study was conducted to develop famine database. Database was analyzed from several aspects.

Based on the findings and understanding from Chapter 2, a method to assess vulnerability to famine was developed in Chapter 3. The method was then applied to past cases.

Chapter 4 is devoted to future predictions of famine. Future status of famine was assessed by applying statistical data to the developed method.

Finally, results are summarized and implications as well as limitations were discussed in Chapter 5.

2. Analysis of past famine

2.1 Development of famine database

Since no comprehensive database of the past famine is available at time of this time, I collected data from different sources and developed a famine database to understand the factors and trends of past famines. In total, 55 major famines since 1900s were collected from a wide range of literatures and documentations including official report of international organizations (e.g. FAO and WHO), research papers (e.g. Devereux 2000), and publications (e.g. Devereux 2006). The following points were included in the database:

Year

Starting year for smaller famines are stated differently from literature to literature, and end year is different even for larger famines. I chose the one that are most frequently used among the referred literatures. Hereafter “year of famine” is referred as “starting year”.

Country

Although many of the famines occurred in only a part of a country/countries, each famine was attributed to the country/countries rather than region since statistic data are available in country scale.

Number of death (depending on availability)

The number of death greatly differs from literature to literature. For some famines there are no record at all. Since famine often occurs during war, it is difficult to separate famine death from war death. In addition, countries that experienced famine often lack administrative

capacity or political will for record keeping. For these reasons, the number of death was estimated from the available data, and used only as a reference.

Pre-famine condition and contributing factors

Various explanations have been offered in literatures for the mechanism and causalities of famine. To summarize those explanations into comparative form, literature study was performed and each famine case was checked against 11 factor categories under 6 groups. Two or three literatures were referred for each famine, and if a literature include a keyword listed under a factor category, then the famine gets the score of 1 for the category (Table.2). The categorization of factors was defined in accordance with the chapter division of “Theories of Famine” (Devereux 1993), which gives most comprehensive and organized overview of famine factors. DeRose (1998) was also referred to supplement missing perspectives. It should be noted that the categorization may miss some newly-emerging features of famine which were not included in those two publications from the past century.

Even though more than one literature were referred for each case (depending on availability), there is a possibility that a factor is relevant to a famine but not mentioned in any of the literatures. In order to confirm whether the literature-based method is adequate, several factors (drought, conflicts and governance) were checked against statistical data and compared with the results of literature study. Some data that were pointed as a contributing factor of famine but not likely to be explicitly mentioned in literatures were also added for this data comparison (democracy and population growth).

Group	Category	Key words
Climatological	Drought	
	Flood	
	Other climatological Factors	Insect, Locusts, Plant diseases, Loss of cattle, Shortage of seeds
Food Market	Price Rise	Failure of food rationing system, Inflation
	Imperfect or Fragmented Markets	Transportation, Limited Access to Markets, Expectation, Speculation and Hoarding
War	War, Conflict, Civil conflict	
Domestic Politics	Colonization, Socialism, Communism	Dictatorship, Indifferent colonial government
	Government Reaction, Food Policy	No food reserves, Failure of relief distribution, Failure of administer relief, Land reform, Continued to collect heavy taxes, Resettlement, Relocation, Displacement
International Politics	Insufficient or Delayed aid, Lack of Non-Food Aid	Late request, Insufficient shipment
	Embargo on Food Aid, Blockade	Western hostility, Indifference, Weapon
Others		Excessive cash crop growing etc.

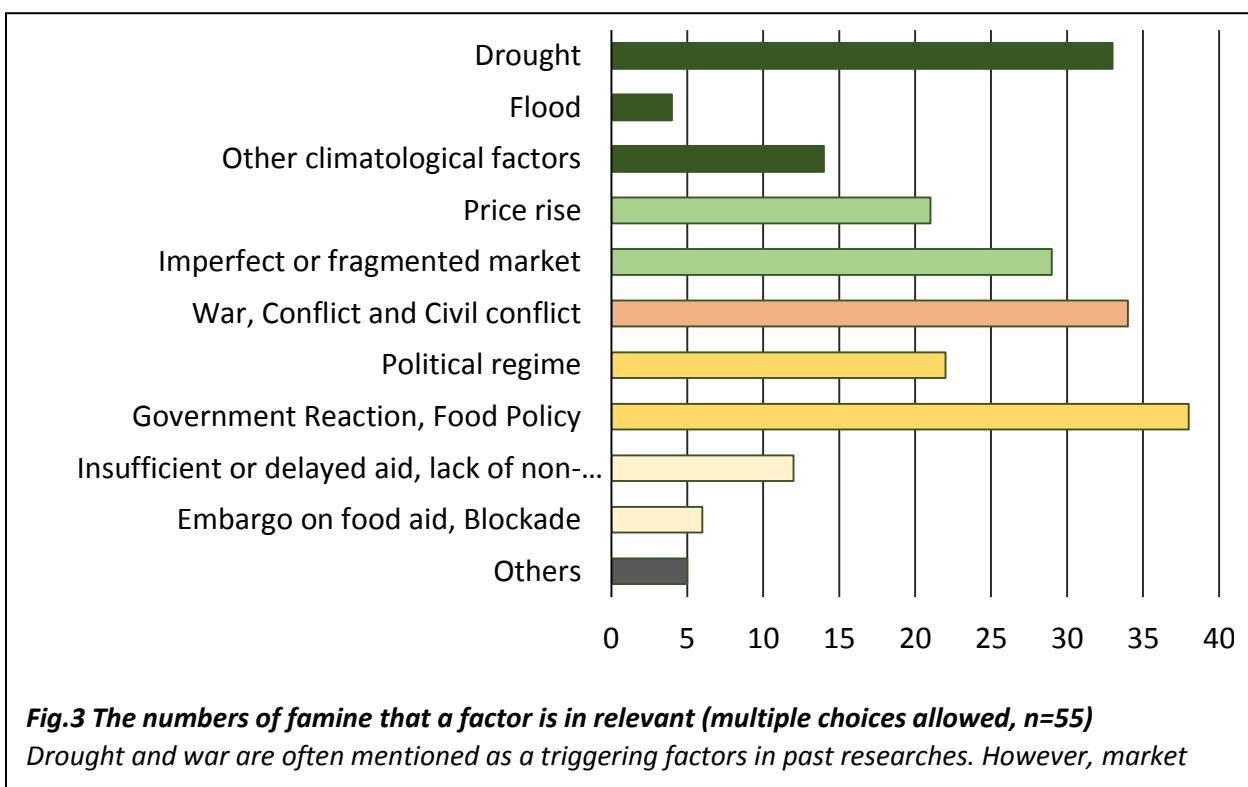
Table.2 Classification of contributing factors of famine
Each famine case was investigated against each factor category. If a keyword is included in any of the referred literature, it is regarded that the factor is relevant to the famine case.

2.2 Chronology of famine

The developed database is attached as an appendix. By using this database, past famines were studied from different aspects to understand characteristics and trends.

2.2.1 Contributing factors of famine

Fig.3 shows correspondence of famines to each factor. Drought and wars, which were explained as the most common triggering factors of famine, were the most frequently observed factors. However, government reaction and government policies were observed to be even more influential than those two triggering factors. It is understood from this result that anthropogenic factors are highly important when discussing famine.



When the result is shown by category, market factors are also conspicuous besides political factors. Both two factors related to the market aspect are relevant to approximately half of the famines. Although international factors appear less frequently in the literatures, they are becoming more important in recent years as countries become integrated to the international economy (Devereux 1993). Since the documentation regarding international factors were mostly

found in the recent famines (1960s~), it can be hypothesized that either international factors are becoming more and more important, or it was not attracting attention previously.

By comparing the results between the literature-based method and the statistics-based method, it can be said that the literature-based method is adequate at least for the major factors. Drought measured in both methods corresponded except for only one case ($24/25=96\%$ accuracy). As for war and conflict, three cases recorded in UCDP database (either armed conflict, non-state conflict or one-side conflict) were not mentioned in any of the literatures, while 13 cases were documented. It might be because war did not lead to famine, or just being overlooked.

It was difficult to compare the results for democracy and governance because of the limited number of samples available. However, as all countries show negative values (Appendix 2-1), it is safe to say that famines occurred in less democratic countries with weak governance in the 20th and 21st century. Population growth rate is a factor that has been suggested since the very beginning of the famine studies (Malthus 1978), but not mentioned in reports or studies of each famine event. When we look at the statistics, they actually show the high value compared to the global average.

Although the literature based method is effective in summarizing contributing factors of different famines that are documented in diverse sources of literatures and in different manners, there is a limitation in that the results can be biased by the choice of literatures. In this study, difference of referred document exist between old and new famines. There are large numbers of research papers about old famines while fewer reports are available. In contrast, research papers are scarce for recent famines while plenty of reports and articles exist. Best effort was taken to take to balance the sources of literatures, but availability of resources set the limitation. Underlying causes might have been overlooked, especially for recent famines, since reports tend

to focus more on the interests of the society or of the issuer (usually an organization), which leads to the biased documentation. In any case, regardless of the literature type, it should be noted that the documentation is interpreted secondary information and thus do not fully represent reality.

2.2.2 Geography of famine

Geographically, famine has been decreasing from Eurasia continent but persisting in Sub Saharan Africa (Fig.4, Fig.5). Until 1950s, Eastern European and Asian countries mainly suffered from famines while only 7 out of 27 famines (26%) occurred in Africa. Russia and China experienced especially large numbers of famine in almost every decade, although no famine has been recorded in both countries since 1960s. This is explained partly by the improvement of infrastructure (Malloy 1926; Dando 1980) and changes in political system (Devereux 2006). On the contrary, countries in Sub Saharan Africa still suffer from famines since 1960s. Ethiopia has experienced six famines since 1960s, at least one famine each decade, although no famine was reported until 1950s. The absence of famine in Africa until 1950s might be due to the lack of records under colonial governments, or it was not that critical. Although it is uncertain whether famine just persisted or became critical in Africa, it can be concluded from this result that the most critical region of famine today is Sub-Saharan Africa as famine is still a serious reality in this region.

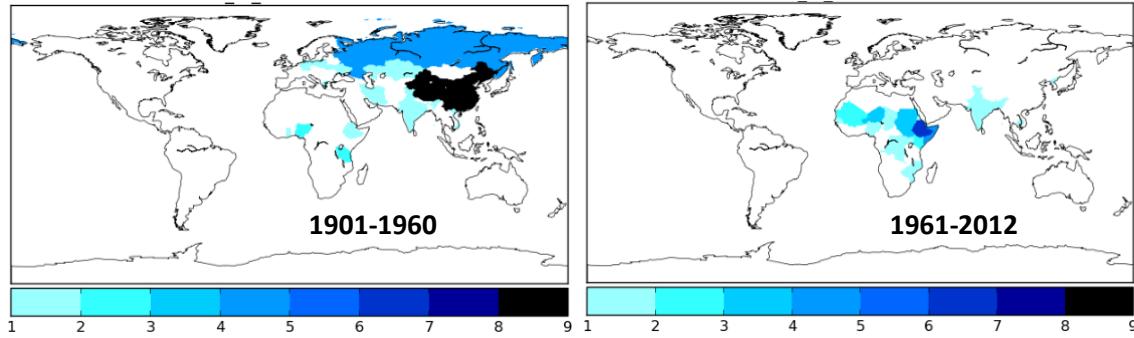


Fig.4 The numbers of reported famine

Eastern Europe and Asia, which used to suffer from famine, have grown out of famine. Famine is dominant in Sub-Saharan Africa since 1960s.

