MENDEL UNIVERSITY IN BRNO

FACULTY OF REGIONAL DEVELOPMENT AND INTERNATIONAL STUDIES

Did food security in Cambodia-Laos-Myanmar-Vietnam countries improve after Millennial development goals?

Diploma thesis

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Abstract

MOSEROVÁ, V. Bc.: Did food security in Cambodia-Laos-Myanmar-Vietnam countries improved after Millennial development goals?, Diploma thesis

Topic of the thesis is a scrutiny of food security in the Cambodia – Laos – Vietnam - Myanmar countries after Millennium development goal were set. The goal is to confirm or refuse the hypothesis of the improvement of food security in CLMV countries after Millennium development goals. The goal would be examined according to the results of the analysis of the data for the period 1990 – 2015. The analysis shall be done using the composite indicator and the trend will be also analysed. The purpose is to create a suggestion that would help improve the situation in this region.

Keywords: CLMV, Cambodia, Laos, Vietnam, Myanmar, food security, composite indicator, Millennium development goals

Abstrakt

MOSEROVÁ, V. Bc.: Zlepšila se potravinová bezpečnost v zemích Kambodža, Laos, Vietnam a Myanmar po zavedení Rozvojových cílů tisíciletí?, Diplomová práce, 2016

Tématem této práce je náhled na téma potravinové bezpečnosti v Kambodži, Laosu, Vietnamu a Myanmaru. Cílem této práce je potvrdit či vyvrátit hypotézu o zlepšení potravinové bezpečnosti v zemích CLMV po zavedení Rozvojových cílů tisíciletí. Cíle byl zkoumán na základě analýzy dat v období 1990 – 2015. Analýza byla provedena pomocí kompozitního indikátoru a také byla provedena analýza trendové funkce. Účelem práce je navrhnout doporučení, která by pomohla zlepšit situaci v regionu.

Klíčová slova: CLMV, Kambodža, Laos, Vietnam Myanmar, Potravinová bezpečnost, kompozitní indikátor, Rozvojové cíle tisíciletí

List of Abbreviations

CLMV	Cambodia, Laos, Mynmar, Vietnam
FAO	Food and Agriculture organization
FAOSTAT	The Food and Agriculture Organization Corporate Statistical Database
FIMI	Food Insecurity Multidimensional Index
GHI	Global hunger index
IFPRI	International Food Policy Research Institute
LDC	Least developed countries
MDG	Millennium development goal
OECD	Organisation for Economic Co-operation and Development
UN	United nations
USAID	United states agency for international development
USDA	United states department of agriculture
WWII	World war II.

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1 Introduction

Food and water are necessary conditions of life on the Earth. All the living organisms need sufficient amount of food and water to survive. There are still problems with ensuring this condition for all people in developing countries.

Food security is a situation, where a person has enough food that contains the necessary nutrients, and it is safe to eat it. It is necessary that the food is physically in place. People must be able obtain the food, i. e. they must have enough money to purchase them, or enough land and other resources to their cultivation. Also important is that foods contain a balanced proportion of nutrients (proteins, fats, carbohydrates, vitamins and minerals) that enable healthy and active life. In numerical terms, a person needs to take an average of at least 1800 - 2100 kcal per day, in order to survive (FAO, 2008).

However, the problem of food security is generally quite complex and should not be associated only with developing countries. In many developing as well as developed countries, the part of the population has a problem with obesity and other citizens of the same country are suffering from hunger.

Food security is a topic for many International as well as national organizations. Food and agriculture organization was founded in 1945 as an organization of United Nations and its main goals are: the eradication of hunger, food insecurity and malnutrition; the elimination of poverty and the driving forward of economic and social progress for all; and, the sustainable management and utilization of natural resources, including land, water, air, climate and genetic resources for the benefit of present and future generations.

In 2000, world leaders made a huge commitment to work towards a series of eight time-bound Millennium Development Goals. The eight goals are based on the United Nations Millennium Declaration, signed in September 2000. The MDGs commit the international community to combat poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women.

Southeast Asia is one the less developed parts of the world and despite the progress that is being made, the food security is still remaining a huge issue. This thesis is focused on the CLMV countries, Cambodia, Laos, Myanmar and Vietnam, because the numbers of undernourished people in these countries are still alarming.

1.1 Objectives

The main objective of this thesis is to test the hypothesis: Did food security improve in Cambodia-Laos-Vietnam-Myanmar countries after Millennium development goals? These countries were chosen because they are less developed countries in the Southeast Asia. The objective will be fulfilled by creating composite indicator of Food security and by analysis of another methods of measuring Food security and Millennium development goals.

The secondary objective is to analyse available literature and apply approaches of measuring food security to the practical part. Based on the result of the practical part, policy recommendations will be suggested.

2 Literature overview

2.1 Food security

2.1.1 Definition

Food security is fundamental human right. Origin of the Food security concept can be found in mid-1970s at the time of global food crisis, but the idea of the dependence between human beings and nature is known for a very long time. Human societies always struggled to ensure that all people have access to sufficient food to lead active and healthy lives. The Chinese philosopher Confucius said: "*Despite the many accomplishments of mankind, we owe our existence to the thin layer of the top soil, and the fact it rains."* (McDonald,2010).

There are several definitions of food security which have a lot in common. Food and agriculture organization defines food security as following statement: *"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life"* (World food summit, 1996). US AID organization adds to this statement another three points that are less abstract:

- A family is food secure when only when its members do not live in hunger or fear of hunger
- The roots of food insecurity can be found in the long term poverty and have high impact on development families, communities and countries
- Long term undernourishment has negative impact on the health and cognitive development and increases susceptibility to illness (U.S. Agency for international development, 2016)

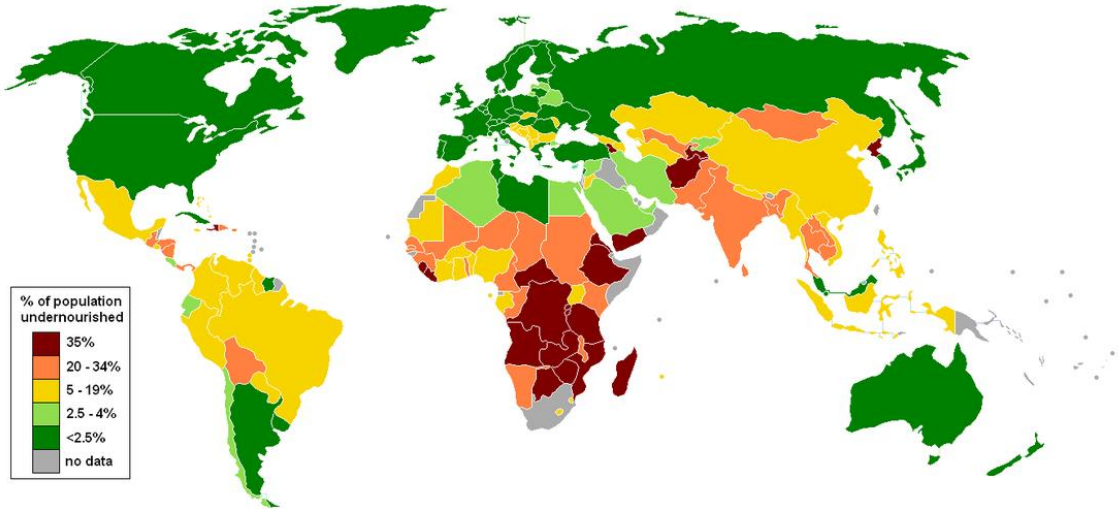
According WHO, the food security is primarily built on three pillars:

- food availability
- food access
- food utilization (Park, Kumar, 2013)

Food and agriculture organization of United Nations (2008) identifies four pillars. The added pillar is called stability of supply and it is crucial for satisfying dietary needs of people. Stability of supply should assure the food security over time.

All over the world, around 842 million people have suffered from chronic hunger in 2011-13. This number represents more than 12 per cent of the population. Differently said, one in eight people on the earth was not able to meet the dietary energy requirements. Most of the people who are suffering of food insecurity, find their homes in the Least developed countries (LDC). The presence of undernourishment in LDCs is a huge issue and more than 14 per cent of inhabitants of these countries between 2011 and 2013 did not have enough food to lead a fulfilled life. Although, the number of hungry people is continuously decreasing globally, this rate of reduction in undernourished people is not sufficient to meet the international targets for hunger reduction (FAO, 2013). The situation of undernourishment in the world is describe in Figure 1.

Figure 1 Undernourishment in countries, 2014 - 2016



Source: FAO, 2016

Bakker (2011) says that food security in the low income countries may be achieved by the cooperation of small scale farming communities and local, national and international agencies. Small scale farming communities has to fell the support from the agencies but they have to be involved in the process of achieving sustainable food security.

The main process in creating food security in countries is optimizing the use of soil and water. Food and water security cannot be separated (food cannot be grown without water) Food production is among the most water intensive activities in society (Aswathanarayana,2008). With declining water availability and limited land that can be profitably cultivated, expansion in area will contribute very little to future production growth. Slow growth in investment in agricultural research, irrigation, and rural infrastructure in developing countries is likely to dampen productivity growth (Rosegrant, 2016).

Food security can be examined on several levels: individual, household, community, national or international and global. Lack of sufficient and livelihoods of people, safe and nutritious food has significant impacts on the health, well – being around the world (McDonald,2010). The main drivers to changes in food systems and dietary patterns, such as urbanization, increased income, capital flow and market liberalization (Kennedy, 2003).

2.1.2 Pillars

Pillar 1: Food availability

Food availability means that eatables are available for people in sufficient amount (the amount of eatables can´t fluctuate significantly) and is determined by the level of food production, stock levels and net trade (FAO, 2008).

Food availability refers to supply, production, distribution and barter of food. Production of food is influenced by many factors including ownership of the land and its usage, land management, selection of crops, livestock management and harvesting periods. Crop production is also dependent on the weather conditions. The

changes of the temperatures and precipitation can cause deficit in the food availability. The soil used for cultivation of crops has high opportunity costs because it can be also used for other purposes, for example urbanization. Due to the fact that in most of the countries the consumers outweigh producers, eatables must be distributed to other areas. Distribution means storage, processing, transportation, packing and placing on the market. Poor food supply chain and storage technologies can increase the amount of the wasted food. Throughout the world, there are only a few individuals or households who are still self-sufficient in terms of food. This creates the need for barter, exchange, or to gaining food for money. Replacing foods requires effective trading systems and market institutions that may have an impact on the food security (Parvathamma, 2015).

Food availability is necessary but no sufficient condition for food security. It can happen that food security at the aggregate level may not translate into food security at family level (China is self-sufficient in food grains but about 142 million Chinese are food insecure). The dilemma is that food demand tends to grow more rapidly than population, driven by socio – economic changes, new food preferences and altered food composition for nutritional reasons (Aswathanarayana, 2008).

Pillar 2: Food access

Food access means the ability to obtain adequate and nutritious food. It means that people have enough source that will allow them to get food they need. They can buy it for others or grow it by their own. Food access relates to prices and allocation as well as preferences of individuals and households.

The undernourishment in countries is not usually caused by lack of food but rather by the poor food accessibility, usually due to the poverty. Food access depends on the household income for the purchase of the food for the usual prices or it depends on the ownership of the land for growing their own food.

There are two different types of food access:

- Direct access – the household produces food using human and material resources.

- Economical access – the household are buying food produced somewhere else

The type of the access is influenced by the area where the household is located. Also household assets, including incomes, properties, heritage or gifts may affect the type of food access in the household (Parvathamma, 2015).

Pillar 3: Food utilization

Means that people has to have right knowledge to use food in the right way. For the best utilization of the food, people has to know information about storage, nutrition, hygiene and water management. A lot of factors influences the food, after the food is delivered to the household. The food has to be safe and nutritious to fulfil the requirements for food security. In order to achieve food security, the food ingested must be safe and must be enough to meet the physiological requirements of each individual. Food safety impacts food utilization, and can by impacted by the preparation, processing, and cooking of food. Food utilization can be also influenced by internal parasites that draw nutrients from body. Because of this, the access to the health care is also very important for the food security. Education about nutrition, metabolism and health issues is the key for improving food utilization (Parvathamma, 2015).

Pillar 4: Stability of supply

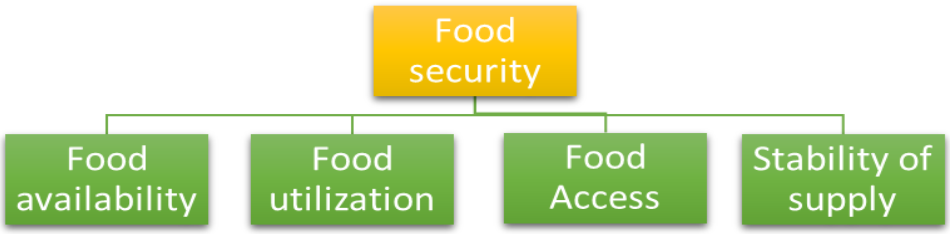
This pillar was added by the FAO. Stability of supply is about ability to gain food over time. Food insecurity, depending on the duration, can be:

- Transitory – short term food shortage is occurring only temporarily
- Seasonal – in specific seasons the food shortage is occurring every year
- Chronic – long term or persistent inability to meet minimum consumption requirements (Devereux, 2006)

Natural disasters, droughts and floods can cause lower yields from the agriculture. Also civil conflicts can influence the access to the food and interrupt the food supply. The supply can be interrupted also by personal reasons such as loss of the

job or health issues that will enable the person to work on the production of the food. Seasonal food shortages may occur through regular alternations of vegetation periods in food production (Parvathamma, 2015). Since diets sustainability is crucial for achieving food and nutrition security in countries, there is an urgent need to design and implement appropriate policies to improve the sustainability of the current food consumption patterns (Capone et al., 2016). Pillars of the food security are shown in Figure 2.