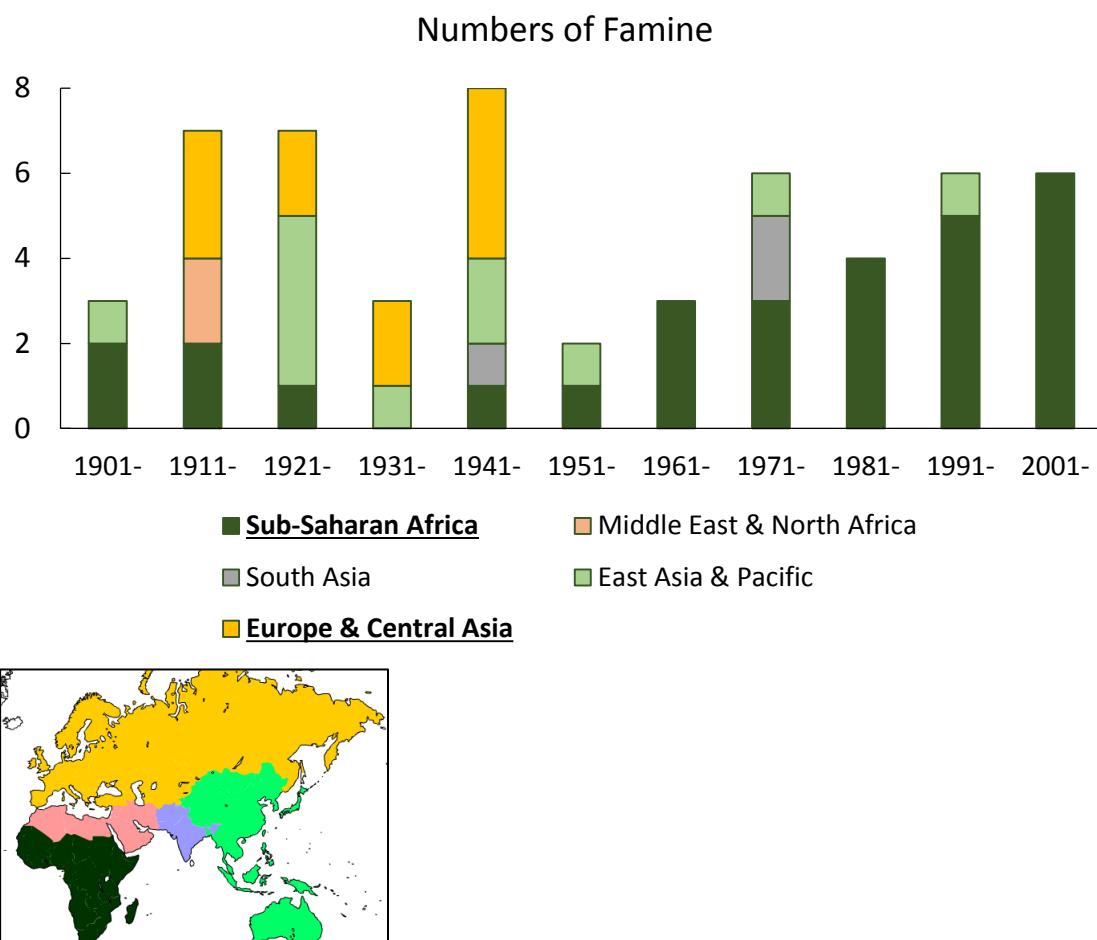


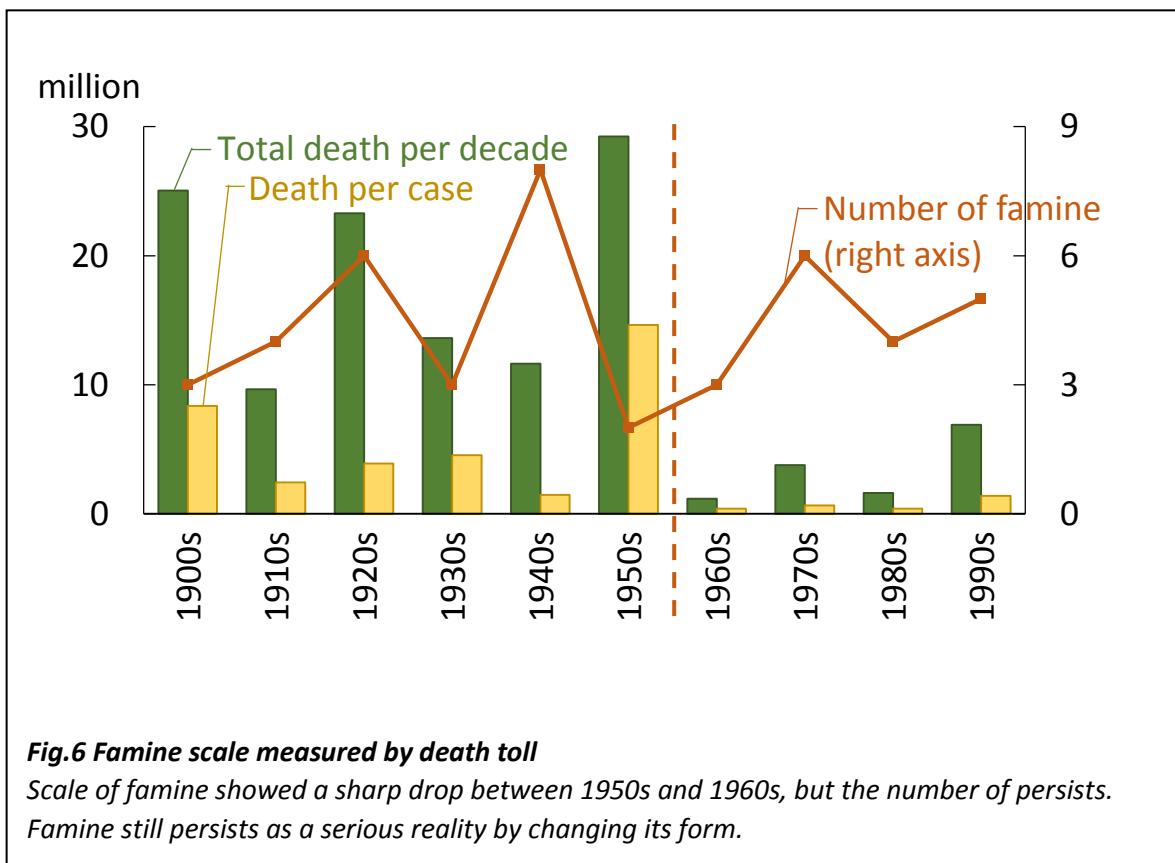
Fig.5 Geographical transition of famine (1901-2012)

Famine persist as a serious issue in Sub-Saharan Africa, while it is decaying from Europe and Asia.

*The most right bar include the data until 2012

2.2.3 Scale of famine

Scale of famine has also been changing over the time (Fig.6). Until 1950s, when famines were dominant in Eurasia continent, more than ten million famine-related death tolls were counted each decade. However, it dropped to approximately five million after 1960s. Although the number of deaths have decreased, the number of famine events in each decade have remained at a stagnant level. This changes in the number of famine mortality corresponds with the statement of Plumper (2007) that differences in famine mortality are due to differences in the governing policies.



2.2.4 Famine without production decrease

Famine is believed to be accompanied by decrease of food production. However, it is observed that famines occur even when production is not decreasing. Fig.7 (a) shows the relationship between increase (or decrease) of agricultural production from past three-years average and the outbreak of famine, for each country every year. Twenty-one countries that experienced famine since 1961 were investigated. By dividing the study period into two equally long terms (1964-1987 and 1988-2011), we can see that famine took place mostly in a year of production decrease in the first period (14 out of 16 cases, 88%), which became only one third in the latter period (6 out of 18 cases, 33%). The average of production increase ratio in famine years grew from 0.88 (significantly smaller than 1.0 ($p<0.05$)) to 1.05 (not significantly greater than 1.0 ($p>0.05$)). Production decrease is not sufficient to explain today's famine.

Examining supply (Fig.7.(b))and import (Fig.7.(c)) would help the understanding of this phenomenon. Fig.7.(b) indicates that cereal supply remains stable even if the production fluctuates. This can be explained by the changes in balance of import, stock and food aid. While per capita cereal imports consistently increasing in the targeted countries (green solid line) since 1960s, it is mostly decreasing when famines occurred (famine outbreak, yellow x). Since imported food is distributed following the market principle, different from locally produced food for subsistence, it is likely that economically disadvantaged people or people in geographically disadvantaged regions are subject to hunger even if the food is sufficient in country scale. Lipton (1977) describes this situation by the word “urban bias” and argued that the food distribution is biased in favor of the interests of urban elites, therefore discriminating against the interests of the

rural poor. Clay (1985) explained the bias toward city by the degree of “integration” of the market:

The paradox of hunger without severe loss of production depends on the level of aggregation. If Bangladesh is regarded as a fully integrated production system with smooth inter-district flows of commodities, then there is no production problem. But to the extent that there are frictions and difficulties in moving commodities between districts, regionalized losses of production can have severe effects on food prices, intensifying the effects of loss of production, income and employment. (Clay 1985, p203)

From those arguments, we can assume that famine in a year of production increase is a result of localized scarcity of food generated by biased or unreasonable distribution of food within a country.

In order to verify this argument, I focused on the case of Sudan and examined the relationship between production, import, and supply of the cereals (kg per capita, Fig.8). Sudan has experienced four large-scale famines since 1961: all of them occurred within one year after drought. However, only one of the famines took place under the condition of production decrease (1984). Other three famines broke out even though production, as well as import, was increasing. Interpretations of famine learned through literature studies are summarized in Table.3.

In all of the four famines, not only the production factors but also the distribution factors were studied. When considering why the distribution system did not function in that specific year at specific region, it is worthy to note that the state of war existed in all three famines that took place in a year of production increase (1988, 1998 and 2003). In case of the famine in 1988, cereal production was about two times larger than the year before despite drought and war, and

cereal import remained the same level. Although the total supply to the people did not decrease, nor slightly increased, southern provinces suffered from food shortage due to the distribution failure caused by rebels. In contrast, there are some cases where drought brought about a severe production decrease but did not lead to a breakout of famine (e.g. 1965, 1987, and 2008). Sudan experienced 14 droughts between 1961-2012, but ten of them did not result in famine.

As a whole, famine can be prevented even if the production was decreased by drought, while it can occur without production decrease. It is necessary to consider the ability and the willingness of the national authority to allocate food to the needy regions. A state of war is a possible factor that causes malfunction of food distribution system and isolate a region from food supply.

2.3 Summary of Chapter2

Famine has been changing its characteristics over a century, both in geography and in scale. The turning point was between 1950s and 1960s, when most of the European and Asian countries became free of famine and the scale of a famine event decreased. This is relevant to the changes of the social situation. 1950s/1960s were the time when worldwide agricultural production showed great increase as a result of the green revolution. The problems of absolute scarcity of food were resolved in many parts of the world, and now the problem of distribution became apparent. As people in city have stronger purchase power as well as voice in politics, food distribution is likely to favor urban area than rural region when the distribution balance of food was changed.

Among various factors, the most dominant triggering factors are drought and wars. Market factors as well as political factors contribute to large number of famines.

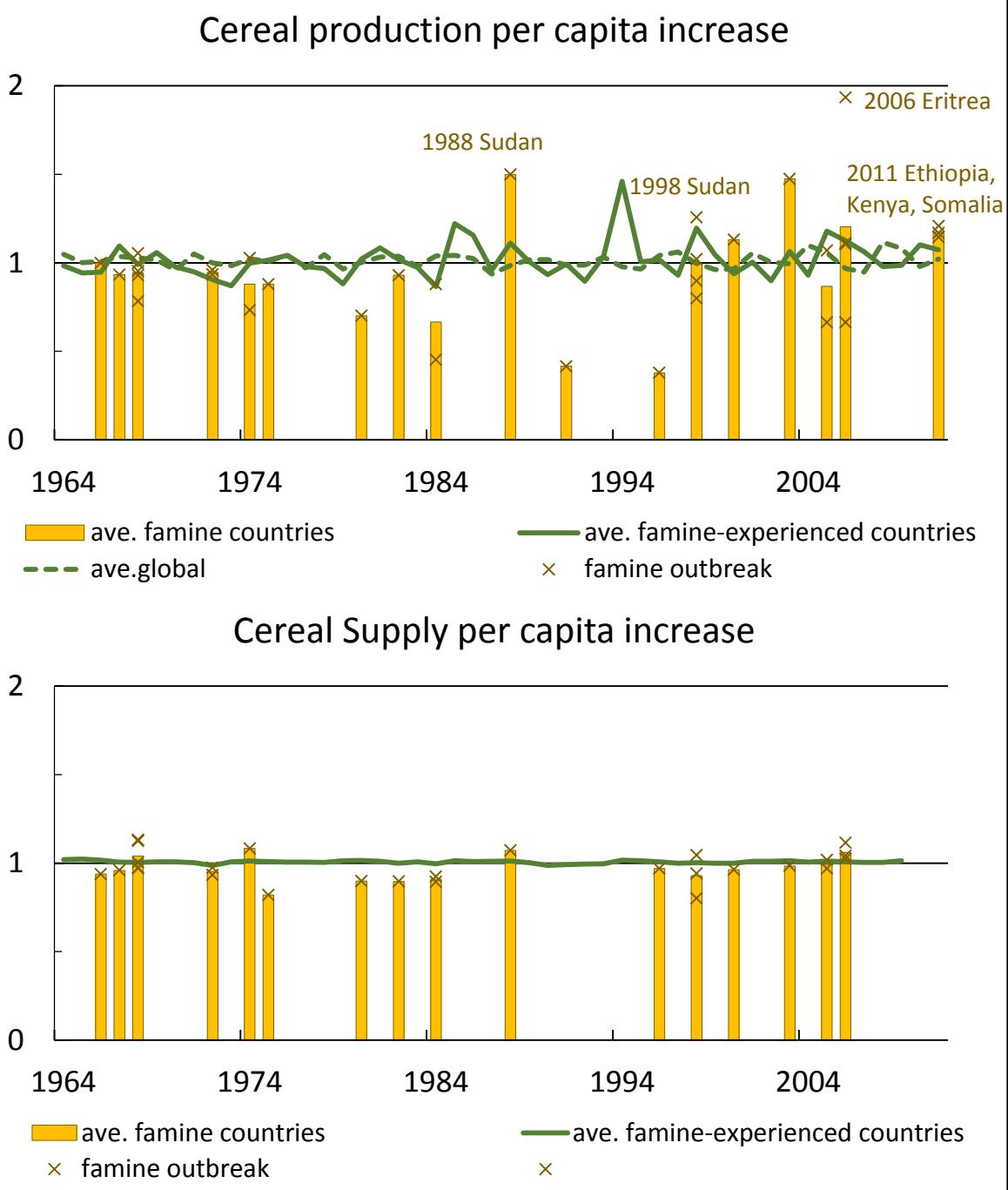
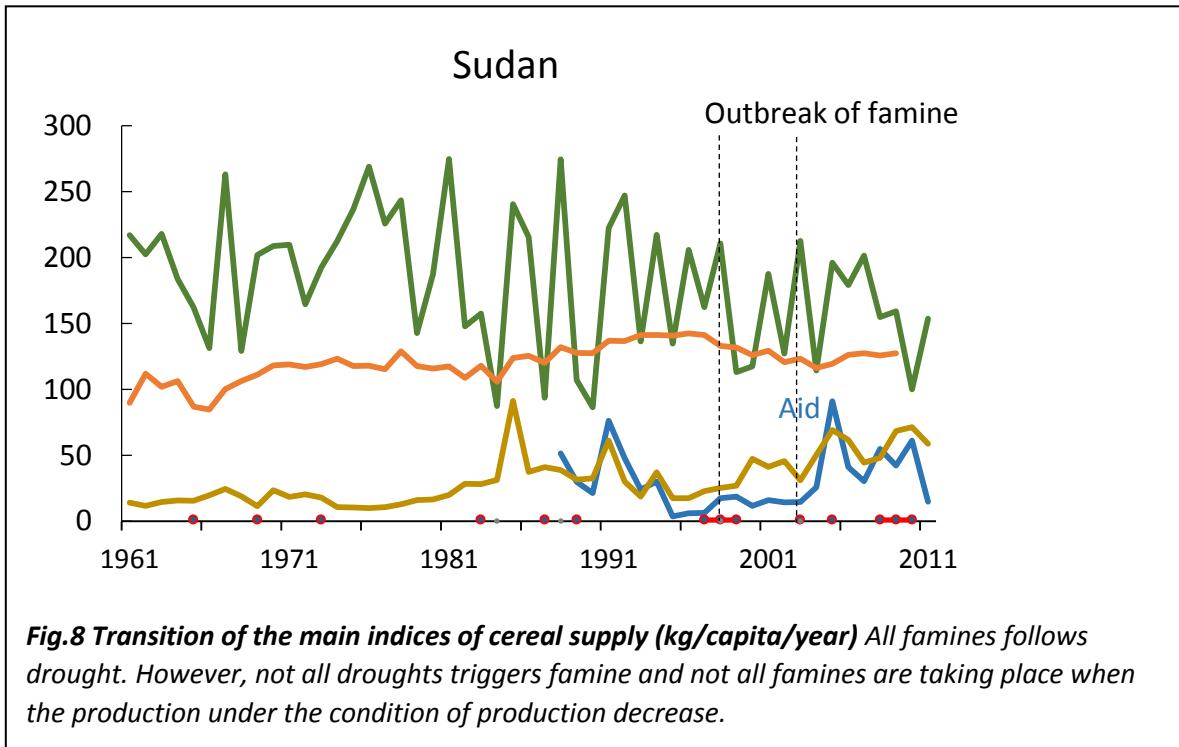