Figure 2 Pillars of food security



Source: own work

2.1.3 Food security in time

In 1943, during WWII, the Food and agriculture organization was created on the initiative of President Roosevelt in the USA. Organization was designed to consider the goal of freedom from want in relation to food and agriculture. The main task was to deal with the poverty and hunger situation after war (Shaw, 2007).

The issue of food security really came to the fore in the 1970s and at the 1974 World Food Conference in Rome the first explicit acknowledgement was made that this issue concerned the whole of mankind: *"Every man, woman and child has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties. (...) Accordingly, the eradication of hunger is a common objective of all the countries of the international community, especially of the developed countries and others in a position to help."* (United Nations. 1975. Report of the World Food Conference, Rome 5-16 November 1974. New York)

Back in the 1970s the problem of food security was mainly seen as a problem of food availability and access. The idea was that the food insecurity will be diminished by guaranteeing the availability of food as well as attempting to ensure price stability both nationally and internationally through increased food production and the use of food surpluses (Simon, 2012)

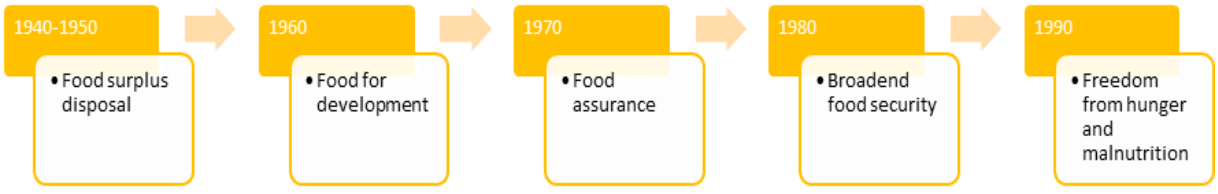
In the 1980s the food production started to increase thanks to the green revolution. However, the food security problem did not disappear. It was realized that even if there is enough food available, people can´t afford it. The focus was on the economic and physical aspects of food security. Food access came to the fore and organizations focused mainly on alleviation of poverty and enhancing the role of women in the development process. In 1986 the food security was divided to transitory, seasonal and chronic (FAO, 2003).

In 1990s the main concern was the quality of food. The food available has to satisfy nutritional requirement and balance diet for people to be food secure. Also the preferences, traditional habits and socially acceptable food sources must be taken into account (Napoli, 2011)

Despite the global effort in recent decades, events of the early twenty – first century demonstrate that providing sufficient food to all people remains an urgent problem situated at the nexus of nature, society and technology (McDonald,2010).

Development of the ideas of food security is shown in the Figure 3.

Figure 3 Food security concepts over time



source: Napoli, 2011

2.1.4 Globalization and climate change

The globalization has several definitions and it is necessary to choose with which one is the most relevant to the topic of food security. For the purpose of this chapter definition which refers to reduction in barriers to the cross-border movement of goods, services and capital will be used. This also includes an increased flow of commodities, technologies, information, financial capital, distribution chains and marketing as well as migration of peoples and labour. In terms of food systems, changes are occurring all along the food chain from production and processing to retail and marketing (Shetty, 2003).

It is evident that globalization has serious impact on the food and agriculture system on the Earth. Food is much more available and diverse than ever but the access to this food can still be problematic for some people. Globalization is closely linked to the phenomenon of urbanization, increasing incomes and market liberalization. The situation in the world is moving towards multinational supermarkets and fast food chains and small local companies and traditional food markets seem to be in decline. The food from supermarkets has higher quality and safety standards as well as lower prices which attracts new customers. (Kennedy, 2010).

Climate change is often discussed topic and there is a lot of opinions whether the climate change is a real issue. According to the Intergovernmental Panel on Climate Change (2014) the land surface as well as the ocean is warming. More precisely said the temperature increased between 1880 and 2012 of 0.85^{0}C and also the number of heavy precipitation increased significantly. The ice loss from the glaciers in not negligible as well as rise of the sea level.

Climate change could be a huge barrier to overcome to achieve a hunger free world. The changes in weather have high impact on crops productivity which is influencing first pillar of the food security, food availability. Another problem can be seen in unstable weather conditions that can cause interruptions in the supply of food or damage stored food. The water supply is also highly bound to natural condi-

tion and even small changes in climate can cause problems in access to drinking water. The impact is supposed to be higher in areas that already suffer from hunger and undernourishment. There is a need of climate smart food system that would secure the food availability and supply regardless the climate change (Wheeler and Braun, 2013).

2.2 Approaches to measuring food security

From the beginning, there were efforts to measure food security. It is generally recognized that food security, and therefore food insecurity, is a multidimensional phenomenon. That means its measuring is not an easy task. There are several indicators that are measuring hunger and the progress in achieving hunger eradication. Determination of these indicators really helped understanding the issue. If the food security can be measured, progress in improving food security can be monitored. The full range of food insecurity and hunger cannot be captured by any single indicator. Instead, a household's level of food insecurity or hunger must be determined by obtaining information on a variety of specific conditions, experiences, and behaviours that serve as indicators of the varying degrees of severity of the condition (Clay, 2002).

2.2.1 Global hunger index

Global hunger index (GHI) is a tool created for measuring hunger globally and also in specific regions. The GHI is calculated every year so the results can be compared over time. The GHI helps to find the reasons of hunger in the world and it aims to reduce the hunger. The idea is also to understand the social a cultural difference in regions that can cause hunger. The GHI in multidimensional index and is composed of four indicators. These indicators are following:

- **Undernourishment:** the proportion of undernourished people as a percentage of the population (reflecting the share of the population whose caloric intake is insufficient

- **Child wasting**: the proportion of children under the age of five who suffer from wasting (that is, low weight for their height, reflecting acute undernutrition)
- **Child stunting:** the proportion of children under the age of five who suffer from stunting (that is, low height for their age, reflecting chronic undernutrition)
- **Child mortality:** the mortality rate of children under the age of five (partially reflecting the fatal synergy of inadequate nutrition and unhealthy environment (IFPRI Welthungerhilfe Concern, 2015)

According to the GHI, the situation in Cambodia, Laos and Myanmar is serious and in Vietnam is moderate as shown in Figure 4.

Figure 4 GHI in CLMV

source: ghi.ifpri.org

2.2.2 Global food security index

Global Food Security Index considers the core issues of affordability, availability, and quality across a set of 109 countries. The index is a dynamic quantitative and

qualitative scoring model, constructed from 28 unique indicators, that measures these drivers of food security across both developing and developed countries. The overall goal of the study is to assess which countries are most and least vulnerable to food insecurity through the categories of Affordability, Availability, and Quality and Safety. First results were shown in October 2012 and are updated every three months. Over time, countries' scores will improve if food prices fall, and deteriorate if prices rise. The indicators are sort according to three dimensions: Affordability, Availability and Quality and safety. The indicators included in this index are in the table 1 (The economist group, 2016).

Table 1 Indicators of Global food security index

Affordability	**Availability**	**Quality and safety**
Food consumption as a share of household expenditure	Sufficiency of supply	Diet diversification
Proportion of population under global poverty line	Average food supply	Nutritional standards
Gross domestic product per capita (PPP)	Dependency on chronic food aid	National dietary guidelines
Agricultural import tariffs	Public expenditure on agricultural research & development	Nutrition monitoring and surveillance
Presence of food safety net programmes	Agricultural infrastructure	Micronutrient availability
Access to financing for farmers	Existence of adequate crop storage facilities	Dietary availability of vitamin A

	Road infrastructure	Dietary availability of animal iron
	Port infrastructure	Dietary availability of vegetal iron
	Volatility of agricultural production	Protein quality
	Political stability risk	Food safety
	Corruption	Agency to ensure the safety and health of food
	Urban absorption capacity	Percentage of population with access to potable water
	Food loss	Presence of formal grocery sector

source: http://foodsecurityindex.eiu.com/Home/Methodology

The results of this indicator were calculated for Cambodia, Myanmar and Vietnam. Laos was not included. The results are described in Table 2.

Table 2 Result of Global food security indicator for Cambodia, Myanmar and Vietnam

Country	**Ranking**
Cambodia	96/109
Myanmar	78/109
Vietnam	65/109

2.2.3 Current Population Survey Food Security Supplement

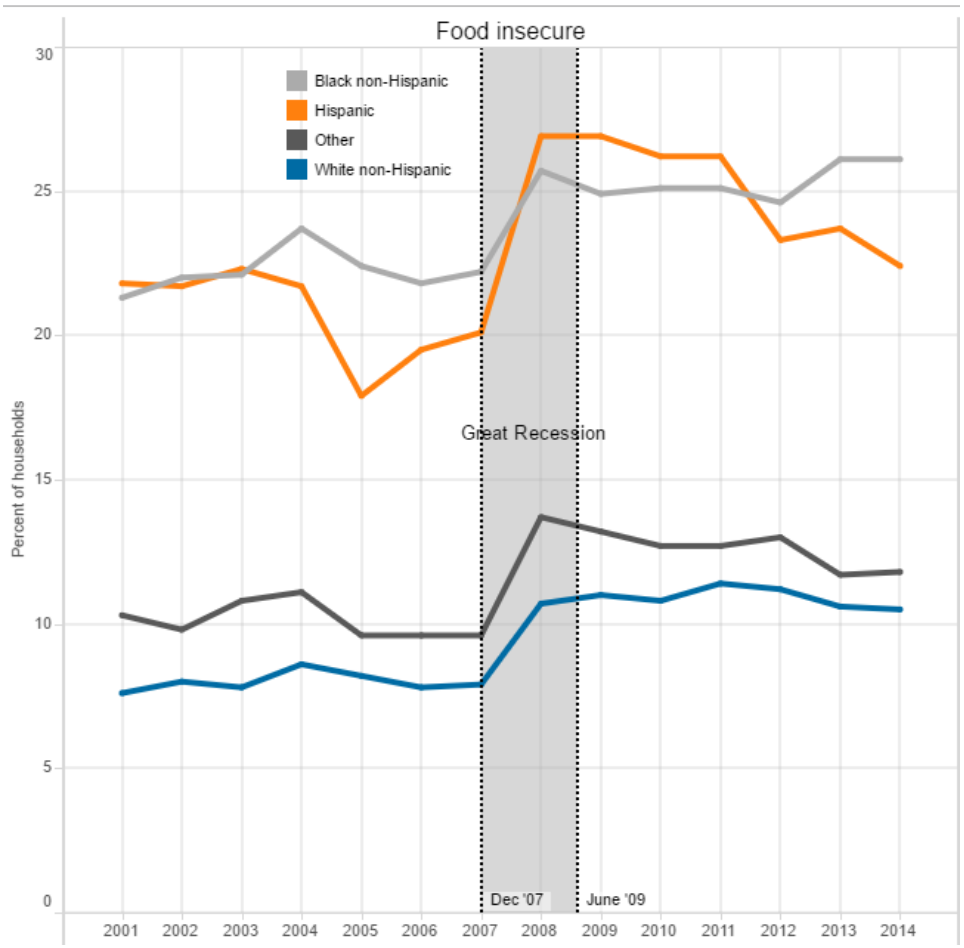
Food security is part of the Current population survey from 1995 and it is one of the oldest population surveys in USA. It asks question about food security, food program participation, and food expenditures of U.S. households. The questions are focused on household and not on individuals themselves. That means usually the person

who buys and prepares the food is the respondent (Coleman-Jensen, Gregory, and Singh, 2015).

This one person was asked questions that should indicate the food security in the household. The questions are primarily focused on ability to afford balance food or being hungry because they did not have enough money to buy it. After the survey was done, the food security status was assigned to the households. Also households with low food security among children were identified by questions asked directly about the food for children. In the survey, respondents reported the sum of money they spent on food during the year and also whether they used any public of private food assistance program. All households with incomes below 185 percent of the Federal poverty threshold were asked questions about the use of Federal and community-based food and nutrition assistance programs. In order to minimize the burden on respondents, households with incomes above that range were not asked the questions unless they indicated some level of difficulty in meeting their food needs on the first of the preliminary screener questions (Bickel et al., 2000).

In the Figure7 there is shown the outcome from the survey according to the ethnicity.

Figure 5 Example of results from the CPS Food security supplement



source:http://www.ers.usda.gov/data-products/food-security-in-the-united-states/interactive-chart-food-security-characteristics.aspx

2.2.4 Food Insecurity Multidimensional Index

The Food Insecurity Multidimensional Index (FIMI) is a synthetic index that combines four dimensions of food security (availability, access, utilization and stability of food). The approach of this index is innovative and comprehensive. Selected indicators deal with the theoretical challenge to investigate the narrowest aspect of food

insecurity combining its causes and consequences, analysing hunger through qualitative and quantitative indicators, despite limited data availability represents one of the main obstacle to the achievement of the purpose (Napoli, 2011).

Indicators are firstly aggregated by dimension and then overall index (FIMI) is calculated by computing these four dimensions. This way it will be possible to capture the state of food insecurity in a country maintaining a view on the impact of each dimension on the index. This index is focusing on both, micro and macro level of food security. The indicators were chosen separately for each dimension of the food security. Two principles were taken into account: the principle of accuracy (using as many indicators as necessary so that analysis can properly guide policy) and parsimony (using as few indicators as possible to ensure ease of analysis for policy purposes and transparency) (Napoli, 2011).

Table 3 Indicators used for FIMI

Dimension	Indicator
Availability	Arable land (hectares per capita)
	Cereal per yield (kg per hectare)
	Cereal domestic supply (kg per capita)
	Share of food aid (% of food aid in the total Dietary Energy Supply)
	Food supply (kcal/capita/day)
	Permanent cropland (% of land area)
	Food production index (1999-2001 = 100)
	Land under cereal production (hectares per capita)
Access	Consumer price index (2005=100)
	GDP per capita (current US$)
	Improved water source, rural (% of rural population with access)
	Rural population (% of total population)
Utilization	Cereal waste (kg per capita)
	Mortality rate, under-5 (per 1,000)
	Prevalence of undernourishment (% of population)
Stability	Cereal stock variation (kg per capita)
	Variability of food production index
	Variability of consumer price index
	Import Dependency Ratio
	Variability of area harvested

source: Napoli, 2011

2.3 Millennium development goals

The millennium development goals (MDG) were introduced in 2000 by the United Nation. The MDG is a commitment of the countries of the world to ensure the development of all countries between 2000 and 2015. The Un millennium declaration was adopted by the world leaders. They The largest gathering of world leaders in history

adopted the UN Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets, with a deadline of 2015 that have become known as the Millennium Development Goals. The purpose is to narrow the gap between developed and developing countries. The idea is that the world resources should be distributed more evenly. The Millennium Development Goals (MDGs) are the world's time-bound and quantified targets for addressing extreme poverty in its many dimensions-income poverty, hunger, disease, lack of adequate shelter, and exclusion-while promoting gender equality, education, and environmental sustainability (Millennium project, 2006)

The list of MDG was created. It contains 8 measurable goals to achieve safer, more prosperous and equitable world. The MDGs are following:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

These goals consist of specific and measurable targets that help to better understand the issue and also help to measure the achievements. However, it is not possible to only focus on solving one problem, all 8 MDGs are therefore very closely linked and their current solution depends on the overall success of the eradication of poverty as such (OECD, 2000).

2.3.1 MDG1: Eradicate extreme poverty and hunger

For the topic of this theses the first MDG is the most relevant. Poverty and hunger is issue in the most of the developing countries. More than a billion people worldwide still live in extreme poverty, and many more experience hunger and are vulnerable

to environmental or price shocks. Undernutrition remains one of the world's most serious public health challenges. Nearly one-third of children in developing countries are underweight or stunted (low height for age), and undernutrition contributes to one-third of all child deaths.

The main problem about the undernourishment of the young children is that children who are malnourished when they reach their second birthday could suffer permanent physical and cognitive damage, thereby affecting their future health, welfare, and economic well-being. For developing countries, the impact on their ability to raise a productive workforce can last for generations (United Nations, 2013).The specific targets of MDG1 are described below.

Halve, between 1990 and 2015, the proportion of people whose income is less than $1,25 a day

In 1990, the number of people with income less than $1,25 a day was more than 43%. That means that to achieve this goal, in 2015 the proportion of the people with income less than $1,25 should be less than 22 % of population. The amount of money which indicates poverty was designed by experts (FAO, 2006).

Before the global financial crisis became actually visible in late 2008, the crisis in food and agriculture had already taken hold. Between 2006 and 2008, global prices had risen by 83 per cent (Loewenberg, 2008,). In 2009, close to 1 billion of worlds 6 billion people were chronically hungry with this number expected to rise as prices for food staples continue to increase (Cresswell, 2009,). It is anticipated that there will need to be an increase in food production of between 70 and 90 per cent over current levels if the world is to feed its people by the year 2030. The food security of individuals is very closely linked to their income and food prices (FAO,2006).

Achieve full and productive employment and decent work for all, including women and young people

The relation between growth, employment and poverty has been largely overlooked. Promoting productive capacity, employment and decent work is on the most important activities to poverty eradication. It is necessary to promote growth in areas where the poor earn their living and to improve their access to the benefits of growth, by improving their mobility and ensuring that infrastructure and markets serve their interests. The recognition that employment and decent work are legitimate and fundamental goals in their own right, and are not the automatic by-products of growth, led to the inclusion in 2005 of this MDG Target (International labour office, 2010).

Halve, between 1990 and 2015, the proportion of people who suffer from hunger

Undernutrition is the underlying cause of death in an estimated 45% of all deaths among children under 5 years of age. Undernutrition also includes fetal growth restriction, stunting, wasting and deficiencies of vitamin A and zinc and suboptimal breastfeeding. The proportion of underweight children in developing countries has declined from 28% to 17% between 1990 and 2013 (WHO, 2016).

Table 4 Indicators for measuring MDG1

Goals and Targets (from the Millennium Declaration)	**Indicators for monitoring progress**
Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than one 1.25 USD a day	1.1 Proportion of population below $1.25 (PPP) per day 1.2 Poverty gap ratio 1.3 Share of poorest quintile in national consumption
Target 1.B: Achieve full and productive employment and decent work for all, including women and young people	1.4 Growth rate of GDP per person employed 1.5 Employment-to-population ratio 1.6 Proportion of employed people living below $1.25 (PPP) per day 1.7 Proportion of own-account and contributing family workers in total employment
Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	1.8 Prevalence of underweight children under-five years of age 1.9 Proportion of population below minimum level of dietary energy consumption

source: Millennium development goals indicators, 2008

2.4 Composite indicator

Composite indicator is created when there is need to compile certain number of indicators into one index based on multidimensional concept that is measured. Multi-

dimensional concepts such as quality of life, social care, human development or sustainability of environment can´t be sufficiently described by only one indicator. Composite indicators produce more synthesized and comprehensive insight into a subject of interest. Therefore, the composite indicator became recognized tool for complex analysis on multidimensional topics (Budíková, Králová and Maroš, 2010)

2.4.1 Principle

Composite indicator is created as a compilation of multiple thematically related indicators, usually called sub – indicators. These sub-indicators should not have common unit of measurement and can have different importance (weight). They have different results of the basic characteristics such as mean, variance and correlation (Giunta, 2006). To construct composite indicator, we should follow these steps:

1. Development of theoretical framework
2. Selection of sub - indicators
3. Treatment of missing values
4. Multivariate exploratory data analysis
5. Normalization of data
6. Assignment of weights
7. Aggregation
8. Testing of composite indicator's stability and robustness
9. Relation with other indicators
10. Presentation and publication of results (Hudrlíková, 2014)

Selection of sub – indicators

To fulfil the criteria of composite indicator, sub – indicators must respect max, min and opt criteria. We are choosing max criteria if the higher value of the indicator is

better than lower (exmp. employment, education etc.). Min type is suitable for indicators where the lowest value is the most desirable (criminal offences, level of corruption etc.). We are using opt criteria when the indicator is desired to achieve some optimal value (etc. median age, fertility). It is important to take into account skewness and extreme values of the indicators as well as absolute and relative variability (Nardo et al., 2005).

Missing values

There are three generic approaches for dealing with missing data. First of them and the also easiest one is the case deletion. If the value is missing for a country or an indicator, then the country or indicator is deleted form the analysis. This method is not always usable because it ignores possible systematic differences between complete and incomplete sample and may produce biased estimates if removed records are not a random sub-sample of the original sample. Standard errors will be larger in a reduced sample. This approach can be used if there is not more than 5% of the values missing. The other two approaches are based on the imputation of the missing data. Single imputation approach uses for example Mean/Median/Mode substitution or Regression Imputation to gain the data. It is important to distinguish situations where the problem of the missing data is minor and situations where standard estimators applied to real and imputed data have substantial bias (OECD, 2008).

Normalization

Normalization is process where sub indicators with different units are transformed into dimensionless indicators. Once the normalization is done we can easily aggregate the sub indicators into index. The normalization process can be different for each composite index. The main approaches are Ranking and Z-scores (Giunta, 2006).

The usage of the ranking method is easy but has its issues. It is based on replacing original values of cardinal variable by their ascending/descending order. By this process the ordinal variable is created and ordinal variables are dimensionless. The

main disadvantage of this method is that it doesn't include information about proximity and the correlations can change. On the other hand, it eliminates the outliers.

Z- scores method replaces values of original indicator of max type by dimensionless Z–scores $Zj = \frac{Xj - \overline{xj}}{\sqrt{\overline{var}}xj}$ with zero mean and unit variance. For the transformation of min formula $Zj = \frac{\overline{xj} - Xj}{\sqrt{\overline{var}}xj}$ is used. Z-scores can be easily aggregated and the higher the value of composite indicator is the better the final rank is (Minařík, 2000).

Assignment of weights

The weights are usually assigned according to their importance. The easiest way is to assign to each sub indicator same weight. This is called equal weighting and it means that each indicator has the weight one. Another approach is called rating scales. It uses odd numbers (3-, 5-, 7- and 9-item scales) which can be converted into subjective criteria (e.g. importance of given indicator can be rated as 1=very much below average, 2=below average, 3=average, 4=above average, 5=very much above average). Weights are then standardized by dividing each item by sum of items across all indicators so that all standardized weights sum up to one. The last approach to assigning weights is called Matrix of pairwise comparison. This method is based on a symmetrical matrix in which number of rows and columns is the same as number of indicators (Nardo et al,2005).

Aggregation

After the normalization and assignment of weights, the aggregation process starts. There are two option of aggregation. The decision of choosing one option is based on the appearance of missing values. Weighted sum approach is used for dataset without missing values and weighted average approach for the dataset with missing values. By this step, the dimensionless composite indicator is created (Minařík, 2000).

Testing of composite indicator's stability and robustness

The use of uncertainty and sensitivity analysis during the development of a composite indicator can contribute to its well-structuring. A several methods should be initially considered. Uncertainty and sensitivity analysis are the suggested tools for coping with uncertainty and ambiguity (OECD, 2008).

2.4.2 Pros of composite indicators

- Summarize complex or multi-dimensional issues, in view of supporting decision-makers.
- Are easier to interpret than trying to find a trend in many separate indicators.
- Facilitate the task of ranking countries on complex issues in a benchmarking exercise.
- Assess progress of countries over time on complex issues.
- Reduce the size of a set of indicators or include more information within the existing size limit.
- Place issues of countries performance and progress at the centre of the policy arena.
- Facilitate communication with ordinary citizens and promote accountability (OECD, 2008)

2.4.3 Cons of composite indicators

- May send misleading policy messages, if they are poorly constructed or misinterpreted.
- May invite drawing simplistic policy conclusions, if not used in combination with the indicators. - May lend themselves to instrumental use (e.g be built to support the desired policy), if the various stages (e.g. selection of indicators, choice of model, weights) are not transparent and based on sound statistical or conceptual principles

- The selection of indicators and weights could be the target of political challenge. - May disguise serious failings in some dimensions of the phenomenon, and thus increase the difficulty in identifying the proper remedial action.
- May lead wrong policies, if dimensions of performance that are difficult to measure are ignored (OECD,2008)

2.5 Current situation in Cambodia – Laos – Myanmar – Vietnam

2.5.1 Cambodia

Cambodia is mostly agrarian country, with approximately 80 per cent of the population living in rural areas. More than 70% of people is working in agrarian sector (National Institute of Statistics, 2011). There was in total 3.16 million households from which 2.5 million households were rural and 0.66 million were urban (Asian Development bank, 2014), so this sector is the most important in the economy. The majority of farmers are smallholder farmers whose live is dependent on the agriculture. They use their farms either for subsistence or small-scale commercial purpose. Paddy fields are dominant, accounting for about 2.63 million hectares during 2007-2011 and the yields increased from 4 million tons in 2000 to 6 million tons in 2007 (Ministry of Agriculture Forestry and Fisheries, 2011).

The economic growth of the country significantly helped to decrease the poverty in Cambodia. In 2004 it was 50% of the population and in 2011 it dropped to 20%. Despite this progression the poverty in rural areas stay in high numbers and the income gap widened. There is still high possibility of getting back to the poverty trap (Asian Development bank, 2014).