Fig.7 Relation between occurrence of famine and increase (or decrease) of the per capita



2



	Production increase (%)	Pre-famine condition	Shock	Response
1984	-55%	*Most of the people rely on farming and off-farm income including livestock.	*Drought caused the failure of harvest in Darfur and loss of pasture.	*Many national and international aid agencies shipped food. *" Problem of distribution which reflects the purchasing power of different social groups in the struggle over available resources (Tony Barnett)"
1988	50%	*Displacement by the war . People in refugee camps depend on infrequent food distribution.	*Drought *Fighting has disrupted agricultural cycles	*Rebels mine roads and prevent food aid to reach the affected region (southern provinces).
1998	26%	*Decades of civil wars between southern and northern Sudan created a vulnerable condition.	*Internal and border insecurity, drought and huge influx of returnees from the north made up a famine condition.	
2003	47%	*2 million people have been displaced by war *The conflict caused problems with trade and markets *Ethnic tensions among tribes		*The rapid expansion of emergency food aid provision in Southern Sudan did decrease resources in other regions of the country , including Darfur. *USAID/OFDA provided five grantees implementing agriculture and food security interventions, including seed and tool voucher programs (FY2010)

Table.3 Four famines in Sudan since 1960s

Production increase is a comparison to the previous three-year average in quantity.

Bold letters are about food distribution within a country and **red letters** shows war and conflict.

3. Development of famine vulnerability assessment method

3.1 Hypothesis of famine vulnerability structure

It is understood from Chapter 2 that most famines are triggered by drought and/or war. As for the famines since 1960s, all famines are related to either or both of those triggering factors (Fig.9). Due to the lack of objective and scientific future projection data of wars and conflicts, I limit the scope of this study to drought-induced famine, which can be estimated by the future projection of climate status. Based on the knowledge from Chapter 2, following vulnerability structure was assumed to estimate the vulnerability to famine (Fig.10). Famine vulnerability consists of two layers: food supply potential and distribution system within a country. The first step for food security is to assure sufficient food to feed the whole population. This can be achieved by stable food production and/or food import. If a country fails to meet sufficient food supply by the combination of unstable production and insufficient import, then distribution within a country becomes an issue. The absolute quantity of food production will not be an issue here, since famine is not a chronic status established on permanent insufficient food supply. If the production is consistently low, the country would then either import more food or learn to survive with a small quantity of food.

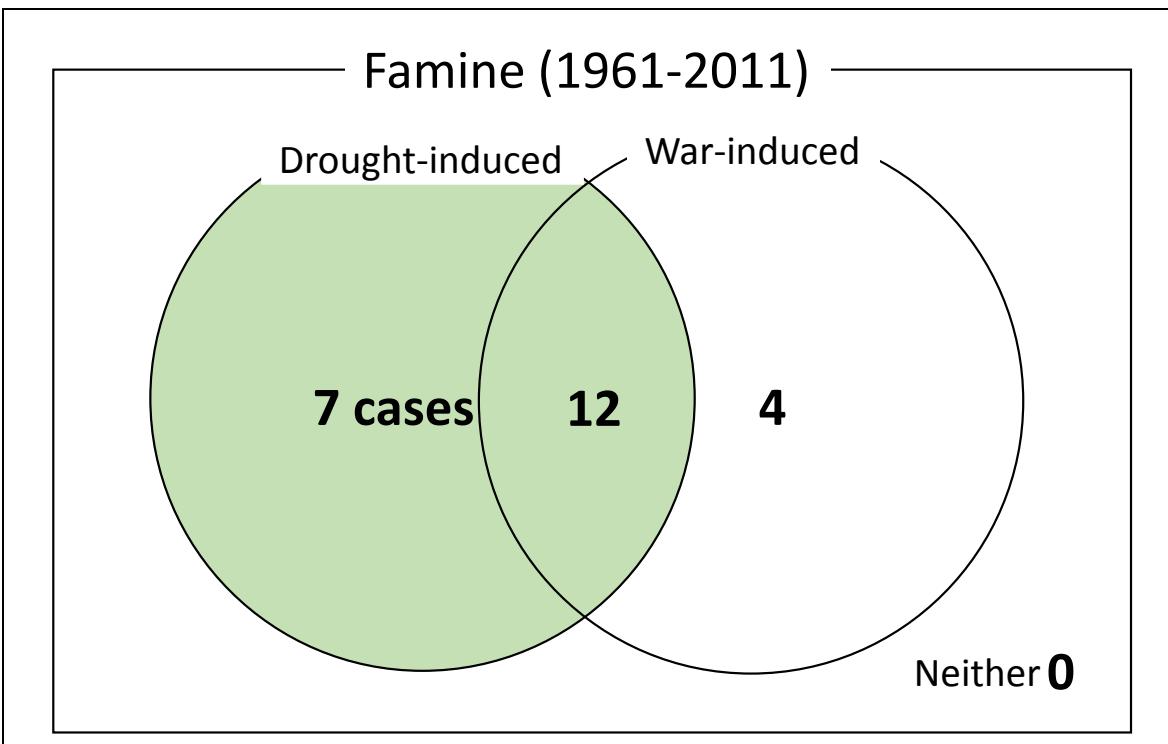


Fig.9 Scope of study

All famines that are relevant to drought were taken into consideration.

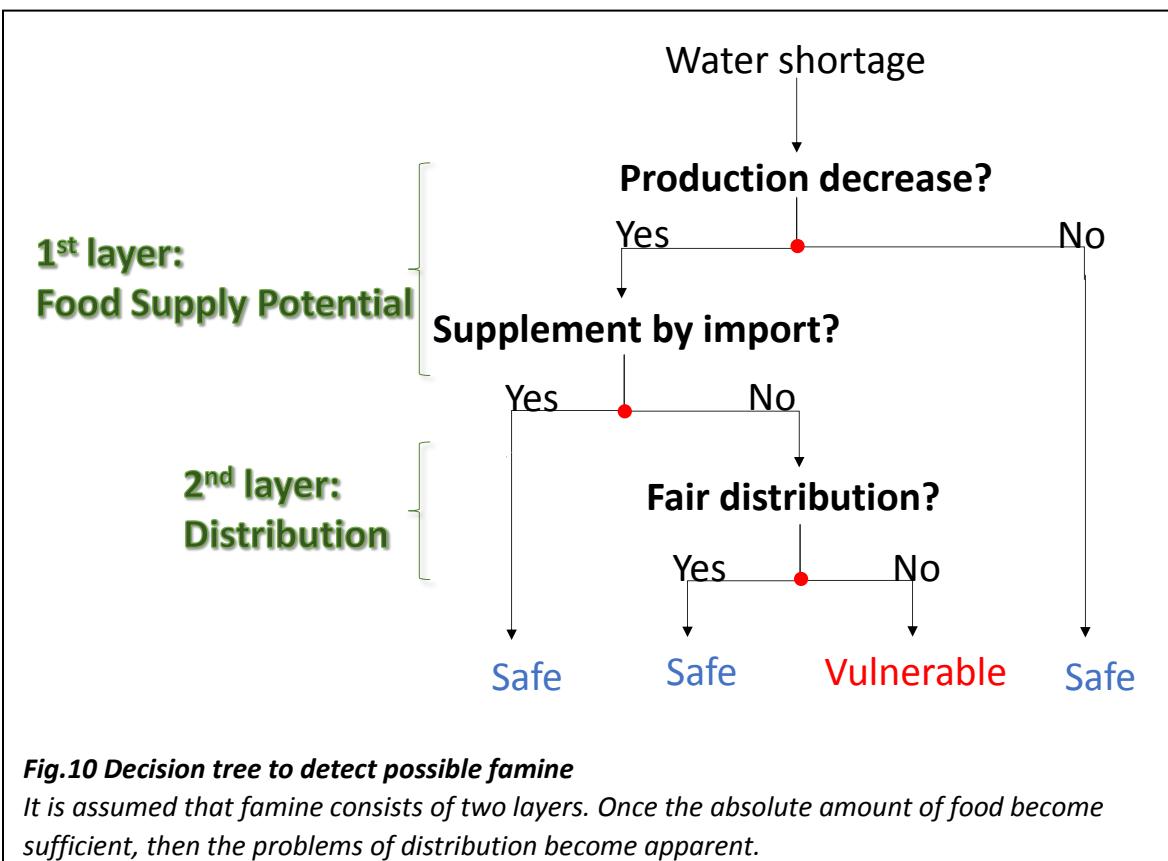
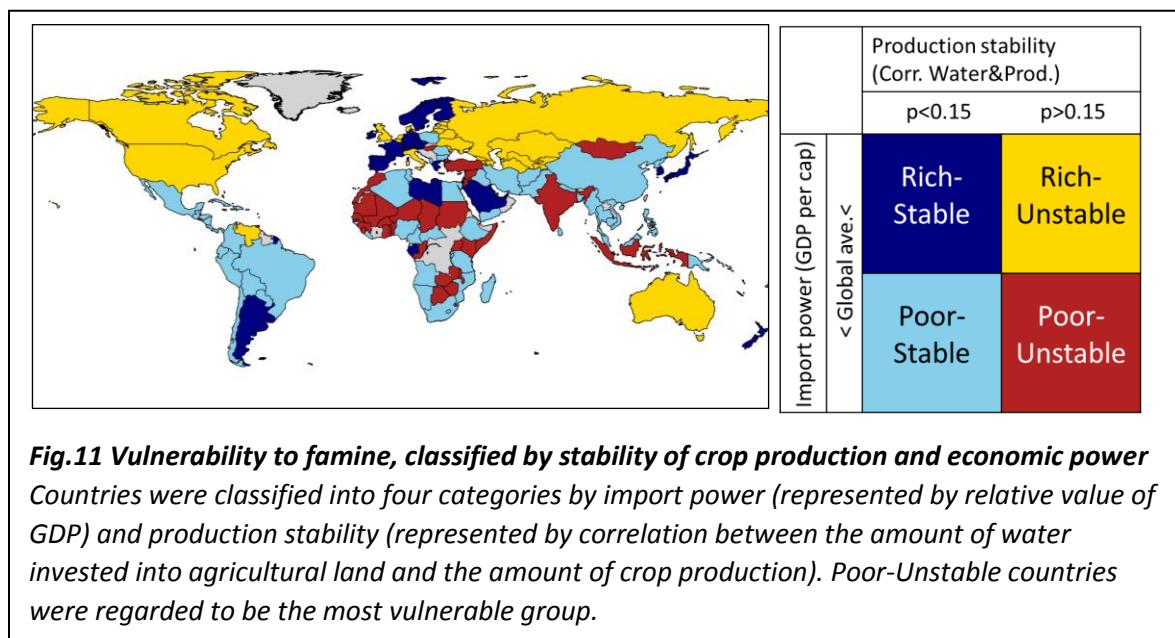


Fig.10 Decision tree to detect possible famine

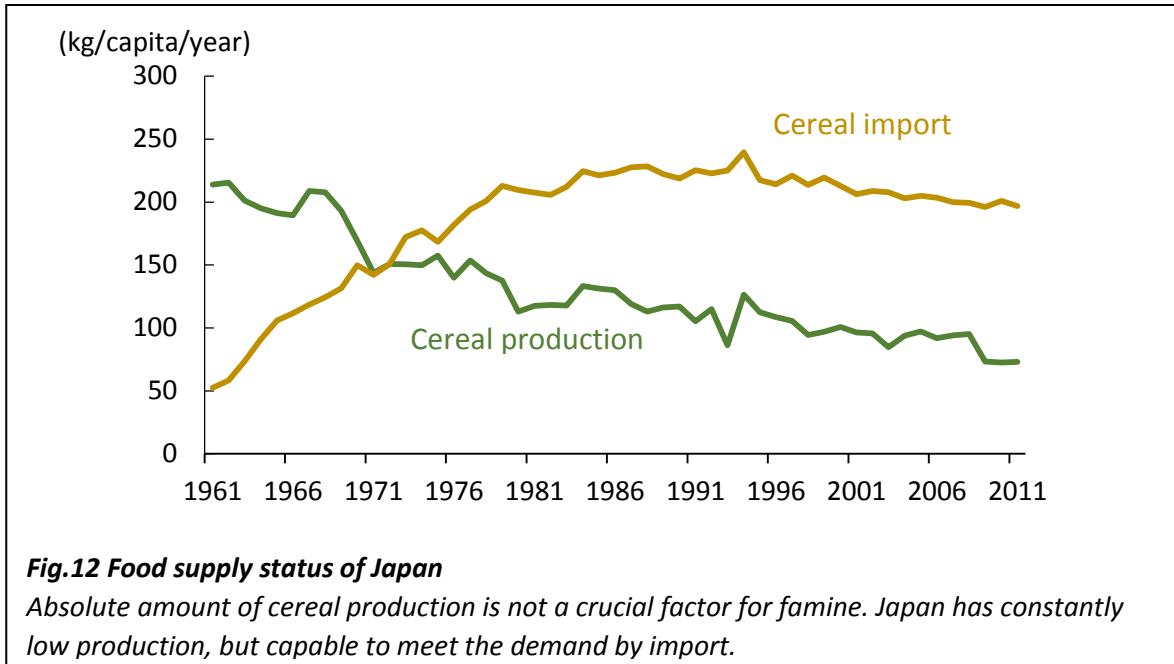
It is assumed that famine consists of two layers. Once the absolute amount of food become sufficient, then the problems of distribution become apparent.