The problems related to the food security are still occurring mainly in the rural areas. The nationwide undernourishment prevalence declined from 37 per cent in 2004 to 33 per cent in 2009, nevertheless rural undernourishment prevalence slightly increased. These numbers shows that the eradication of poverty can be achieved only if the situation gets better in the rural areas of Cambodia (National Institute of statistics, 2011).

According to Barrett (2008) food security in the rural household can be improved by entering the market. The advantage of farmers reaching the market in not only in selling more of their production but also in exploitation of new technologies and in adaptation their production to the market needs to gain more income. There are also risk factors in entering the market, for example farmers can be negatively affected by the price volatility. The market oriented farming can be also influence by the external factors such as road connectivity, natural disasters or agriculture policies.

The road connectivity can be real problem in Cambodia for the famers from the remote rural areas. During many years of the war almost all infrastructure in Cambodia was destroyed and it is only slowly getting rebuild. In 2012 there was 47,207 km of the roads of which only 11% were national roads and more than 70% were rural roads (The Infrastructure and Regional Integration Technical Working Group 2009). The road density comparison is shown in the table 5:

Table 5 Road density comparison Cambodia

Description	Japan	Philippines	UK	Cambodia	Vietnam	Thailand
Road Network Density (km/km2	3.16	0.67	1.58	0.26	0.78	0.38
NR Network Density (km/km2	0.14	0.10	0.19	0.03	0.05	0.11

source: The Infrastructure and Regional Integration Technical Working Group, 2009

As you can see Cambodia has the lowest road density ration from all countries. These figures indicate that to improve national economy, Cambodia should develop more road networks and improve existing ones.

2.5.2 Laos

The Lao People's Democratic Republic is one of the world's least developed countries. Laos in experiencing economic growth and reduction in poverty rates during last decade. However, the food insecurity in Laos remains almost without change. Between 2002 and 2008 the percentage of people who dement food insecure decreased only by 1 percent. Food insecurity seems to be especially prevalent in the north of the country, with seven of the nine worst affected provinces situated in Northern Laos (Leroux, Anke, et al. 2016).

Laos is the world's most heavily bombed country in the world. Two thirds of the country are still contaminated with unexploded ordnance. It is not only dangerous for the inhabitants as it can cause harmful injuries but it also prevents using the land for agriculture. Natural disasters such as floods, droughts and pests are occurring periodically and can lead to acute undernutrition. The infrastructure is also undeveloped. Micronutrient deficiencies affect large parts of the population. The reason can be seen in high consumption of rice which does not contain necessary vitamins. Over 40 percent of children under 5 and 63 percent of children under 2 suffering from anaemia, and almost 45 percent of children under 5 and 23 percent of women between 12 and 49 years of age affected by sub-clinical vitamin A deficiency (World food programme, 2016).

The main source of proteins is fishing. Fishing in rivers requires specific knowledge and equipment, such as boats, special nets and other gear, because of strong water flows. In the poorest areas, where the cheaper fishing gear has to be used, the fishing possibilities are limited to accessing resources along the edges of the rivers with smaller gear during periods of lower water, and assisting others during peak fishing periods (Foppes, Joost, and Sounthone Ketphanh 2014).

Lao government has efforts to graduate from the Least Developed Countries category, by 2020. We partner with local and international development (Slater, Richard, and Khamlouang Keoka 2012).

2.5.3 Myanmar

Myanmar is the largest country in Southeast Asia with a land area of 676,578 km. It is rich in natural resources with immense possibilities, including agricultural land, forestry, natural gas, various metals and gems, and water resources (World food programme, 2016 b).

Myanmar, that was for decades isolated country, is now experiencing numerous political and economic reforms. economic opportunity. The economic impacts are already visible in increased foreign direct investment. Two sectors facing major changes are agriculture and hydropower. These two sectors are the most significant in Myanmar's economy. The economy is based on small subsistence and marginal farmers. 30 % of Myanmar's population lives in urban areas. The main crops cultivated in Myanmar include cereals (e.g. paddy, wheat, maize, sorghum), oilseeds (e.g. groundnut, sesame, sunflower, mustard), diffident kinds of pulses, industrial crops (e.g. cotton, jute, sugarcane, rubber, coffee), kitchen crops (e.g. chilly, onion, garlic) and fruits and vegetables (Cho, Ame, Aung Tun Oo, and Stijn Speelman 2016).

Fish is important for domestic food security. It is the main source of animal protein and the lead provider of micronutrients. These nutrients are important especially for child development. Fish is important cost in the food budget of households, 14% of food expenditure is spent on fish and 19% of food expenditure on rice. Fish farming also generates a lot of employment – about twice as much per acre as paddy farming. Fish-farming accounts for about 20% of domestic fish consumption in Myanmar (Belton, Ben, et al.,2015).

Severely high rates of Vitamin A deficiencies (37% of pre-schoolers) indicate that Vitamin A is lacking in the daily diet. Anaemia is a severe public health issue, extremely high among pregnant women, children under 5 and also high in non-pregnant women (FAO,2014).

2.5.4 Vietnam

Land is still a key player in the development process of Vietnam. More than 20% of GDP is composed of agriculture and less than 30% of Vietnamese population lives in urban areas. The rural population is composed of poor and small-scale paddy rice farmers. Rice is the most important staple food in Vietnam and its most important export product, which makes the agricultural sector key to poverty reduction and food security. Vietnam is the second largest exporter of rice in the world but there is a high number of household who are still buying more food than producing. Vietnam was highly influenced by the financial crisis in 2008 that caused fast increase of prices of food. This situation made Vietnam one of the hunger hotspots in Asia and Pacific (Rutten et al., 2014).

After almost a decade of high growth, Vietnam tumbled to low growth rates in 2008 due to the global financial crisis. Real GDP growth averaged 7.25 per cent during 2001-07, this was one of the highest numbers in Asia. Average annual growth slowed down to 5.5 per cent in 2008-09; revived to a little over 6.25 per cent in 2010-11 with expansionary policies; and then fell again to 5.25 per cent during 2011-13 (Kalra, 2015).

Vietnam Government is active in the efforts to improve food security. Government research institutes have been experimenting with new rice technologies to develop more generative and more resistant varieties. In Vietnam, hybrid rice seeds were first distributed in the early 1990s in the country's north. The socialist government has been working hard to increase the national coverage of hybrid rice and by 2008 it was being grown in 31 provinces in the north and five provinces in central Vietnam (Bonin and Turner, 2012).

Despite government's efforts, Vietnam's rural populations is still facing challenges in overcoming poverty. There is an inconsiderable number of rural population who owns no land or has only limited access to the small, low quality plots. In the mountain areas, natural disasters are occurring quite frequently and disrupt the production of crops as well as negative weather patterns that have influence in the

agriculture. Most poor people live in the north-central and north-east regions, in the Mekong Delta and central coastal regions, which are home to seven out of 10 of Vietnam's poor. Members of the country's 53 ethnic minority groups face particular hardships, these groups account for only 13 percent of Vietnam's population but 30 percent of the country's poor (IFAD, 2013).

2.6 Orientation analysis

2.6.1 Global hunger index

Global hunger index is a tool created for measuring hunger globally and also in specific regions. The GHI is calculated every year so the results can be compared over time. The GHI in multidimensional index and is composed of four indicators: undernourishment, child wasting, child stunting and child mortality. In the Table 8, the values of the Global hunger index in the reference years, except year 2010.

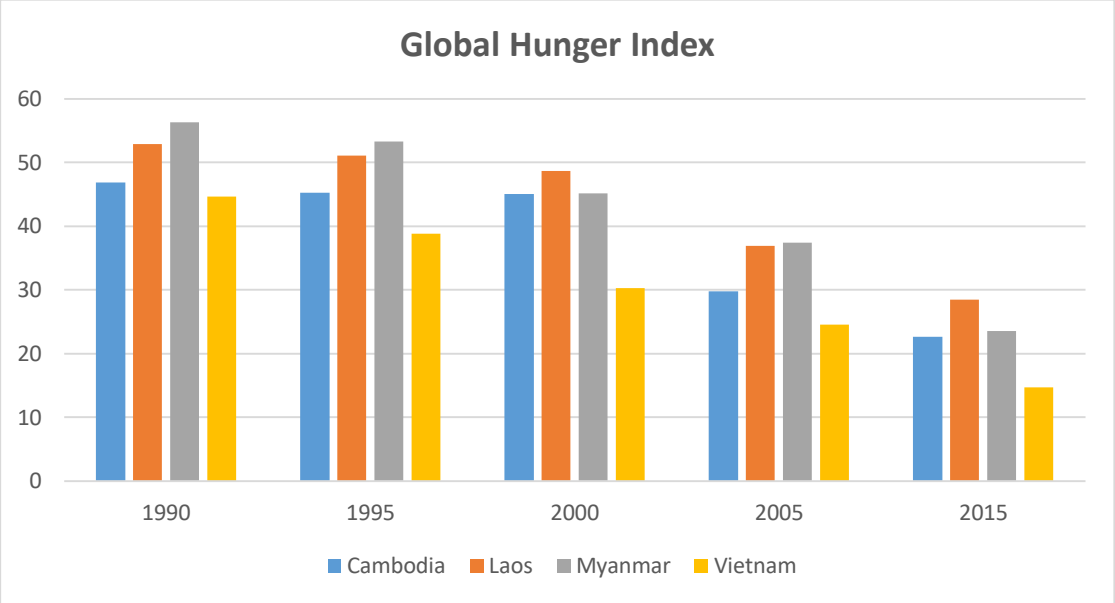
Table 6 GHI in CLMV

Country	1990	1995	2000	2005	2015
Cambodia	46,9	45,2	45,0	29,8	22,6
Laos	52,9	51,1	48,7	36,9	28,5
Myanmar	56,3	53,3	45,1	37,4	23,5
Vietnam	44,6	38,8	30,3	24,6	14,7

source: International food policy research institute

In the graph 1, it can be observed that index is decreasing in all countries. The ranking of the countries changed over the years only between Laos and Myanmar. Vietnam has the lowest value of indicator through observed years.

Graph 1 GHI in CLMV

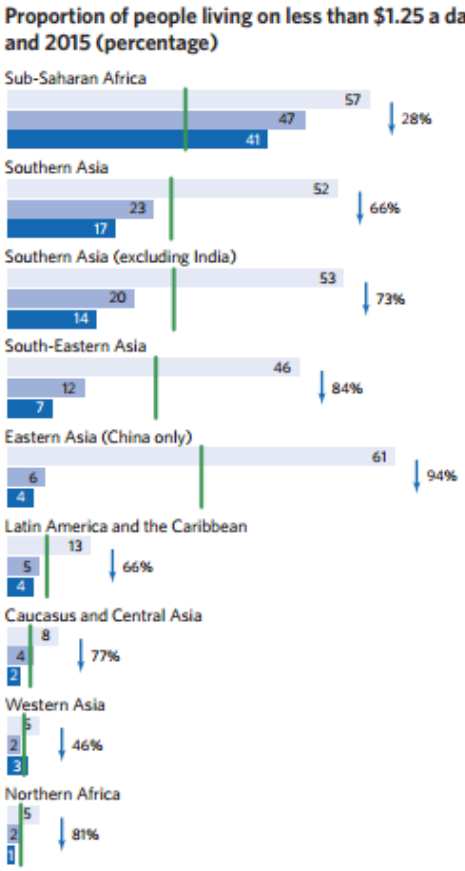


Source: own work

2.6.2 Millennium development goal 1

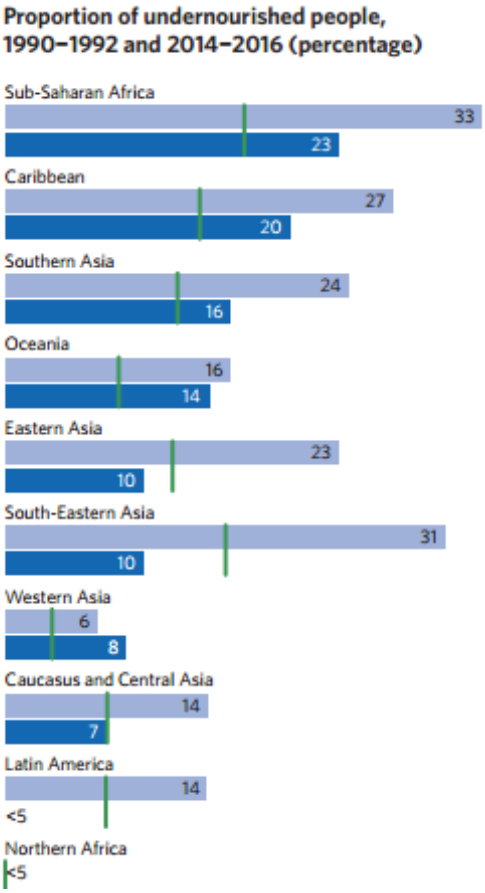
Year 2015 was the target year of the Millennium development goals. In the Figures 7 and 8, there is shown a decline in the variables measuring MDG1: Eradicate extreme poverty and hunger. The number of people living on less than 1.25 USD a day dropped by 84 % in South – East Asia countries and proportion of undernourished people dropped by 66 %. The MDG targets of halving the proportion of people living in extreme poverty and hunger have been met or almost met in most of the monitored countries.

Figure 6 MDG1a



source: MDG report 2015

Figure 7 MDG1b



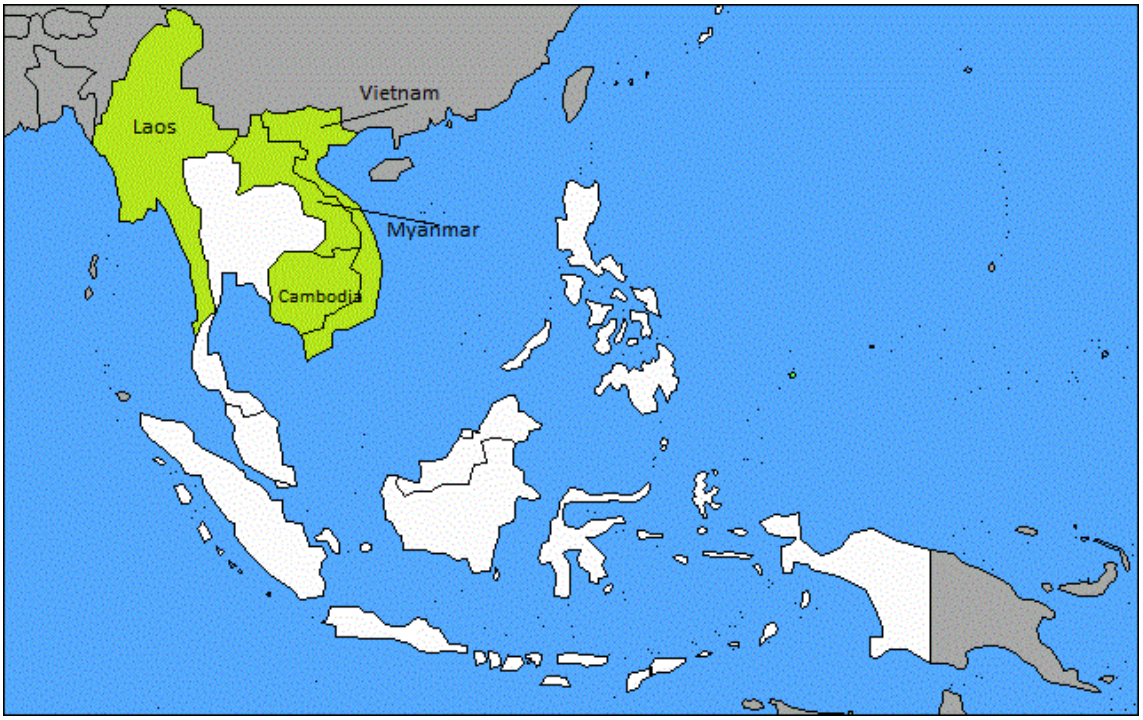
source: MDG report 2015

3 Methodology and Data

3.1 Analysed countries

For the analytical part of the work will be analysed countries belonging to the CLMV. These countries are Cambodia, Laos, Myanmar and Vietnam, they were considered the slowest developing countries of Southeast Asia. The map of the countries is shown in the Figure 11.

Figure 8 Map of CLMV countries



source: own work

3.2 Composite indicator

For the first part of the analytical part of the work, the composite indicator of food security will be created. Food security is very complex topic and cannot be described by single indicator. The composite indicator will be created for the years 1990, 1995, 2000, 2005, 2010 and 2015 in order to create the time series of the food security for each country.

3.2.1 Selection of sub – indicators

Selection of sub – indicators is the most important part of the process of creating composite indicator. In this work the sub – indicators were chosen from the food security indicators suitable for measuring food security, created by FAO and described in Table 6.

Table 6 Food security indicators

Availability	Average dietary energy supply adequacy
	Average value of food production
	Share of dietary energy supply derived from cereals, roots and tubers
	Average protein supply
	Average supply of protein of animal origin
Access	Percent of paved roads over total roads
	Road density
	Rail lines density
	Gross domestic product per capita (in purchasing power equivalent)
	Domestic food price index
	Prevalence of undernourishment
	Share of food expenditure of the poor
	Depth of the food deficit
	Prevalence of food inadequacy

Stability	Cereal import dependency ratio
	Percent of arable land equipped for irrigation
	Value of food imports over total merchandise exports
	Political stability and absence of violence/terrorism
	Domestic food price volatility
	Per capita food production variability
	Per capita food supply variability

Utilization	Access to improved water sources
	Access to improved sanitation facilities
	Percentage of children under 5 years of age affected by wasting
	Percentage of children under 5 years of age who are stunted
	Percentage of children under 5 years of age who are underweight
	Percentage of adults who are underweight
	Prevalence of anaemia among pregnant women
	Prevalence of anaemia among children under 5 years of age
	Prevalence of vitamin A deficiency in the population
	Prevalence of school-age children (6-12 years) with insufficient iodine intake

Source: own work according to FAO

The indicators are divided to the groups according to the pillars of food security. For this work I chose from each pillar 2 indicators, so in total there is 8 sub-indicators used. The choosing process was based on the availability of the data in all the years needed and also on the representation of all pillars. The sub - indicators chosen for the purpose of this work are described in Table 7.

Table 7 Chosen sub – indicators

Availability	Average dietary energy supply adequacy
	Average value of food production
Access	Prevalence of undernourishment
	Depth of the food deficit
Stability	Value of food imports in total merchandise exports
	Per capita food production variability
Utilization	Percentage of population with access to improved water sources
	Percentage of children under 5 years of age who are underweight

Source: own work

For the analysis, data from years 1900, 1995, 2000, 2005, 2010 and 2015 were used. The year 1990 was chosen as the starting year of the analysis because most of the MDGs is related to this year. The five-year interval was chosen based on the availability of the data. 2015 is the target year of MDGs so it was also chosen as the last year of the analysis, despite the fact, that some data had to be estimated.

3.2.2 Treatment of missing values

In the dataset the missing values not exceed the 5% limit of missing values, so the missing values will not be used in the analysis. The exception is year 2015, for this year, there would not be enough data, so they will be predicted by the Excel forecast function, with the 95 % confidence interval. The predicted data will be marked by the sign "*".

3.2.3 Multivariate exploratory data analysis

For the analysis, basic characteristics such as Mean, Standard deviation, minimum and maximum values of the indicator will be computed. The correlation matrix of the sub - indicators will be created to analyse correlations among sub – indicators.

Basic statistics as well as correlation matrixes will be computed in program Statistica.

3.2.4 Normalization of data

For the normalization, the Z- score method will be used. It is necessary to determine whether the chosen sub – indicators are MAX type or MIN type. Z- scores method replaces values of original indicator of max type by dimensionless Z–scores $Zj = \frac{Xj - \overline{xj}}{\sqrt{var}xj}$ with zero mean and unit variance. For the transformation of min formula $Zj = \frac{\overline{xj} - Xj}{\sqrt{var}xj}$ is used. In this case, for the normalization, mean and st. deviation from the data from all countries will be used to ensure better comparability of data in context. The advantage of this method is that it provides no distortion from the average and unifies variation of indicators. Due to the linear relationship the relative differences between the values will remain after the normalization retained.

3.2.5 Assignment of weights

The weights are assigned according to their importance, based on the expert analysis. For this work it is used equal weighting, where all the sub – indicators have the same weight that is equal 1.

3.2.6 Aggregation

As an aggregation method, weighted average will be used, because of the presence of missing values.

3.3 Pillars of food security

To assess the situation in the countries were analysed the causes of the progress of the food security indicator. For this analysis, data in pillars will be summed up and the best and worst pillar will be marked. The best pillar has the highest score of the composite indicator, the worst pillar has the lowest score of the composite indicator.

It is necessary to use current data to address the current situation, but it is not suitable to use estimated data, so the data from 2010 will be used.

3.4 Linear regression analysis

Linear regression analysis is an approach for modelling the relationship between a dependent variable y and one or more independent variables denoted X. At the centre of the regression analysis is the task of fitting a single line through a scatter plot. The simplest form with one dependent and one independent variable is defined by the formula y = a + b*x, where

y = estimated dependent

a = constant

b = regression coefficients

x = independent variable

Correlation coefficient (R) and coefficient of determination (R^2) will be calculated for each country, based on the result of the linear regression. Multiple correlation coefficient (R) indicates the strength of the association between set of independent variables as a whole and given dependent variable. The value can range from +1 to -1 where:

+1 = perfect positive relationship

0 =no relationship

-1 = perfect negative relationship

Coefficient of determination (R^2) measure the proportion of variance of the dependent variable that is explained by the independent variables set as a whole. The coefficient can vary between 0 and 1. The higher the value of R2, the greater the explanatory power of the regression equation (Seber and Lee, 2003).

Regression analysis can be used to predicts trends and future values. The regression analysis can be used to get point estimates. Typical questions are “what will the price for gold be in 6 months from now? What is the total effort for a task X? The prediction will be done in 95% confidential interval.

For the linear regression analysis, program Statistica 12 will be used.

3.5 Variables

Average dietary energy supply adequacy

All the sub – indicators were chosen according to the FAO methodology.

Average dietary energy supply adequacy expresses the Dietary Energy Supply (DES) as a percentage of the Average Dietary Energy Requirement (ADER). Each country's or region's average supply of calories for food consumption is normalized by the average dietary energy requirement estimated for its population to provide an index of adequacy of the food supply in terms of calories.

Average value of food production – X2

The indicator expresses the food net production value (in constant 2004-06 international dollars), as estimated by FAO and published by FAOSTAT, in per capita terms. It provides a cross country comparable measure of the relative economic size of the food production sector in the country. The indicator is calculated in three year averages, from 1990-92 to 2011-13, to reduce the impact of possible errors in estimated production, due to the difficulties in properly accounting of stock variations in major food.

Prevalence of undernourishment – X3

The prevalence of undernourishment expresses the probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover her/his energy requirement for an active and healthy life. The indicator is computed by comparing a probability distribution of habitual daily dietary energy consumption with a threshold level called the minimum dietary energy Requirement. Both are based on the notion of an average individual in the reference population.

Depth of the food deficit – X4

The depth of the food deficit indicates how many calories would be needed to lift the undernourished from their status, everything else being constant. The average intensity of food deprivation of the undernourished, estimated as the difference between the average dietary energy requirement and the average dietary energy consumption of the undernourished population (food-deprived), is multiplied by the number of undernourished to provide an estimate of the total food deficit in the country, which is then normalized by the total population.

Value of food imports in total merchandise exports – X5

This indicator provides a measure of vulnerability and captures the adequacy of foreign exchange reserves to pay for food imports, which has implications for national food security depending on production and trade patterns. The indicator is calculated in three year averages, from 1990-92 to 2010-11, to reduce the impact of possible errors in estimated trade flows.

Per capita food production variability –X6

Per capita food production variability corresponds to the variability of the "food net per capita production value in constant 2004-2006 international $" as disseminated in FAOSTAT. The per capita food production variability compares the variations of the per capita food production across countries and time.

Percentage of population with access to improved water sources – X7

Access to an improved water source refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 litres a person a day from a source within one kilometre of the dwelling.

Prevalence of anaemia in pregnant women – X8

Prevalence of anaemia in pregnant women is the percentage of pregnant women whose haemoglobin level is smaller than 110 grams per litre at sea level. Anaemia is a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs. Specific physiologic needs vary with a person's age, gender, residential elevation above sea level (altitude), smoking behaviour, and different stages of pregnancy. Iron deficiency is thought to be the most common cause of anaemia globally, but other nutritional deficiencies (including folate, vitamin B12 and vitamin A), acute and chronic inflammation, parasitic infections, and inherited or acquired disorders that affect haemoglobin synthesis, red blood cell production or red blood cell survival, can all cause anaemia. The prevalence of anaemia is an important health indicator. When used with other measurements of iron status, the haemoglobin concentration can provide information about the severity of iron deficiency. The cut-off values for public health significance is 40%. A prevalence of anaemia equal or higher than this level signals a severe public health problem.

3.6 Data

The table 9 shows chosen indicators of the analysis, with their units and type. The code is added for better orientation in the analysis. The units differ so there is a need of normalization of the data.

Table 8 Data, min or max type, units

Pillar	Sub - indicator	Unit	Code	Type
Availability	Average dietary energy supply adequacy	%	X1	MAX
	Average value of food production	International $ per capita	X2	MAX
Access	Prevalence of undernourishment	%	X3	MIN
	Depth of the food deficit	%	X4	MIN
Stability	Value of food imports in total merchandise exports	Constant 2004-2006 thousand international $ per capita	X5	MIN
	Per capita food production variability	%	X6	MIN
Utilization	Percentage of population with access to improved water sources	%	X7	MAX
	Prevalence of anaemia in pregnant women	%	X8	MIN

Source: own work

In the table 10, the data matrix for year 1990 is shown, there is one missing value which is less than 5 % missing values in the matrix, so there is no need for imputation of this value. Data matrices for years 1995 – 2015 are listed in Appendix A.