3.1.1 Assessment of food supply sufficiency

Occurrence of famine was compared with the vulnerability of food supply evaluated by the sensitivity of crop production to amount of water used for agriculture (production stability) and GDP per capita (import power) (Fig.11). Countries were divided into four groups according to those two indices and countries that have neither stable crop production nor economic power to supplement production deficiency were assumed to be the most vulnerable to famine (Poor-Variable). Details of the classification is described in Appendix 1.



Here the absolute amount of cereal production was not considered. If a country's cereal

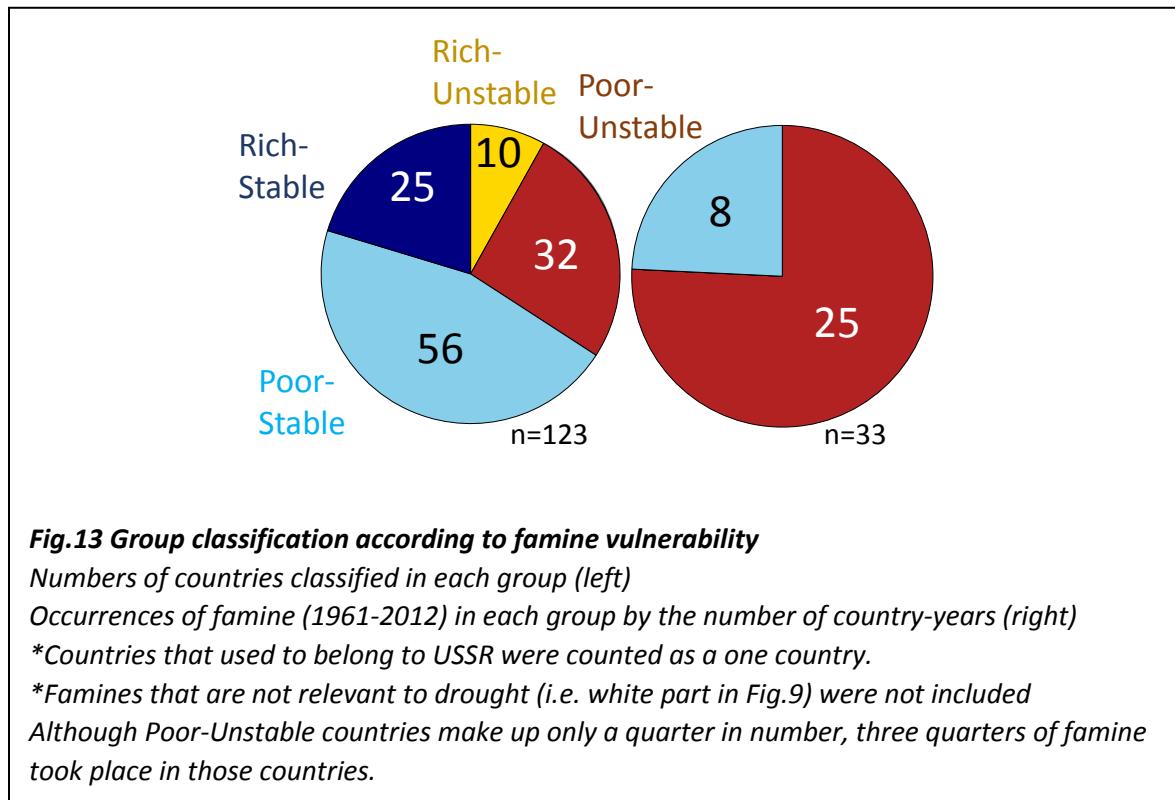


production is consistently low, the country could be in a status of chronic malnutrition, but not necessarily fall into famine if the country has either stable production, sufficient import power, or the capability to efficiently distribute food. Japan is a good example of having low production but in a status of food security due to a strong import power (Fig.12).

Due to the availability of data, only famines since 1961 were considered for the analysis of this section. Comparing the occurrence of famine since 1961⁵ (Fig.4 right) and the vulnerability of food supply in each country, we can see a clear similarity between two maps especially in African continent. Fig.13 shows that as much as two thirds of all famines occurred in Poor-Unstable countries, although the group makes up only a quarter of all countries. Another one third of famine occurred in Poor-Stable countries which have lower ability to import food although the production is relatively stable. Not a single famine

⁵ Since the classification is based on the data of 1961-1990, it is reasonable to compare with the famine since 1961.

occurred in Rich-Stable and Rich-Unstable countries that have economic power to import food. It is reasonable to say that economic power and stability of production accounts for the large portion of famine.



3.1.2 Consideration of distribution factors

Next, distribution factor was taken into account to explain what differentiates the countries that suffer from famine and those that do not within a same group defined by production stability and import power. (*i.e.* within Poor-Stable and Poor-Unstable). As the countries in the same group are considered to be in the similar status of acquiring food as a country, it is distribution or allocation within the country that makes difference. As we have learned from the literature study (2.2.1), the top three factors concerning food distribution are government reaction,

imperfect/fragmented market and political regime. (Fig.3). (Drought and war are related more to production than distribution). These three parameters were selected as the representations of each of the three factors and were applied to Poor-Stable and Poor-Unstable countries. Selected parameters and their explanations are summarized in the following table (Table.4).

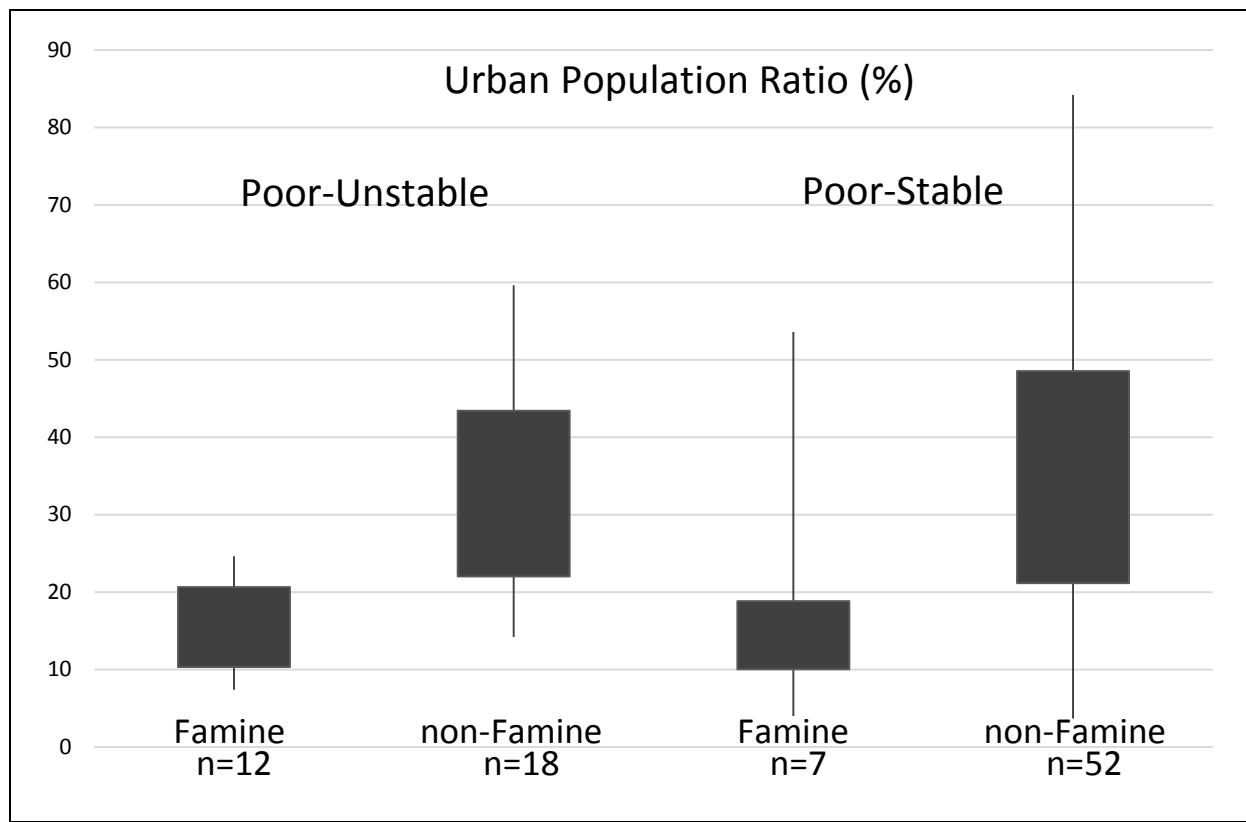
Countries in Poor-Stable and Poor-Unstable groups were divided into two sub-groups, those countries that have experienced at least one famine in study period (1961-2012) and those have not. The differences between Poor-Unstable and Poor-Stable countries were also examined to know whether the production stability matters for the distribution factors. Three parameters were compared between groups and sub-groups by using box plot. The box plot is useful in analyzing small datasets where histograms are not suitable. A box extends from the 25th percentile to the 75th percentile.

Fig.14 shows how the values are different between the countries that have experienced famine and that have not, as well as depending on the differences in production stability (Poor-Unstable and Poor-Stable). In all three parameters, famine-experienced countries show lower values than non-experienced countries. No significant differences were observed between production stability. The result of t-test shows that the average of urban population rate is significantly lower in famine-experienced countries than non-experienced countries by statistically significant level of 5%, two-sided test. Similar tendency was observed in Voice and Accountability (VA) and Government Effectiveness (GE), but neither of them was statistically significant. When the urban population rate is compared with malnutrition rate, negative correlation was observed (Fig.15). Although famine as an event is not a simple extension of chronic status of malnutrition, we could say it is reasonable to use urban population rate to discuss unreasonable and unequal distribution of food within a country.

As a result of the examinations above, urban population rate was selected as the parameter to represent how well the country can distribute food within a country, and incorporated into the vulnerability assessment method.

Selected parameter	Relevant factor	Explanation	Data description
Urban population rate	Imperfect or fragmented market	Generally speaking, famine occur not in the city, but in the rural or remote region. In times of famine, town-dwellers can still get some food while country people starve to death. This is explained by the existence of political power in the towns (Spitz 1978) or by the integration to market system (Clay 1985) as well as connection by transport networks (Dando 1980). The more people concentrate in city, the less the risk of famine in rural region will be.	The World Bank, 1961-2012
Voice and Accountability (VA)	Political regime	Participation of the citizens for the selection of the government, freedom of expression, freedom of association, and a free media. Those are some of the examples to measure VA, and quite the same as the elements of democracy suggested by Sen (1987).	The World Bank, 1996-2012
Government Effectiveness (GE)	Government reaction	The quality of the civil service and the degree of its independence from political pressures, and the quality of policy formulation and implementation. Those elements of GE could well describe the government capacity to execute effective and efficient food polity and food-related action to distribute food, when it is in short.	The World Bank, 1996-2012

Table.4 Three possible parameters to consider distribution factors of famine
According to the literature-based analysis of past famine cases, above three factors were selected as the most influential factors concerning distribution within a country.



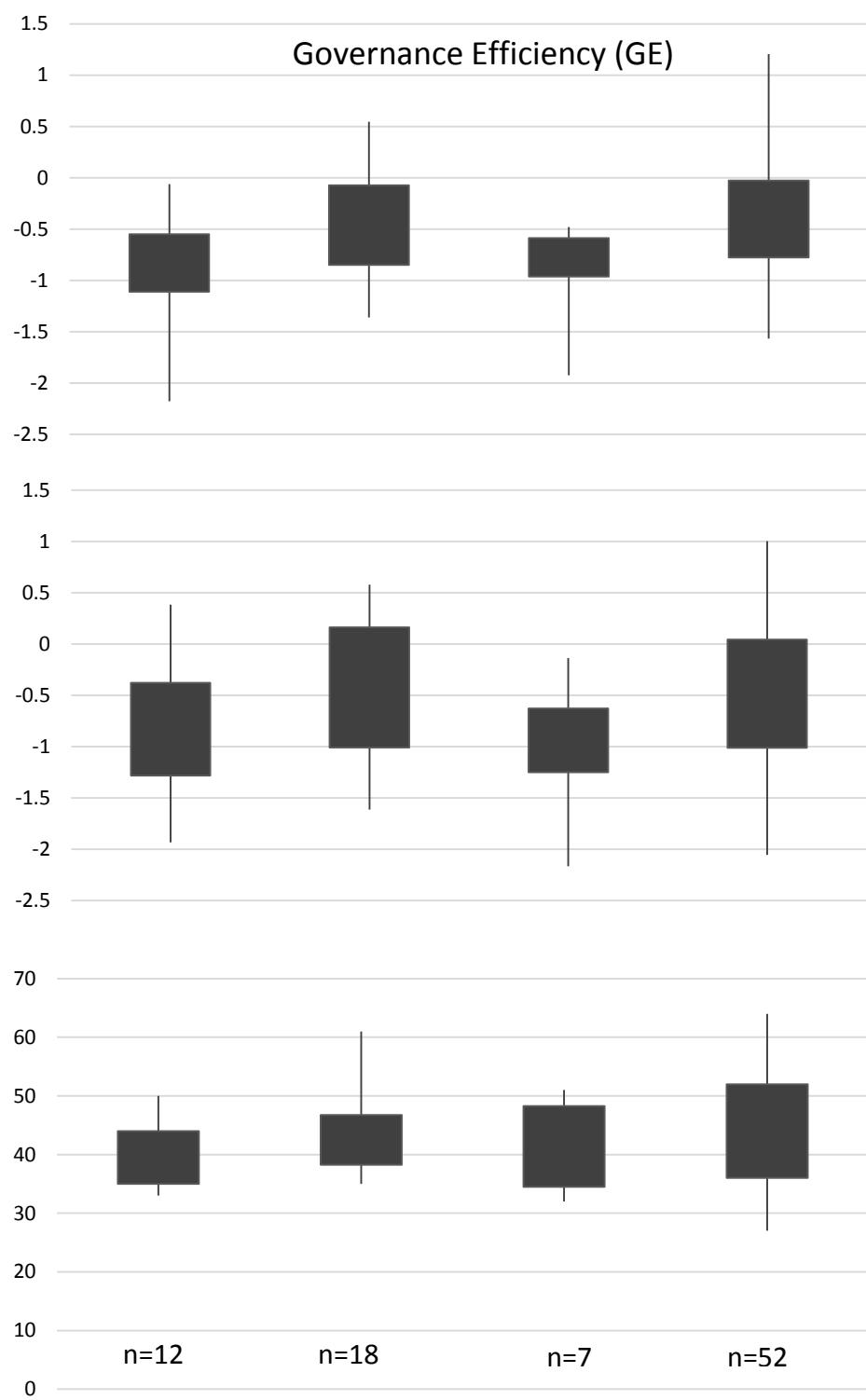


Fig.14 Indices for food distribution efficiency within a country in each group

Poor-Unstable countries showed lower values than Poor-Stable countries, and famine-experienced countries showed lower values than non-experienced countries in general. Urban population ratio showed statistically significant differences.

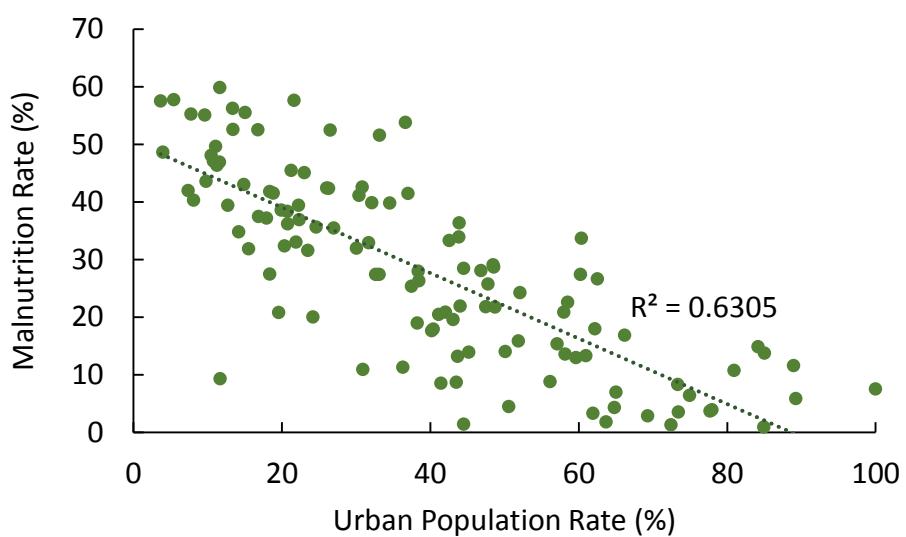


Fig. 15 Relationship between urban population rate (average of 1961-2011) and Malnutrition prevalence (height for age, average of 1961-2011, FAO)

Malnutrition rate is low in the societies where urban population rate is high. Societies with high urban population rate have more efficient distribution system (market integration). The definition of "urban" differs from country to country, but mostly based on agglomeration and certain size of localities (UN).

Parameter	Data Source	Time Period	Meaning
Agricultural Water Input (AWI)	(H08 output)	1961-1990	Correlation between those two parameters represents the production stability according to the changes in available water.
Agricultural Production (Cereals, Roots and Tubers)	FAO STAT	1961-2011	
GDP per capita (nominal, current USD)	The World Bank	1961-2011	This represents the purchase power of the country in global market.
Urban Population Rate	United Nations	1961-2011	How well the country can distribute food within a country and deliver it to the very needed region.

Table 5. Description of parameters for famine vulnerability assessment model

3.2 Assessment of famine vulnerability

3.2.1 Parameter settings

Specification of each parameter and its data source is summarized in Table 5. Threshold value was explored and defined as following.

Correlation between agricultural water input and the amount of production:

Since agricultural production is determined by temperature, water, soil and several other factors, it is rare to see strong relationship between solely water and production. The value of $p=0.15$ was empirically set as a threshold. While this may be deemed an unusually relaxed criteria in the field of natural science, it is still not so unreasonable considering only 20 percent of the global food production can be predicted by climate-induced variables (temperature and soil moisture)(Iizumi et al. 2013).

$$\begin{cases} p < 0.15 & \text{Stable production} \\ p > 0.15 & \text{Production decreases in case of water shortage} \end{cases}$$

GDP per capita:

Economic power in this study pertains to the capability to import food when the production is insufficient or below expectation. In such cases, relative purchasing power within the international market system is an issue, rather than absolute richness of a country. In order to focus on the relative purchasing power of a country under the competition in the market system, global average of GDP per capita was set as a threshold value for each year. Global average of

GDP per capita was defined as total GDP (nominal) of the world divided by the total population of the world. This is different from the average of GDP per capita of all countries, since it takes into account of differences in the size of population.

$$\begin{cases} \text{GDP (Ave. 1961-2011)} > \text{Global ave. Production deficit } \textit{can} \text{ be supplemented by import} \\ \text{GDP (Ave. 1961-2011)} < \text{Global ave. } \textit{cannot} \text{ be supplemented by import} \end{cases}$$

Urban population rate:

Threshold value for urban population rate was set as 30% through examinations. This threshold value does not change over the time since the value represent the spatial distribution of people and resources that accounts for the decision making of a country on how to distribute food. Further studies are needed to decide better criteria.

3.2.2 Evaluation method

The result of famine vulnerability assessment was compared by the actual occurrences of famine during 1961-2011 to see how well the assessment method represented the actual famine. It is true that a famine may not occur even if a country is vulnerable, if there is no triggering event. It is assumed that there should be at least one event of drought within fifty years. If the country has a vulnerable condition but did not experience even one drought, then the country is assumed to have less risk of famine since risk is a multiplication of hazard and vulnerability (*cf.* PAR Model).

Threat Score (TS) was used to evaluate the performance of the assessment method (Fig.16). TS is useful to deal with the rare event where the value of d is extremely large. In such cases,

		Event forecast	
		Yes	No
Event observed	Yes	A (hits)	b (misses)
	No	C (false alarms)	d

$$\text{Threat Score (TS)} = a/(a+b+c)$$

$$\text{Accuracy} = (a+d)/(a+b+c+d)$$

Fig.16 Calculation of Threat Score

In this case, threat score is more suitable than accuracy to evaluate the performance of the assessment model, since famine is a rare event.

accuracy will be automatically high and thus would be less meaningful.

3.2.3 Results of the detection of possible famine

Fig.17 shows the evaluation result of the assessment method. TS was 63%. For the purpose of this study, to identify the famine vulnerable countries, misses are far more critical than false alarms. Two countries that were missed by this estimation are Ethiopia and Mozambique. Both those countries are below the criteria for GDP per capita and urban population rate, but only the susceptibility to water shortage was not detected. Another common point between the famines in those two countries is the strong contribution of wars toward the outbreak of famine. In both countries, food distribution system collapsed and a part of the country was cut off to fall into the

status of famine (e.g. famines in 1982 Mozambique and 1984 Ethiopia). In case of 1984 Ethiopia, aid was delivered from international community but did not reach to the affected population since the government had only a limited access to the region (Braun 1998). This phenomenon agree with the notion of Lefwich and Harvie (1986) that war may badly disrupt normal economic and disruptive activities as well as agricultural production. It can be understood that it is by destroying the normal status of food distribution system that war causes famine. Although we limited the target of the study to drought-induced famine, those famine that both drought and war count for were not excluded (Fig.9). Those famines that drought *is* related but war showed

1961-2011(whole)		Model	
		o	x
Actual	o	12	2
	x	5	104
GDP	0	Sum	123
Urban Pop.	30	Sum_est	17
Accuracy	94.3	Sum_fam	14
Threat Score	63.2		

Fig.17 Evaluation result of the model (Accuracy and Threat Score are shown in %)

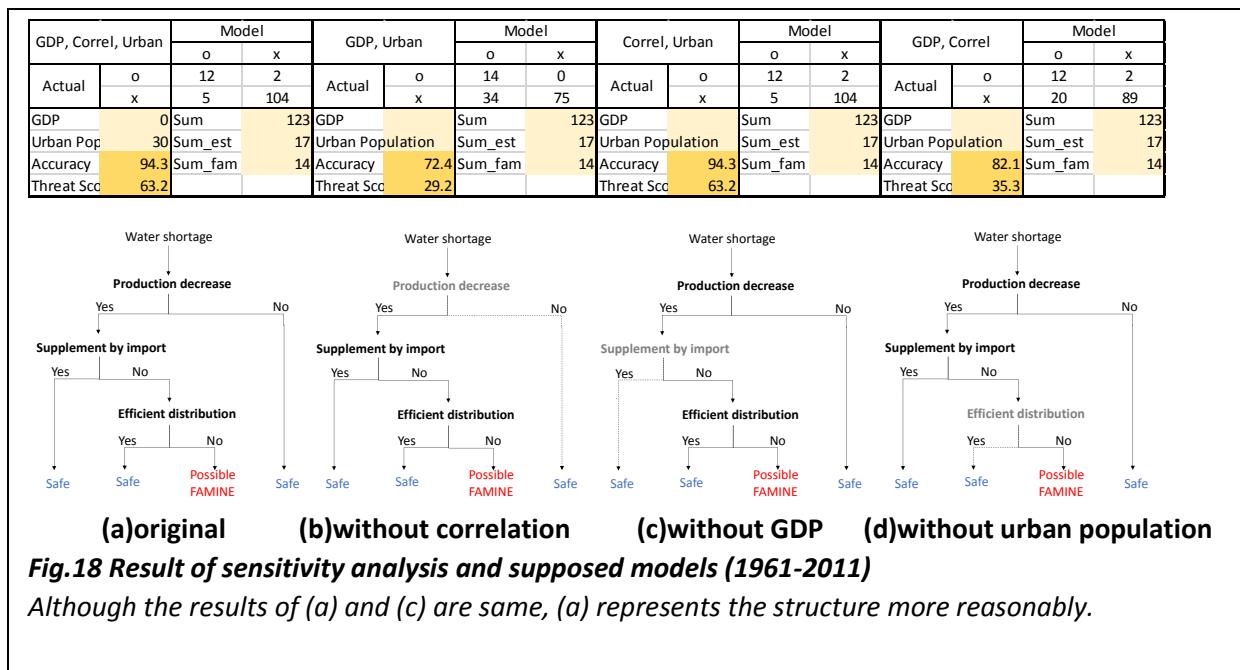
stronger contribution were missed by the assessment method and thus it can be concluded that war, that destroys distribution system within a country, was the main reason of misses.

3.2.4 Sensitivity analysis

In order to determine which of the three factors is the most influential, three variations of the assessment method were tested by reducing one parameter each (Fig.18). If the TS largely

decreased by reducing one parameter, that means the parameter has great contribution and interpretability to the assessment method.

The TS of the original assessment method is not smaller than that of any other method. This indicates that the selection of parameters were adequate. However, GDP per capita seems to have no effect on the results (Fig.18(a) and (c)). This is because there was no country that has high GDP level but low urban population rate during the study period. Therefore, the GDP factor is not functioning well at this stage. However, it is still reasonable to include this factor in two reasons. Firstly, food import is a crucial factor of food security and it is unreasonable not to