Table 9 Data 1990

	X1	X2	X3	X4	X5	X6	X7	X8
Cambodia	99	119	32,1	205	10	10,9	23,4	60,4
Laos	91	129	42,8	325	10	10,1	Missing	51,9
Myanmar	77	131	62,6	511	18	4,7	58,5	49,4
Vietnam	88	148	45,6	368	5	3,3	62,7	49,1

Source: own work

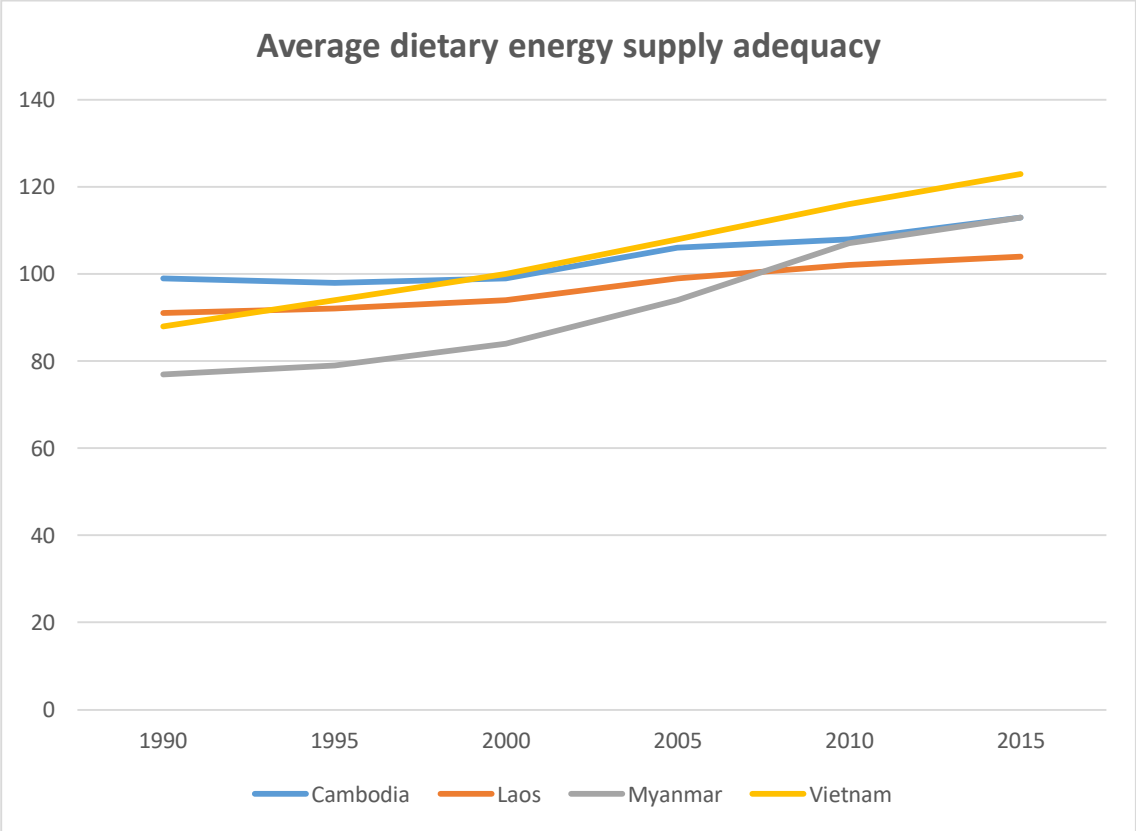
4 Results

4.1 Progress of variables in countries

Average dietary energy supply adequacy – X1

If the indicator is growing, it means that Average Dietary Energy Requirements are fulfilled more, people have higher calories intake. We can say that this indicator is MAX type. The indicator grew over the years in all monitored countries as it is described in Graph 2.

Graph 2 Average dietary energy supply adequacy



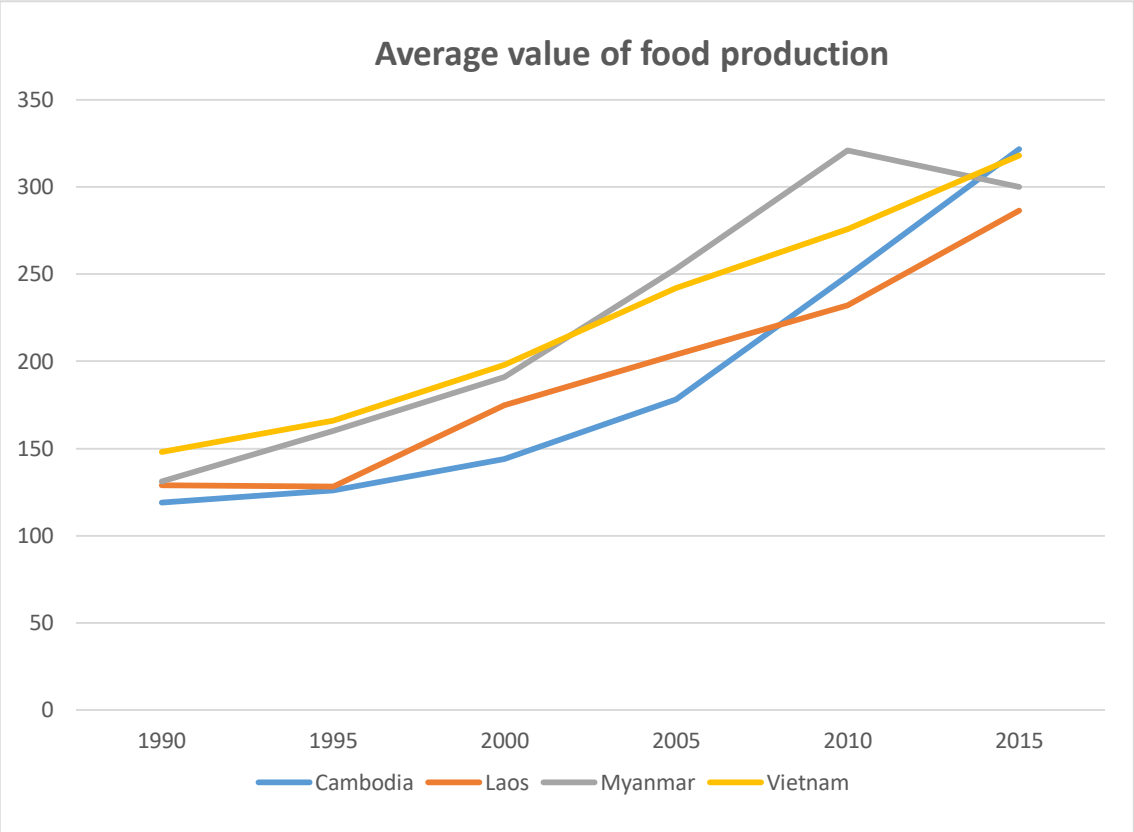
Source: own work

Average value of food production – X2

When the indicator is higher, it means that the production of the food in the country grew. The indicator is expressed in the constant price, so it is not influenced by the changes of prices. The indicator is MAX type. Till the year 2010 the indicator grew

in all countries, however in 2015 dropped little bit in Myanmar, which was hit by widespread flooding. The progress in this indicator is described in Graph 3.

Graph 3 Average value of food production

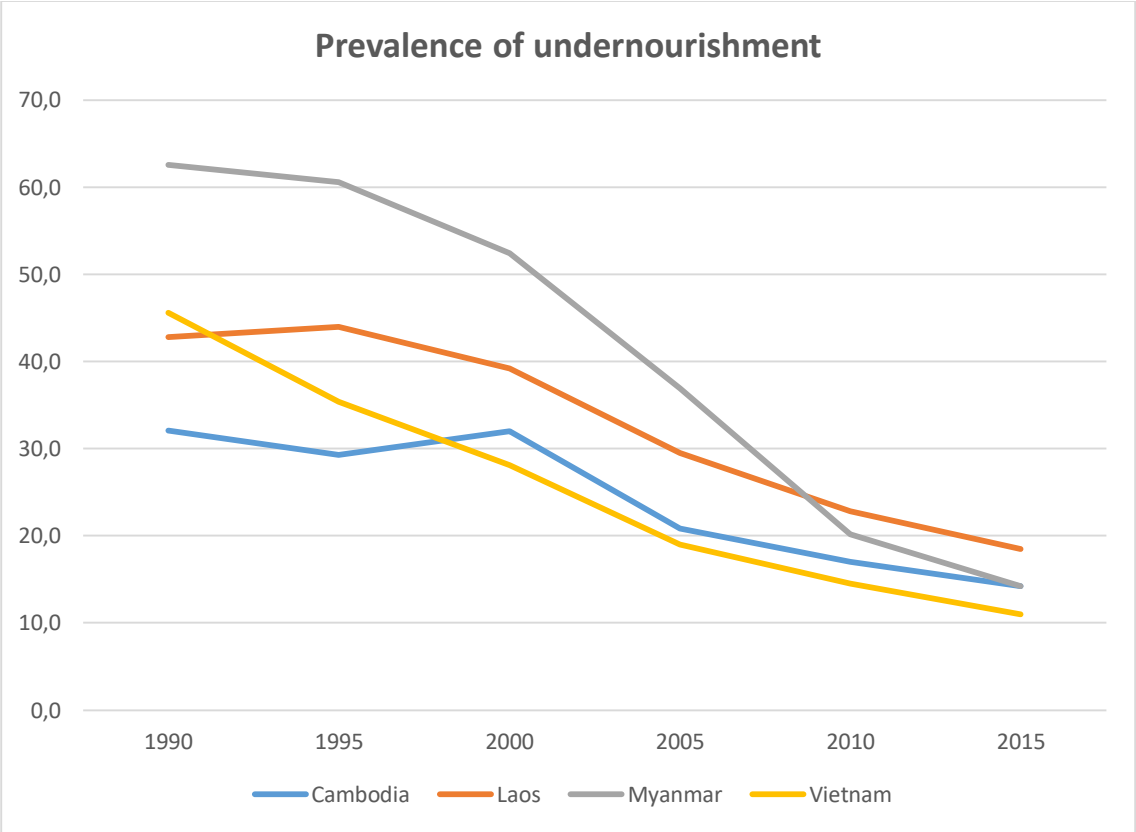


Source: own work

Prevalence of undernourishment – X3

When the indicator is growing, the percentage of undernourished people in the country is higher, which is unwanted effect. This indicator is MIN type. Till 2000, the prevalence of undernourishment fluctuated around same numbers in Myanmar and Cambodia, after 2000 there is significant drop of this indicator in all monitored counties as shown in Graph 4.

Graph 4 Prevalence of undernourishment

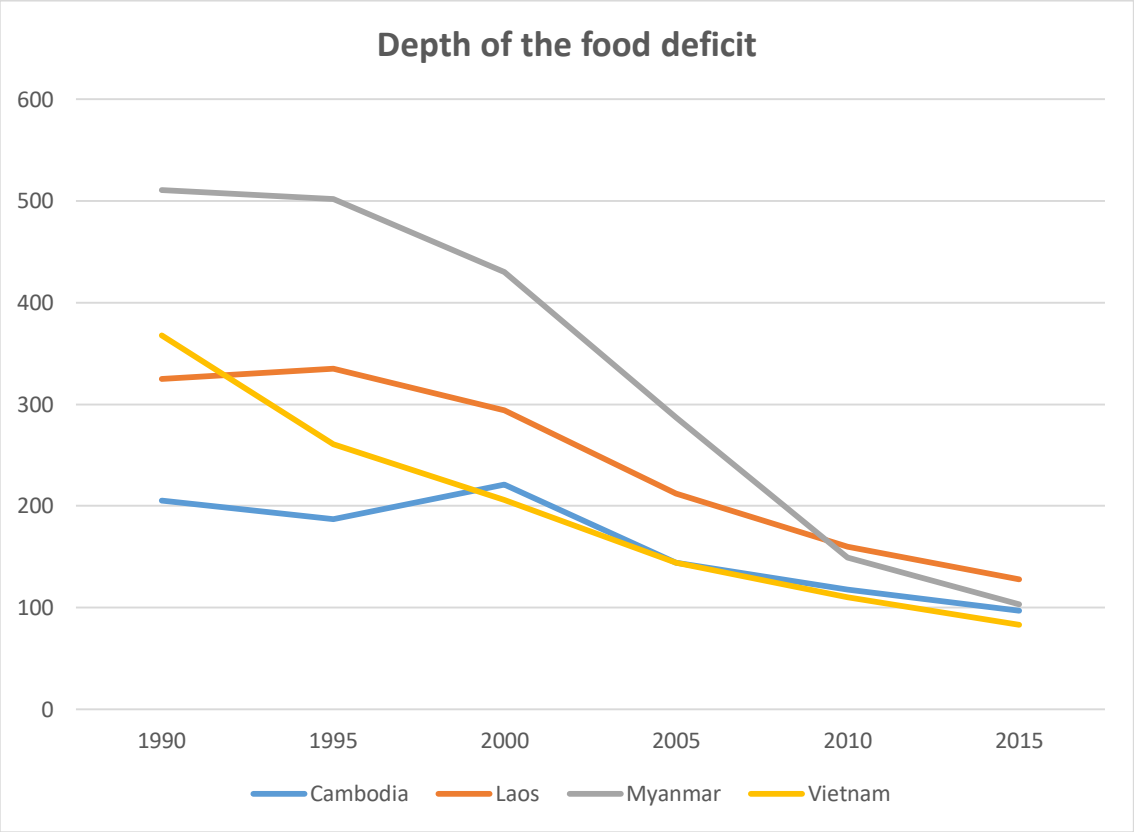


Source: own work

Depth of the food deficit – X4

The higher the indicator is, the higher is the gap between dietary energy requirements and real consumption. This indicator is MIN type, because it is desirable to reduce the gap as much as possible. The progress of this indicator is described in Graph 5.