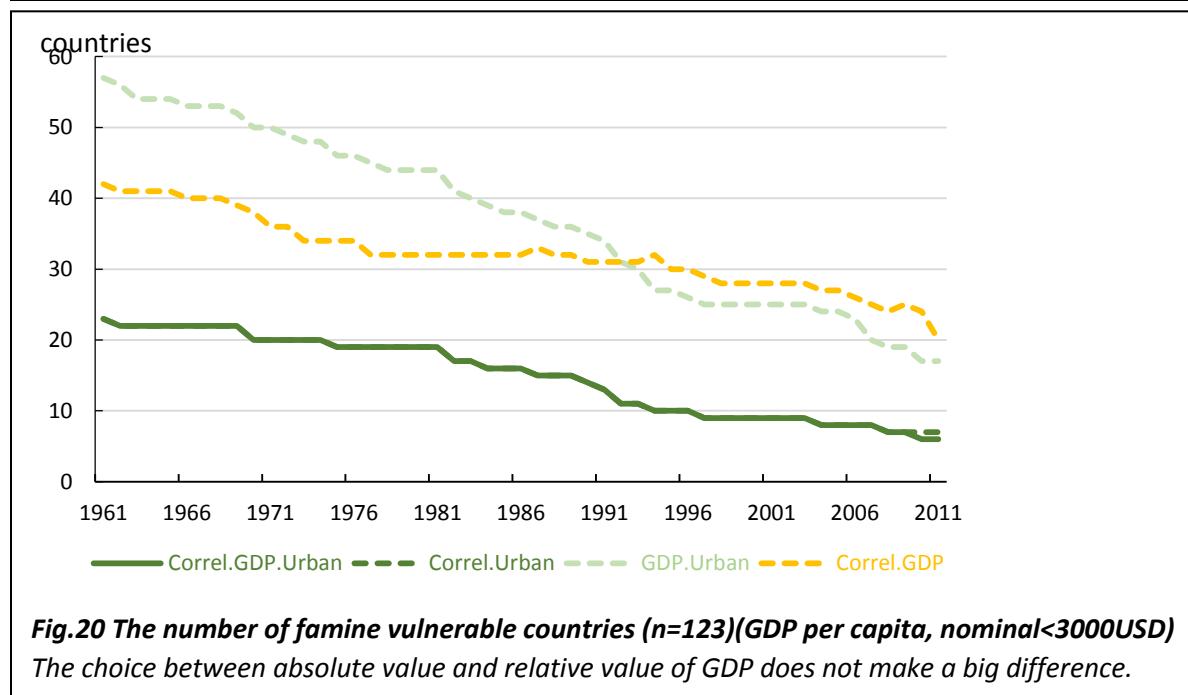
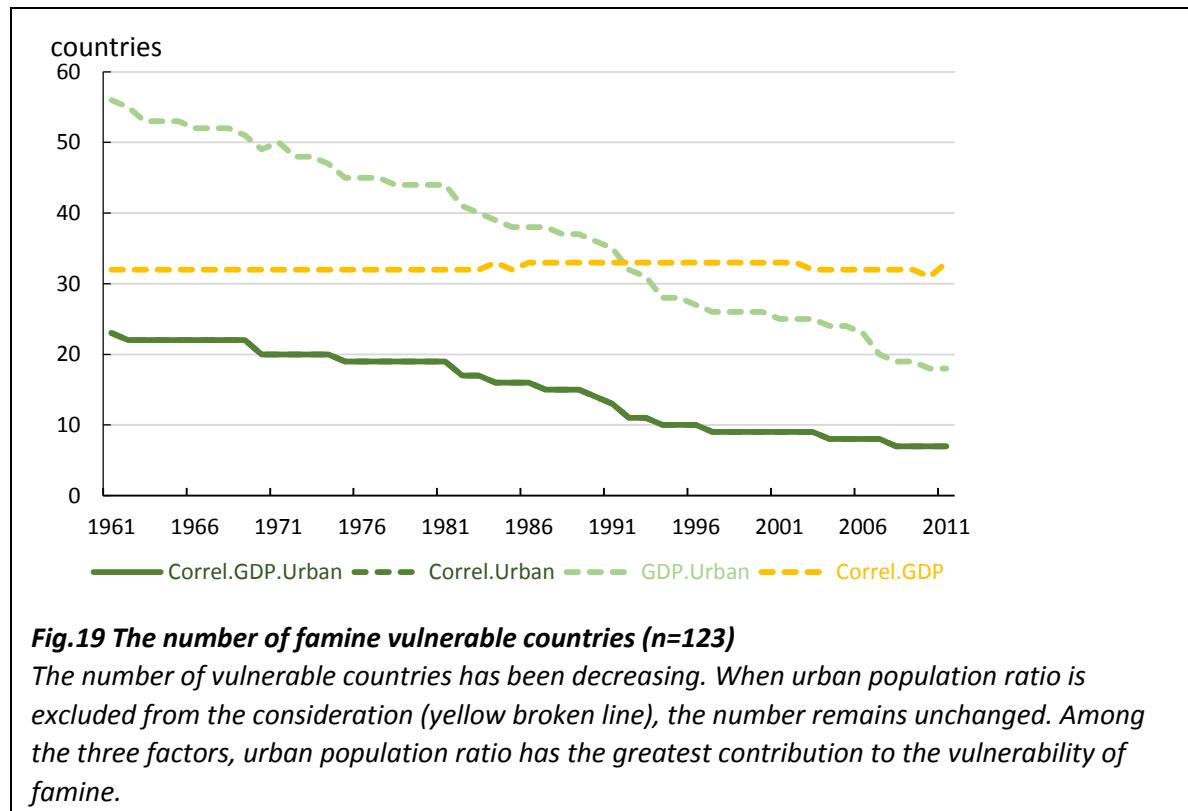
consider the economic factor. Even if the results are the same, method (c) lacks the principle. Secondly, there is a possibility that such country exist if we examine the data by year, not by the average of 50 years, or in the future. As for the other two factors, we can see the contribution of correlation (stands for production decrease) is the largest among the three (Fig.18(b)).

3.2.5 Chronology of famine vulnerability

In the former section, values of GDP per capita and urban population data were averaged by country over 50 years and vulnerability to famine was spatially compared. In this section, vulnerability to famine was assessed in each year to see the temporal changes in 50 years. Annual data was input to the same method and vulnerability was assessed by country in each year. Production stability (correlation between water and production) was set as constant due to its assessment method. The total number of vulnerable countries is shown in Fig.19 in solid line. It has decreased from 23 in 1961 to 7 in 2011. As the number has been continuously decreasing, the largest decrease was observed in 1980s. In order to know which factors are dominant in the vulnerability, sensitivity analysis was conducted in the same way as the former section. The differences between a broken line and a solid line are explained by the factor that are excluded from the broken line. The vulnerability assesses by GDP per capita and correlation (yellow broken line) has not been changing at all. This is because the relative economic power in the global economy remains at the same level even if the country shows economic development in itself. This argument makes sense when countries are having difficulties in taking the share of limited amount of food, and that is the typical case under famine condition. However, it is also true that the total amount of global supply has increased. As Sen (1984) argues that someone's entitlement to food can fall by both nominal and real income declines, it would be useful to take a look on the absolute value of GDP per capita besides relative value. Fig.20 shows the similar result as Fig.19, but the GDP per capita value was measured not by the comparison with the global average but by the absolute amount. $\text{GDP per capita} = 3,000\text{USD}$ (nominal) was set as a threshold value. Although the results in both method shows the same trend (solid line in Fig.19 and Fig.20), vulnerability assessed by GDP per capita and correlation appears differently (yellow

broke line). It is inferred that not only the relative value but also the absolute value of GDP accounts for the decrease of famine vulnerability. This is in consistent with the argument of

Devereux (1993) that the real value of income can be decreased by the changes in nominal as well as real purchasing power.



4. Future projection

Vulnerability to famine in future (from 2015 until 2050) was estimated using future projection statistic data and the famine vulnerability assessment method.

4.1 Input data

Estimation of population and urban population rate were obtained from the World Bank. Projection of GDP issued from the Price Waterhouse and Coopers consulting firm (PwC) was

Data	Data source	Period
GDP (nominal)	PwC	2015-2050
Population	The World Bank	2015-2050
Urban population rate	The World Bank	2015-2050

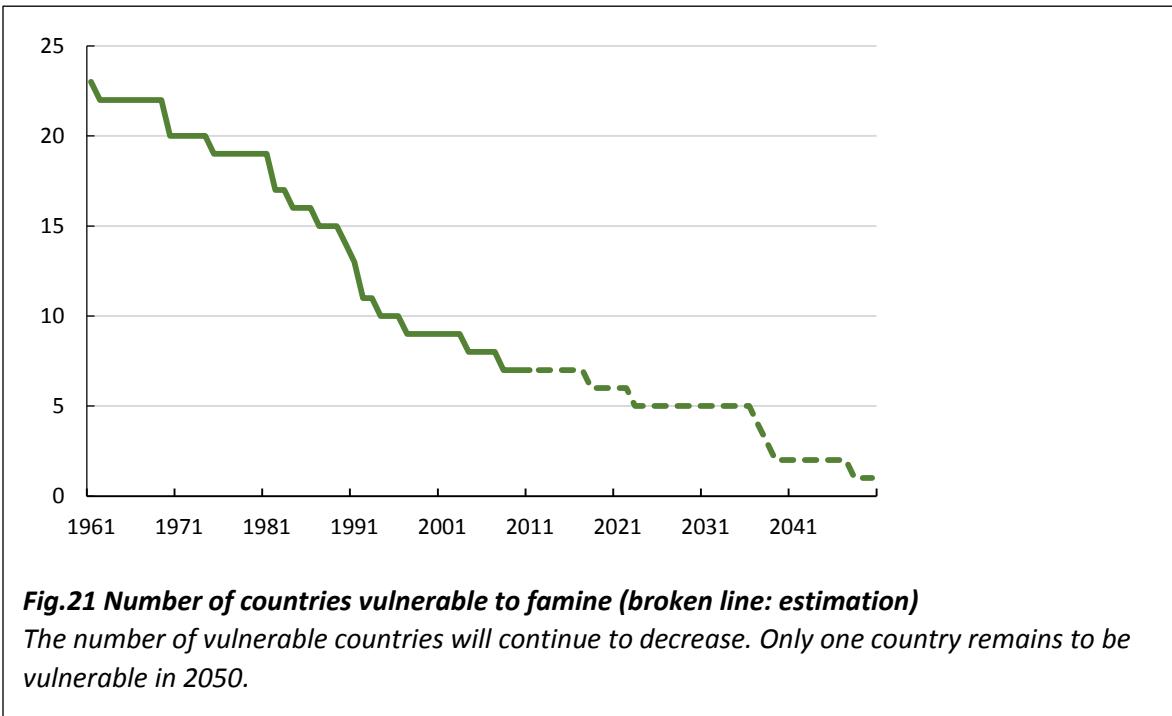
Table 6 Input data for future projection

used for this study because of its temporal and special coverage.

4.2 Application of famine vulnerability assessment method

Fig.21 shows the number of countries that are vulnerable to drought-induced famine. Data from 2015 onward is estimations. The number of vulnerable countries will continue to decrease and only one country remains to be vulnerable in 2050. The last country remains to be vulnerable to drought –induced famine is Swaziland.

As urban population rate has been increasing and will continue to increase globally, many of the countries are assessed to be getting out of the vulnerable status. However, urban population ratio is merely an indicator of distribution efficiency and increase of urban population itself



would not be a solution of famine.

5. Conclusion

In this research, a method was developed to assess the vulnerability to famine in each country.

Database of famine that summarizes multiple factors of famine was developed through literature study and past famines were analyzed from several different aspects. According to the database, drought and war have been the most common trigger of famine over a hundred years. Geographic changes as well as changes in scale of famine were observed, and the turning point was between 1950s and 1960s. This was the time when global crop production became sufficient to feed whole population but famine still persisted. Once the demand was satisfied, biased distribution towards urban area within a country became an apparent problem.

Based on the understanding acquired through the literature study, the decision tree method was proposed to assess the vulnerability to famine in each country. It is assumed that vulnerability to famine consists of two layers: food supply potential and distribution within a country. Production stability and import power was considered to assess food supply potential, and the distribution within a country was represented by the urban population ratio. Although it is widely acknowledged that famine is an outcome of a complex interaction of a multiple factors, this simple method explains great portion of drought-induced famine. Urban population ratio is the most influential among the three factors. The number of countries that are vulnerable to drought-induced famine has been decreasing and are likely to continue decreasing. It was assessed that 23 countries were vulnerable in 1961; this number decreased to 6 in 2011, and only one country will remains to be vulnerable to drought-induced famine in 2050.

However, war-related famine were often overlooked by the suggested method. This is because war-status destroys or malfunctions the normal status of food production or distribution system (Devereux 1993). Even if the criterion to avert famine were met, countries can still fall in to famine if a war status are present. Besides this limitation, reasonable and objective threshold value for three parameters are yet to be proposed. The improvement of criteria would advance the subjectivity and the quality of vulnerability assessment.

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FEWS <http://www.fews.net/>

Filler (2013) <http://joycefiler.wordpress.com/2013/01/16/famine-in-ancient-egypt-and-nubia-what-is-the-evidence/>

Appendix 1: Method of assessing the impact of water shortage to famine

Impacts of water shortage to famine were estimated by focusing on the correlation between water availability and food production. In order to know whether the production could be affected by the amount of water in the country, the amount of annual production of main crops (maize, rice, wheat, roots and tubers) was converted into kcal and its correlation with “Agricultural Water Input (AWI)” was calculated for each country. AWI is defined as “the total amount of the water applied into agricultural land in forms of precipitation and irrigation”. Agricultural production data was derived from FAOSTAT and AWI was calculated by global hydrological model H08 (Hanasaki 2010). Study period is 1961-1990. Since some countries show constant growth in production, their long-term trends were removed in order to focus on the interannual variation. Lag correlation was applied for the countries and crops that the harvest year lags behind the growing year. Significance level was set as 15%, and if there is a significant correlation between AWI and agricultural production, the food production of the country is regarded to be vulnerable to water shortage (Fig. A1). GDP per capita was adopted as an indicator of economic power to classify countries according to the ability to recover production deficit by food import. The threshold value was set as 10,000 USD per capita (PPP, 1981-1990 average). This is commonly used threshold value between developing countries and developed countries. Countries that have population larger than 10 million were taken into account for this study (155 countries). As a result, countries were divided into four groups (Fig. A2) and Poor-Variable countries are regarded to be the most vulnerable countries when water shortage happens.