Graph 5 Depth of the food deficit

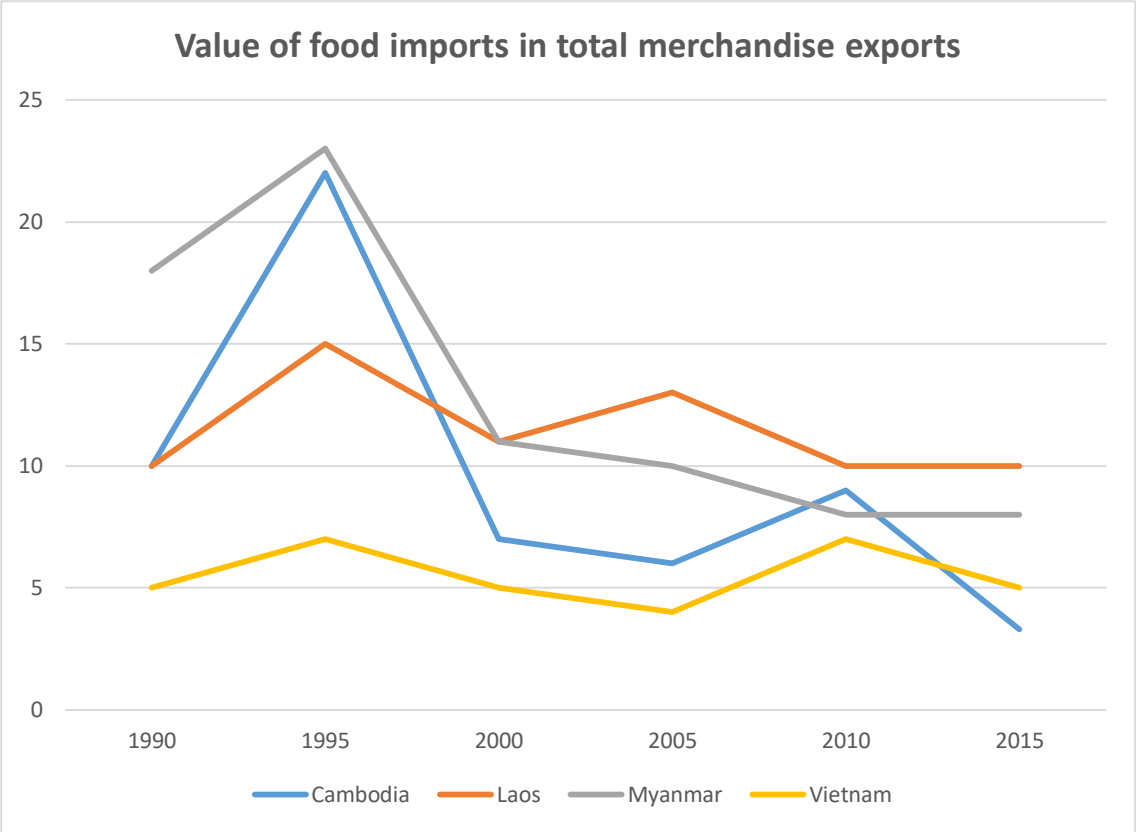


Source: own work

Value of food imports in total merchandise exports – X5

The progress of the indicator is shown in the Graph 6. It is a MIN type indicator.

Graph 6 Value of food imports in total merchandise exports

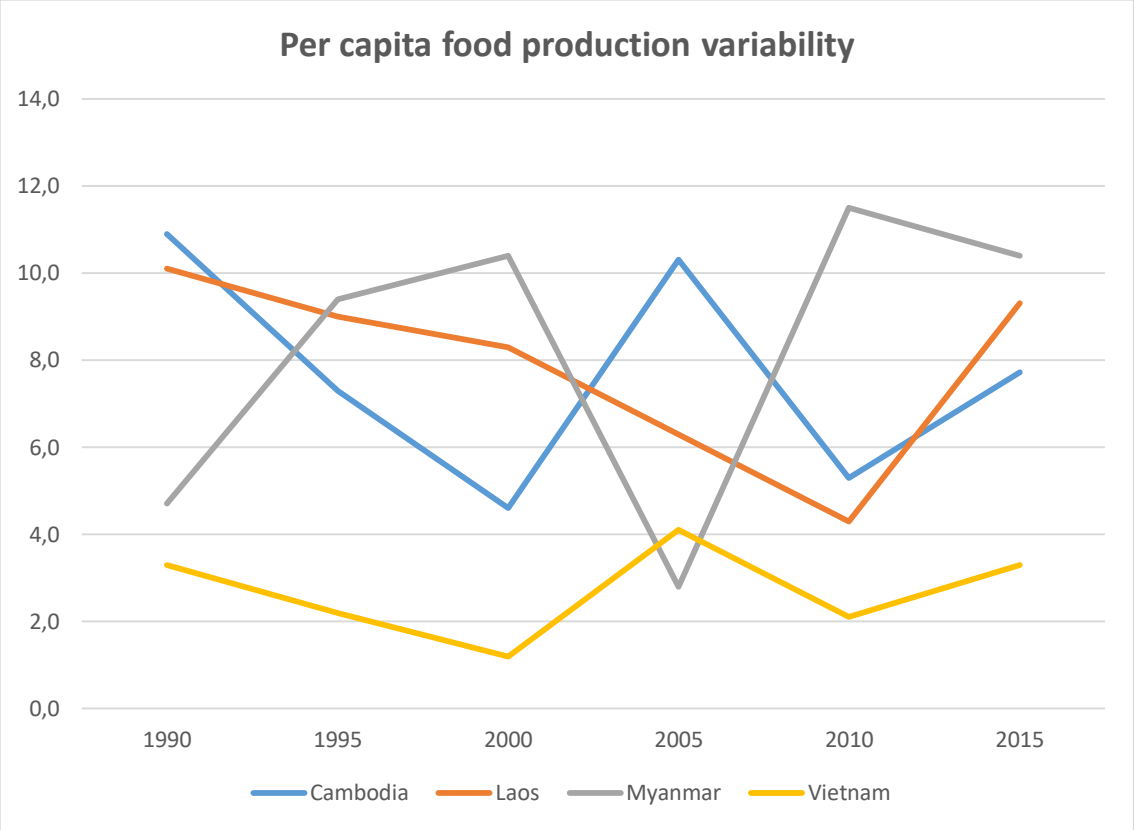


Source: own work

Per capita food production variability –X6

This indicator is MIN type, the goal is to achieve the smallest possible variability of food production and to reduce to food production shocks. In the Graph 7, it can be seen, that the variability does not have any trend and the values are fluctuating irregularly.

Graph 7 Per capita food production variability

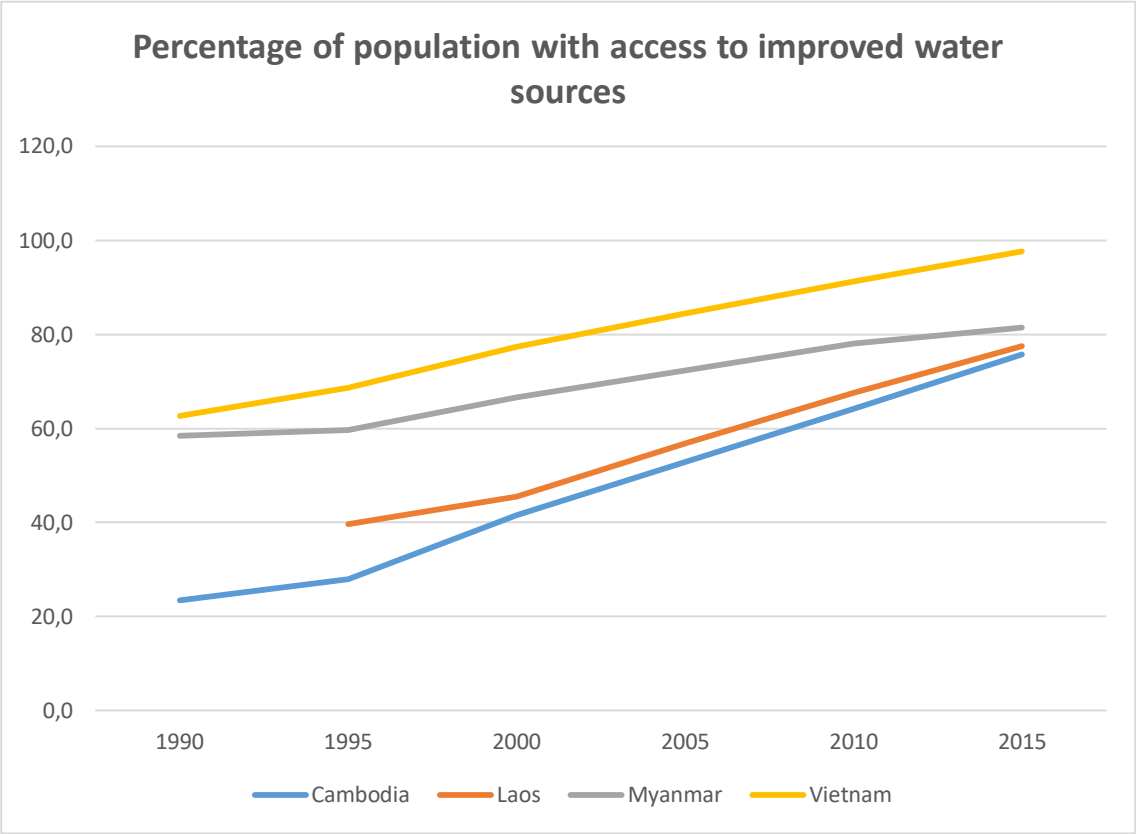


Source: own work

Percentage of population with access to improved water sources – X7

The higher the indicator the higher percentage of the citizens has access to the improved water sources. This indicator is MAX type, because it is desirable to increase the number of people with this access. Access to improved water sources grew in all countries during the reporting period as shown in Graph 8.

Graph 8 Percentage of population with access to improved water sources

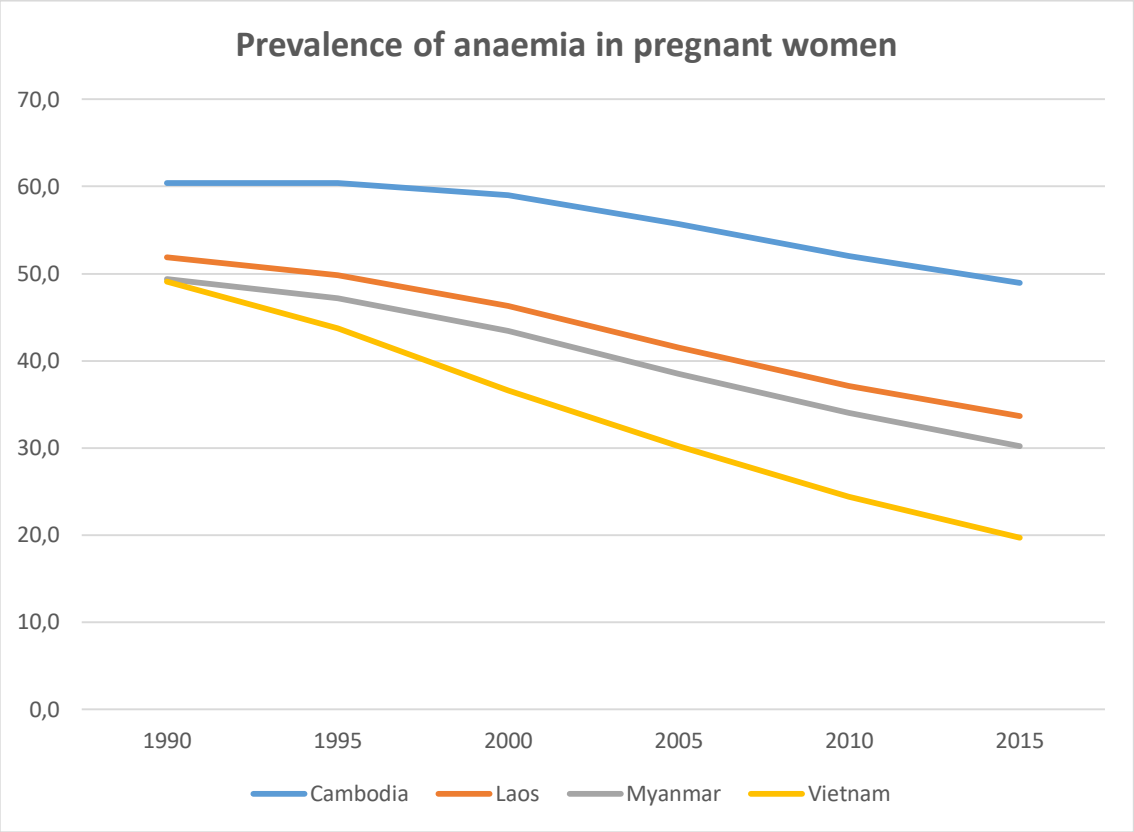


Source: own work

Prevalence of anaemia in pregnant women – X8

Anaemia is a serious health condition that should be eradicated, that means this is a MIN type indicator. In 1990, in all countries the percentage of women exceeded the significant 40 %. In 2015, the only country that did not succeed to lower the value under 40 % is Cambodia as shown in Graph 9.