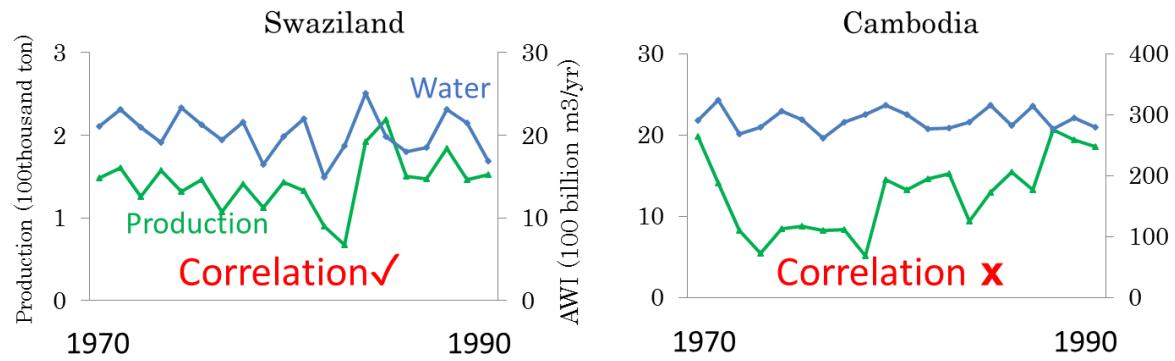


Fig.A1 Correlation between Agricultural Water Input and agricultural production

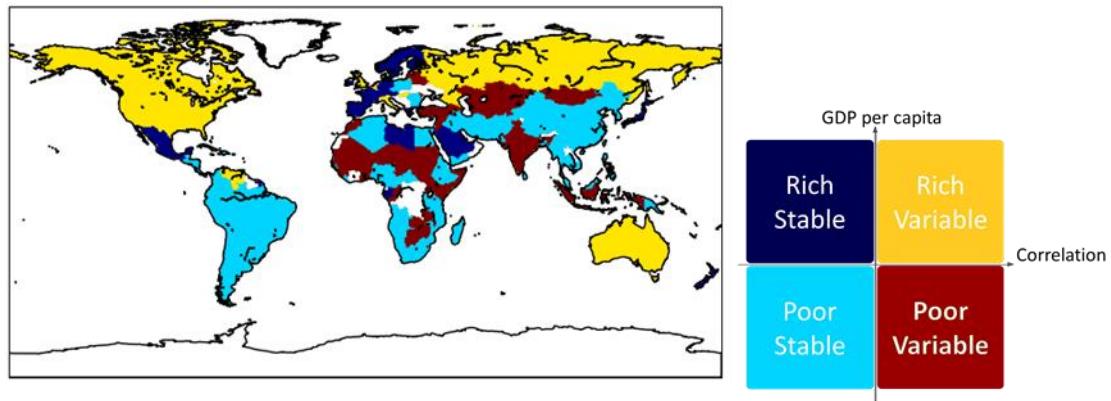


Fig.A2 Vulnerability to Water Shortage

Appendix 2-1: Famine Database (Contributing Factors)

				Environment			Food Market		War	Government		National Response	International Politics	
	Year	Name	Region	Drought	Flood	Other climatological factors	Price rise	Imperfect or fragmented market	War, Conflict and Civil conflict	Political regime	Government Reaction, Food Policy	Insufficient or delayed aid, lack of non-food aid	Embargo on food aid, Blockade	Others
1903	1903-1906	Nigeria	Nigeria											
1906	1906	Tanzania (south)	Tanzania					1		1		1		
1907	1907, 1911	Famines in east-central China	China				1				1			
1913	1913-14	West Africa (Sahel)	Nigeria, Ghana etc	1				1		1		1		
1914	1914-1918	Mount Lebanon famine during World War I	Lebanon						1	1		1		1
1916	1916-1917	Famine in Germany in WWI	Germany				1		1	1	1	1		
	1916-1917	Winter famine in Russia	Russia					1		1	1	1		
1917	1917-1919	Famine in Persia	Iran (present day)								1	1		
	1917-1919	Tanzania (central)	Tanzania	1						1		1		
1917-1921	A series of famines in Turkestan at the time of the	Turkestan (Kazakhstan today)		1						1	1	1		
1920	1920-21	China (Gansu, Shaanxi)	China											
1921	1921	Russian famine of 1921	Russia	1					1	1		1	1	
1922	1921-1922	Famine in Volga German colonies in Russia (=Tatarstan)	Russia	1					1	1	1			
1923														
1926														
1927	1927	North-west China	China	1					1	1		1		
1928	1928-1929	Famine in Rwanda-Burundi	Rwanda and Burundi (present)											

	1928–1930	Famine in northern China	China	1				1			1	1			
1929	1929	China, Hunan	China	1				1	1		1	1			
1932	1932–1933	Soviet famine (Atarlin's Forced Famine)	Ukraine								1				1
1936	1936		China												
1940	1940–1943	Famine in Warsaw Ghetto	Occupied Poland					1	1	1	1				
1941	1941–44	Leningrad famine	Russia					1	1	1					
	1941–1944	Famine in Greece	Greece					1		1	1	1			
1943	1943	China (Henan)	China	1				1		1	1	1			
	1943	Bengal famine of 1943	Bengal, India		1	1	1	1	1	1		1			
	1943	Famine in Ruanda-Urundi	Rwanda and Burundi (present)	1				1	1	1		1			
1944	1944	Dutch famine of 1944	Netherlands					1	1	1		1			
1945	1945	Vietnamese Famine of 1945	Vietnam	1			1	1	1			1			
	1947	Soviet Famine of 1947	Soviet Union	1				1	1		1	1			
1958	1958	Famine in Tigray	Ethiopia	1		1						1			
1959	1959–1961	The Great Chinese Famine	China					1	1		1	1			

1966	1966	Wag-Lasta (Wollo) famine	Ethiopia		1		1	1				1	1		1
1967	1967–1970	Biafran famine	Nigeria							1		1	1		
1968	1968–1972	Sahel drought	Mauritania Mali Chad Niger Burkina		1		1		1			1	1		
1972	1972	Maharashtra drought	India		1					1		1	1		
	1972–1973 1973–1975 another	Famine in Ethiopia (Wollo & Tigray)	Ethiopia		1		1		1			1	1		
1974	1974–75	Somalia	Somalia		1		1	1	1	1		1	1		
	1974	Bangladesh famine of 1974	Bangladesh			1		1	1	1		1	1		1
1975	1975–1979	Khmer Rouge	Cambodia				1		1	1		1	1		
1980	1980–1981	Karamoja	Uganda		1				1	1			1		1
1982	1982–85	Mozambique	Mozambique		1					1		1			
1984	1984–1985	Sudan (Darfur, Kordofan)	Sudan		1				1				1		
	1984–1985	1984–1985 famine in Ethiopia	Ethiopia		1		1		1	1		1	1		1
1988	1988	Sudan (South)	Sudan		1				1	1			1		1
1991	1991–1992	Famine in Somalia	Somalia		1					1			1		

1996	1996	North Korean famine	North Korea		1		1	1		1	1		1		1
1998	1998	1998 Sudan famine	Sudan	1		1	1	1	1						1
1998–2000	1998–2000	Famine in Ethiopia	Ethiopia	1		1	1	1	1				1	1	
1998–2004	1998–2004	Second Congo War	DRC Rwanda						1	1		1			
2000	2000–2007	Zimbabwe food crisis	Zimbabwe	1			1					1	1		1
2003	2003–	Darfur Conflict	Sudan	1						1		1			1
2005	2005(2001-02?)	Malawi food crisis	Malawi	1	1										1
2006	2006	Niger food crisis	Niger	1		1	1	1					1		
2011	2011–2012	Horn of Africa food crisis	Djibouti Eritrea Ethiopia Kenya Somalia	1						1					
2012	2012	Famine in Somalia	Somalia Ethiopia Kenya	1						1					
		Famine in West Africa	Senegal Gambia Niger Mauritania Mali Burkina	1											

Appendix 2-2: Famine Database (Documentations)

	Year	Name	Region	Death (range)	Pre-famine	Shock	Response
1903	1903-1906	Nigeria	Nigeria	5000			
1906	1906	Tanzania (south)	Tanzania	37500			
1907	1907, 1911	Famines in east-central China	China	25000000			
1913	1913-14	West Africa (Sahel)	Nigeria, Ghana etc	125000			
1914	1914–1918	Mount Lebanon famine during World War I	Lebanon	Killed about a third of the population			
1916	1916–1917	Famine in Germany in WWI	Germany				
1916	1916–1917	Winter famine in Russia	Russia				
1917	1917–1919	Famine in Persia	Iran (present day)	8,000,000-10,000,000			
1917-1919	1917-1919	Tanzania (central)	Tanzania	30000			
1917–1921	A series of famines in Turkestan at the time of the Bolshevik revolution (October Revolution)	Turkestan (Kazakhstan today)	killed about a sixth of the population				

1920	1920-21	China (Gansu, Shaanxi)	China	500000			
1921	1921	Russian famine of 1921	Russia	5000000			
1922	1921-1922	Famine in Volga German colonies in Russia (=Tatarstan)	Russia	5-9 million			
1923							
1926							
1927	1927	North-west China	China	6000000			
1928	1928-1929	Famine in Ruanda-Urundi	Rwanda and Burundi (present day)	300000			
	1928-1930	Famine in northern China	China	3000000			
1929	1929	China, Hunan	China	2000000			
1932	1932-1933	Soviet famine (Atarlin's Forced Famine) of Ukraine and North Caucasus area.	Ukraine	7,000,000-10,000,000			
1936	1936		China	5000000			
1940	1940-1943	Famine in Warsaw Ghetto	Occupied Poland	112000			
1941	1941-44	Leningrad famine	Russia	1000000			
	1941-1944	Famine in Greece	Greece	300000			
1943	1943	China (Henan)	China	5000000			

	1943	Bengal famine of 1943	Bengal, India	2,100,000-3,000,000			
	1943	Famine in Ruanda-Urundi	Rwanda and Burundi (present day)	300000			
1944	1944	Dutch famine of 1944	Netherlands	20000			
1945	1945	Vietnamese Famine of 1945	Vietnam	400,000-2,000,000	*Drought and insects reduced the spring 1944 rice crop by 19 percent compared to the previous year.		
1947	1947	Soviet Famine of 1947	Soviet Union	1,000,000-1,500,000			
1958	1958	Famine in Tigray	Ethiopia	100,000-397,000			*The government denied to accept relief.
1959	1959-1961	The Great Chinese Famine	China	15,000,000-43,000,000	*Production, distribution and consumption of food were entirely controlled by the central government.	*Fall in aggregate food production *High government procurement from rural areas *Government diverted resources from agriculture to industrialization.	*Government returned workers who had been recently moved to urban areas *Government abandoned many of the more extreme policies of collectivization.
1966	1966	Wag-Lasta (Wollo) famine	Ethiopia	45,000-60,000	*Chronic poverty *Those who died were those at the bottom of the social scale		*Government continued to collect taxes when people are already dying. *Government's leisurely reaction *Food which was brought in for sale was rot while the poor starved. *Resettlement
1967	1967-1970	Biafran famine	Nigeria	1000000	*Independence. Its boundaries had been defined quite arbitrarily. *Ethnic tensions broke out when the military took over.	*Civil war *The oil-rich eastern region of Biafra was surrounded by government troops, cut off and starving.	*The main cause of mortality was kwashiorkor (malnutrition). (cf. infectious diseases) *The first massive relief operation of Oxfam - Save the Children Fund alone was responsible for feeding nearly 1,500,000 people in Nigeria.

1968	1968–1972	Sahel drought	Mauritania Mali Chad Niger Burkina Faso	101000	*Specific policies, initiated during the colonial period and continued by independent governments, can be identified as reducing the ability of West African farmers and herders to exploit their environment with an adequate safety margin.	*West African Sahel drought	*UN Sahelian Office was created to address the problems of drought in the region (1973). *Extensive damage to livestock. 15–45% losses of cattle, sheep and goats. *Economic development was hindered by the losses of livestock. *Citizens were unable to take effective measures to protect themselves from 6-year-long drought. Approximately half the individuals in the Sahelian region took flight from their rural communities to more developed urban centers. Overcrowding became an immense problem (eg. malaria). *Government response was limited for financial reasons and others.
	1972	1972	Maharashtra drought	India	100000	*Widespread drought all over Maharashtra, even in the traditionally heavy rainfall talukas.	*Large scale Maharashtra-wide movement *The first "employment guarantee scheme" began in the country by workers' movement, but not enough work was created under this scheme to allow people to live. *Grain was not produced. Fodder was also not produced.
	1972–1973 1973–1975 another phase (preventing famine)	Famine in Ethiopia (Wollo & Tigray)	Ethiopia	200,000–500,000	*South Wollo is heavily populated and cultivated. *The land has been divided and subdivided due to population growth.	*Drought (but not FAD) *Harvest failure of 1973 was attributed to the loss of oxen and the shortage of seeds	*Insufficient capacity and facility of relief camps. *Foreign aid arrived after the peak of the starvation was over. *Mismatch of aid with real distress *Inability to move food sufficiently quickly into the affected areas, due to inadequate roads and bad transport. *Food was carried out of Wollo *Drastically reduced available workforce, which in turn affects the land. *Grain Deficit Study Committee had been set up and requested for supplementary food, though it was late and insufficient. *Government played down the severity of the situation and neglected the suffering
	1974	1974–75	Somalia	Somalia	20000	*Tension between Northern and Southern Somalis *Drought *Serious food shortage and sudden collapse of entitlements *The widespread crop failure and the subsequent food shortages in neighbouring Ethiopia contributed.	*Governmental policy. The nationalisation process and the introduction of price controls seriously disrupted food markets. *Shutting down of the major historic trade axis. *Failure of the food rationing system introduced by the government *Government forced over 100,000 nomads to be transferred from relief camps in the north to more arable lands of southern Somalia, pursuing its objective of settling and converting pastoralists to farmers.

	1974	Bangladesh famine of 1974	Bangladesh	1500000	*Independence war ravaged the economy *Seriously affected by the oil shock *Weak economy	*Price inflation, which started before the flooding, skyrocketed rice prices (black money from India, global food price rise). *Series of devastating floods. However floods and droughts are part of its agriculture. The problem was more on distribution than on production.	*Wealthy people hoarded rice *The new government's inability to import food from abroad. US placed a food embargo. *Hardly any flow of petro-dollar from Middle East while those countries did not recognize Bangladesh's application for UN membership. *The poor internal distribution system of aids. Government preferred to feed the urban middle classes and failed to reach the very poor. *"Market failure" famine
1975	1975–1979	Khmer Rouge	Cambodia	1,500,000-2,000,000	*Severe damage of the Vietnam war. 75% of its draft animals destroyed. *Khmer Rouge Regime. City dwellers were displaced to villages.	*Huge flood destroyed rice planting.	*The government stockpiled rice to trade with China, anticipating war with Vietnam. This escalated the food deficit. *Austere rationing *Strong reaction from diverse NGOs, not only food aids but also medical aids and supports for human rights.
1980	1980–1981	Karamoja	Uganda	30,000-50,000	*The poorest region of the country. Persistent poor harvest *Cattle rustling and insecurity *Poor governance and landlessness *Due to unreliable rainfall pattern, drought and hunger are a recurrent feature of life in Karamoja. *The widespread insecurity in Karamoja resulted in many family groups planting far less than in normal years. *Competition over scarce resources, particularly water and pasture. *Insecurity resulted in complete breakdown of trade and commerce, which is highly dependent on cattle. No grain from outside the region was brought in and people who still had money could not find little grain to buy at any price.	*Recurrent food shortages due to localized drought *Increased raiding between groups *General political turmoil	*Massive food relief were delivered by international organizations, but not before the enormous death. *Young men who began to go to school often did not finish and have become unemployed school leavers. These alienated youth are easily recruited into raiding and banditry. The raiding and banditry have taken their toll in human lives as well
1982	1982-85	Mozambique	Mozambique	100000	*The infrastructure and agricultural profile of the country remain profoundly influenced by its colonial heritage. *Destroyed infrastructure due to wars *Widespread use of monocultural crops (particularly cotton) reduced food security of the country and encouraged labor migration	*Very serious drought, possibly the most serious one of the century until then. *The drought was prolonged and intensified by El Niño *Famine was exacerbated by the conflict between the Frelimo government and the South African-backed Renamo.	*Because of the war, food aid could not be delivered to the affected populations. *South Africa and Renamo's disruption of famine relief.
1984	1984–1985	Sudan (Darfur, Kordofan)	Sudan	250000	*Most of the people rely on farming and off-farm income including livestock.	*Drought caused the failure of harvest in Darfur and loss of pasture.	*Many national and international aid agencies shipped food. *"Problem of distribution which reflects the purchasing power of different social groups in the struggle over available resources (Tony Barnett)"

	1984–1985	1984–1985 famine in Ethiopia	Ethiopia	1000000	*More than two decades of insurgency and civil war. *46% of GDP was allocated to military spending to quell insurrections. *People in south Shoa had less experiences of famine compared with people in Wollo.	*Drought *Governmental policies, specifically the set of counter-insurgency strategies *'Social-transformation' in non-insurgent areas	*Inability and unwillingness of the government to deal with the famine provoked universal condemnation by the international community. *The great majority of the aid was channelled through the government, which had only a limited access to the affected population. *Forced resettlement of peasants caused additional deaths. *Food Relief food was used as an "incentive" for the resettlement
1988	1988	Sudan (South)	Sudan	250000	*Displacement by the war. People in refugee camps depend on infrequent food distribution.	*Drought *Fighting has disrupted agricultural cycles	*Rebels mine roads and prevent food aid to reach the affected region (southern provinces).
1991	1991–1992	Famine in Somalia	Somalia	300000	*Collapse of the central government *In state of civil war for several years. *Several years of drought *Destroyed infrastructure *Crowding, lack of clinical services, inadequate immunization status of the population, limited access to potable water and poor sanitation.	*Conflict and drought	*Displacement and disruption of livelihood *Vicious cycle of political instability, breakdown of public services and conflict over the remaining resources and services. *The synergistic effect of malnutrition (particularly vitamin A deficiency) and disease. *US forces and UN coalition forces sent food aid. *Public health measure. A mass immunization campaign was implemented
1996	1996	North Korean famine	North Korea	200,000 - 3,500,000	*China and former Soviet Union implemented market price. Hard currency payment systems sharply reduced North Korea's ability to import goods. *Poor international relationship. Labeled a terrorist state. *Aid-dependent	*Began with economic crisis and became severe after a flood.	*Several UN agencies sent survey groups and aids. *US maintained a policy to economically isolate NK.
1998	1998	1998 Sudan famine	Sudan	70000	*Decades of civil wars between southern and northern Sudan created a vulnerable condition.	*Internal and border insecurity, drought and huge influx of returnees from the north made up a famine condition.	
	1998–2000	Famine in Ethiopia	Ethiopia	19900 (Gode zone alone) -100,000		*Eritrean–Ethiopian War over their mutual border worsened the food shortage caused by a drought.	*Aid agencies had responded late in drawing people into relief camps *Communicable diseases such as measles spread rapidly in relief camps
1998–2004	Second Congo War	DRC/Rwanda	3800000-5,400,000	*Political unrest between DRC/Rwanda caused by Hutu refugee at genocide in Rwanda in 1994 *International demand for natural resources *Economic mismanagement and patrimonial rule failed to adequately deal with natural resources *Low national income, limited access to health and education, and the total disintegration of economic and transport infrastructure *Land tenure policies	*The Second Congo War (1998–2003) --> production decrease, limited access to markets, reduction of financial means *Eastern Congo, which is rich in natural resources, continued to be unstable even after the war	*UN's mission called MONUC is mandated to protect civilians and help in the reconstruction of the country. *Despite international community's support for political and diplomatic efforts, no effective steps have been taken. *IMF, WB and other international bodies increased their development aid and financially supported the government's transitional reform *Presence of foreign militias is a major source of insecurity *The war has resulted in considerable regional disparities. *Coping strategies (e.g. development of peri-urban and urban agriculture)	

	2000	2000-2007	Zimbabwe food crisis	Zimbabwe	<ul style="list-style-type: none"> *Unstable political environment due to the flawed process of the Presidential election *The deteriorating economic situation with high inflation, high unemployment and closure of factories and businesses due to dwindling confidence in the investment environment. *Extreme decline of foreign currency due to withdrawal of aid by the donor community and a severe reduction in foreign exchange earnings from sales of tobacco, gold, and cotton. *Over 30% of the population were affected by HIV/AIDS, which has had a detrimental effect on the economy and caused increased pressure on health services. 	<ul style="list-style-type: none"> *The land reform programme that made commercial farmers homeless and jobless by compulsory acquisition. *Erratic rainfall (floods followed by drought in the 2001/02 crop season) 	<ul style="list-style-type: none"> *Imports have been insufficient to meet the production deficit *Prices on the black market have soared due to an absolute shortage of maize etc. *'Politicisation of data' Food was being used as a political weapon. Families that supported the opposition were denied the right to buy food from the government's Grain Marketing Board warehouse *Save the Children and Oxfam were banned by the government from distributing WFP food aid as they were viewed as loyal to the opposition party. *The crisis received a certain amount of media attention and has been included in various aid agency appeals, with food aid viewed as a priority. *Most of the appeals were food and there are less on health or others
	2003	2003-	Darfur Conflict	Sudan	<ul style="list-style-type: none"> *2 million people have been displaced by war *The conflict caused problems with trade and markets *Ethnic tensions among tribes 		<ul style="list-style-type: none"> *The rapid expansion of emergency food aid provision in Southern Sudan did decrease resources in other regions of the country, including Darfur. *USAID/OFDA provided five grantees implementing agriculture and food security interventions, including seed and tool voucher programs (FY2010)
	2005	2005(2001-02?)	Malawi food crisis	Malawi	<ul style="list-style-type: none"> *Around 15% of the population is estimated to be HIV/AIDS. Loss of labour due to death, illness or the diversion of labour to care for the sick affecting agricultural production *Agriculture-driven economy *Increasing natural disasters 	<ul style="list-style-type: none"> *Drought *Flood 	<ul style="list-style-type: none"> *FAO promoted crop diversification to reduce reliance on maize, small livestock production, small-scale irrigation and income generating activities.
	2005-2006	2005-2006	Niger food crisis	Niger	<ul style="list-style-type: none"> *Several years of economic hardship have lowered people's capability to deal with shocks. *Agriculture-driven economy 	<ul style="list-style-type: none"> *Drought *Locusts *With limited food supplies, increasingly high prices for local food staples, and falling livestock prices, many vulnerable households (particularly pastoralists) have had difficulty accessing food 	<ul style="list-style-type: none"> *Lack of seeds in hard-striken regions despite adequate rainfall. *EWS including GIEWS forecasted a food crisis in late 2004. The extent of natural damage was known, but not the extent of economic depression and the impact of crop failure on rural populations. *FAO made an appeal for funding, but the donor responses were slow.
	2006	2006	Horn of Africa food crisis	Djibouti Eritrea Ethiopia Kenya Somalia			
	2011	2011-2012	Famine in Somalia	Somalia Ethiopia Kenya	258000		
	2012	2012	Famine in West Africa	Senegal Gambia Niger Mauritania Mali Burkina Faso			

Appendix 2-3: Famine Database (comparison with statistical data)

	Year	Name	Region	Death (range)	Death	Death/Popul ation (%)	Drought		Conflict						Population growth	
							Drought (EMDAT)	Drought (literature)	Conflict (literature)	Armed Conflict	Non-State Conflict	One-side Conflict	Democracy (- 2.5 ~ 2.5)	Governance (- 2.5 ~ 2.5)		
1966	1966	Wag-Lasta (Wollo) famine	Ethiopia	45,000-60,000	52500	0.205	1	1	-	1					2.55	
1967	1967-1970	Biafran famine	Nigeria	1000000	1000000	1.906	-	-	1	1					2.22	
1968	1968-1972	Sahel drought	Mauritania Mali Chad Niger Burkina Faso	101000	101000	0.511	-	1	-	-	1	1	1	3.02		
							1								1.20	
							1								1.89	
							1								2.88	
							1								1.69	
1972	1972	Maharashtra drought	India	100000	100000	0.017	1	1	-	-					2.31	
1973-1975 another	1972-1973	Famine in Ethiopia (Wollo & Tigray)	Ethiopia	200,000-500,000	350000	1.161	1	1	-	1					3.03	
	1974	Somalia	Somalia	20000	20000	0.549	1	1	-	-					2.21	
1975	1974	Bangladesh famine of 1974	Bangladesh	1500000	1500000	2.116	1	-	1	-					1.57	
	1975-1979	Khmer Rouge	Cambodia	1,500,000-2,000,000	1750000	23.126	-	-	1	1					0.48	
1980	1980-1981	Karamoja	Uganda	30,000-50,000	40000	0.319	1	1	1	1					3.10	
1982	1982-85	Mozambique	Mozambique	100000	100000	0.786	1	1	1	1					2.42	
1984	1984-1985	Sudan (Darfur, Kordofan)	Sudan	250000	250000	1.510	1	1	1	1					3.52	
	1984-1985	1984-1985 famine in Ethiopia	Ethiopia	1000000	1000000	2.532	1	1	1	1					3.21	
1988	1988	Sudan (South)	Sudan	250000	250000	1.338	1	1	1	1					3.01	
1991	1991-1992	Famine in Somalia	Somalia	300000	300000	4.747	1	1	1	1	1	1	1		0.27	
1996	1996	North Korean famine	North Korea	200,000 - 3,500,000	1850000	8.403	-	-	-	-	-	-	-	-1.94	-1.91	1.25

1998	1998	1998 Sudan famine	Sudan	70000	70000	0.264	1	1	1	1	1	1	-1.81	-1.22	2.43
	1998–2000	Famine in Ethiopia	Ethiopia	19900 (Gode zone alone)	59950	0.096	1	1	1	1	1	-	-0.97	-0.94	3.01
	1998–2004	Second Congo War	DRC Rwanda	3800000- 5,400,000	4600000	8.824	-	-	1	1	1	1	-1.88	-1.97	2.13
							1			1	-	1	-1.31	-0.92	10.46
2000	2000-2007	Zimbabwe food crisis	Zimbabwe				1	1		-	-	-	-1.11	-0.78	1.12
2003	2003-	Darfur Conflict	Sudan				1	1	1	1	1	1	-1.44	-1.25	2.71
2005	2005(2001-02?)	Malawi food crisis	Malawi				1	1		-	-	-	-0.48	-0.80	2.80
	2005-2006	Niger food crisis	Niger				1	1		-	-	-	-0.30	-0.79	3.79
2006	2006	Horn of Africa food crisis	Djibouti Eritrea Ethiopia Kenya Somalia				1	1	1	-	-	-	-1.10	-0.90	-
							-			-	-	-	-2.03	-1.31	3.96
							1			1	1	1	-1.16	-0.57	2.85
							1			-	1	-	-0.14	-0.58	2.76
							1			1	1	-	-1.83	-2.31	2.65
2011	2011-2012	Famine in Somalia	Somalia Ethiopia Kenya	258000			1	1	1	1	1	1	-2.07	-2.16	2.81
							1			1	1	-	-1.33	-0.47	2.68
							1			-	1	1	-0.28	-0.57	2.77
2012	2012	Famine in West Africa	Senegal Gambia Niger Mauritania Mali Burkina Faso				1	1	1	2011	-	-	-0.05	-0.46	2.96
							1			-	-	-	-1.25	-0.51	3.27
							1			2011-2012	-	-	-0.40	-0.70	3.95
							1			2011-2012	-	-	-0.94	-0.91	2.65
							1			2012	2012	-	-0.55	-0.99	3.16
							1			-	-	-	-0.35	-0.63	2.98

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謝辞

修士課程の2年間、色々な経験をし、たくさんのこと学びました。でも論文の謝辞を事前に書いておくということは学習しませんでした。時間がありません。

学部生のときから、沖大幹教授には本当にお世話になりました。留学していた修士1年の一年間は、遠く地球の反対側から常に温かく見守りいろんなことに挑戦させてください、困ったときにはいつもメールで相談に乗ってくれました。修士論文の季節になっても研究から逃げ続ける私に、自己満足でいいから自分で満足できる論文を書けと檄を飛ばし、優しく厳しく育ててくださって、本当にありがとうございます。

副査の Petr Matous 先生は、副査面談の度に厳しくも的確なコメントをください、自分の研究の意義や妥当性を深く考え直す機会と与えてくださいました。コメントだけでなくチョコもください、ありがとうございました。

沖一雄先生、芳村圭先生、守利悟朗さん、Kim Hyungjun さん、木口雅司さん、中村晋一郎さん。いつもよく話す先生ばかりではないけれど、お昼ご飯の時や飲み会の時、面白い話をしてくださって、いろいろなことを教えてくださって、研究室生活の楽しいひと時をありがとうございます。

乃田啓吾さんと村上道夫さんは、多大なる時間を割いて研究の相談に乗ってくださいました。小さな気づきにこだわって深く追究する面白さを教えてくださって、ありがとうございました。

黒澤さん、戸井さん、塙田さん。秘書さんには日々の生活の些細なことから卒業に関する大事なことまで、本当にいろいろな面でお世話になりました。時にはお母さんのように心配してください、ありがとうございます。

スタッフの皆さん、先輩後輩の皆さん、たくさんたくさんお世話になって、一人ひとりと山ほどの思い出があって、書きたいことはたくさんあるのですが、ごめんなさい時間がありません。後で一人ひとりとお話をしたいと思います。本当に本当にありがとうございます。

最後に、言うことを聞かない娘に半ば呆れつつも、オーストリアやケニアやその他地球上のどこにいても大きな愛を持って見守り続けてくれた両親に、心から感謝します。

お世話になった皆さんに感謝の言葉は尽くせませんが、これから社会に出て少しずつ恩返し
していきたいと思います。

2014年2月6日 岡根谷実里