Graph 9 Prevalence of anaemia in pregnant women.



Source: own work

4.2 Basic characteristics

For calculating the composite indicator, it is important to first calculate basic statistical characteristics. Among these necessary, important characteristics are: arithmetic mean, median, minimum, maximum, variance and standard deviation. In the table 11, there are shown basic characteristics for year 1990, years 1995 – 2015 are listed in Appendix B.

Table 10 Basic characteristics 1990

	Mean	Median	Min	Max	Var	St. Dev
X1	88,7500	89,5000	77,0000	99,0000	82,92	9,1059
X2	131,7500	130,0000	119,0000	148,0000	144,92	12,0381
X3	45,7750	44,2000	32,1000	62,6000	159,66	12,6355
X4	352,2500	346,5000	205,0000	511,0000	15958,25	126,3260
X5	10,7500	10,0000	5,0000	18,0000	28,92	5,3774
X6	7,2500	7,4000	3,3000	10,9000	14,52	3,8101
X7	48,2000	58,5000	23,4000	62,7000	465,69	21,5799
X8	52,7000	50,6500	49,1000	60,4000	27,93	5,2846

Source: own work

In the table 12, there are shown values of the Mean and standard deviation from the FAO Indicators of the food security file. These values were used to normalize the data matrices, in order to get comparable results. Values marked "*" are estimated values.

Table 11 Mean and Standard deviation in the world

	1990		1995		2000		2005		2010		2015	
	Mean	St. dev	Mean	St. dev	Mean	St. dev	Mean	St. dev	Mean	St. dev	Mean	St. dev
X1	112	17,4	113	16,5	115	16,5	118	15,4	120	14,2	123	15,0
X2	242	227	248	229	264	242	281	249	303	253	323*	263*
X3	24,2	16,8	23,7	16,4	21,3	14,4	18,3	12,9	15,6	11,5	13,8	11,2
X4	138	140	127	138	111	117	110	107	90	96	81	97
X5	7	132	6	108	5	75	5	105	5	119	5*	131*
X6	1,7	13,0	2,8	14,7	2,0	12,9	2,5	13,3	2,3	11,2	2,3*	12,7*
X7	78,7	22,3	80,8	21,1	83,1	19,4	85,4	18,1	87,7	16,6	90,1*	15,0*
X8	42,0	10,6	39,9	11,6	37,6	12,0	35,5	11,6	33,2	11,0	31,3*	10,1*

Source: own work

4.3 Correlation matrix

In the next step, correlation matrices were created to find out whether there are significant correlations among indicator. Significant similarity is not desirable because when the data are nearly the same then it is as if we used the same data twice. The table13 shows correlation among indicators in year 1995. There is significant correlation between indicator X1, X3 a X4 caused by using similar variables in the computation of these indicators. It is not entirely correct to use all indicators, but no other data were available in all years and the goal was to keep two indicators in every pillar. Correlation between X6 and X7 was not marked as significant in all reporting years. Correlation matrices for years are listed in Appendix C.

Table 12 Correlation Matrix 1990

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,000							
X2	-0,412	1,000						
X3	-0,998	0,351	1,000					
X4	-0,999	0,446	0,995	1,000				
X5	-0,610	-0,471	0,661	0,580	1,000			
X6	0,766	-0,901	-0,722	-0,790	0,041	1,000		
X7	-0,813	0,865	0,773	0,835	0,035	-0,997	1,000	
X8	0,854	-0,826	-0,818	-0,873	-0,109	0,989	-0,997	1,000

Source: own work

4.4 Composite indicator

The data matrices were normalized by the Z – score method using Mean and Standard deviation from the world´s data. For the aggregation, the weighted average was used, because of the presence of missing data. The normalized matrix for year 1990 is shown in table 14. The normalized matrices for years 1995 – 2015 are listed in Appendix D.

Table 13 Normalized matrix, 1990,

	MAX	MAX	MIN	MIN	MAX	MIN	MAX	MIN	
	X1	X2	X3	X4	X5	X6	X7	X8	Composite indicator
Cambodia	-0,74	-0,54	-0,47	-0,48	0,02	-0,71	-2,48	-1,73	-0,89
Laos	-1,20	-0,50	-1,11	-1,33	0,02	-0,64		-0,93	-0,81
Myanmar	-2,01	-0,49	-2,28	-2,66	0,08	-0,23	-0,91	-0,69	-1,15
Vietnam	-1,37	-0,41	-1,27	-1,64	-0,02	-0,12	-0,72	-0,67	-0,78

Source: own work

This process of normalization and aggregation were run in each year and the results are shown in table 15.

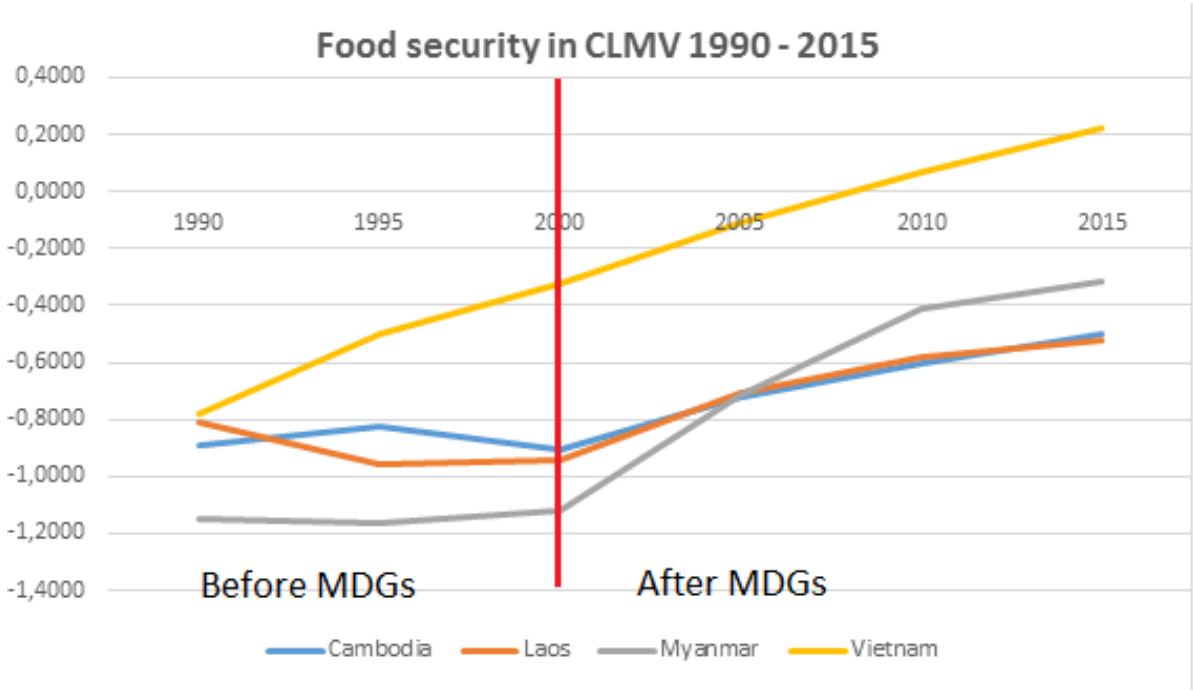
Table 14 Result of food security indicator

	1990	1995	2000	2005	2010	2015
Cambodia	-0,8907	-0,8268	-0,9061	-0,7246	-0,6054	-0,5035
Laos	-0,8130	-0,9562	-0,9401	-0,7060	-0,5783	-0,5244
Myanmar	-1,1479	-1,1624	-1,1214	-0,7130	-0,4150	-0,3167
Vietnam	-0,7778	-0,5019	-0,3264	-0,1098	0,0669	0,2223

Source: own work

In all countries, the value of the food indicator grew between years 1990 and 2015. Between 1990 and 2000 negative progress of the indicator can be observed in Cambodia and Laos, which shows the importance of the MDGs, introduced in 2000. After 2000, the progress in all countries is positive and food security indicator grew as can be seen in Graph 10.

Graph 10 Results of food security indicator



Source: own work

From the Graph 10, it is evident, that the best situation regarding food security is in Vietnam. It is the only country that exceeded the 0 line, which means that the food security in Vietnam is higher than world´s average. The second rank belongs to Myanmar, though the difference between Vietnam´s and Myanmar´s performance is substantial. Cambodia and Laos are since 2000 developing almost identically, so they both belong to the third rank. The biggest change can be seen in Myanmar that went from the last rank in 1990, to the second rank in 2015.

The results of composite indicator were also studied separately for each country. The trend line was added to the graphs to show the progress of the composite indicator in each country. Linear regression analysis was used to analyse the relationship between dependent variable (Food security composite indicator) and time. The exact equation of the linear regression in this case will be Y = a + b1*X1

where

a = constant number of dependent variable without influence of all independent variables.

b1 = change in dependent variable associated with change in first independent

X1 = value of first independent variable.

The linear regression analysis results will be used to perform prediction of the development of the composite indicator.

4.4.1 Cambodia

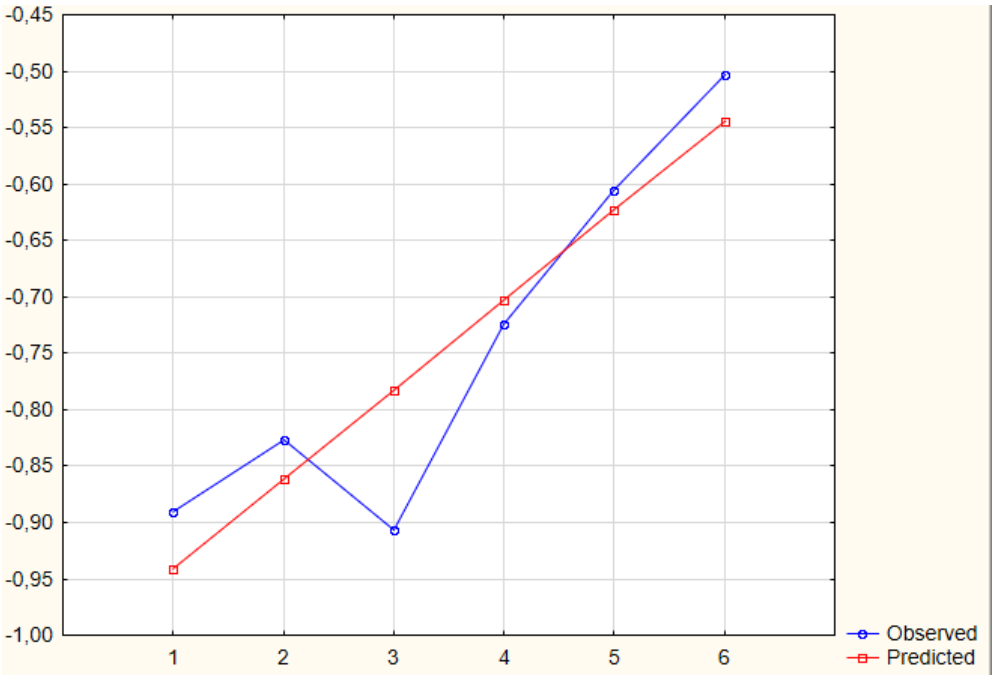
In Cambodia there is a growing trend observed. The biggest deviation from this trend can be seen in 2000, when the political situation in Cambodia was really unstable. After 2000, the political reforms started to take place in Cambodia and motivated international donors. Also in 2001 the first bridge across the Mekong River opened, linking east and west Cambodia (BBC, 2016). This really helped to improve food availability and access. Nevertheless, the food security still remains under the worlds average.

The model can be described as **Y = -1,021 + 0,0796 *X**, the plus sign in the model means growing trend of food security, we can confirm the hypothesis about improvement of food security.

R: 0,91482963 means perfect positive relationship, the food security grows over the time

R2: 0,83691326 means that 83,7 % of the dependent variable is explained by the independent variable

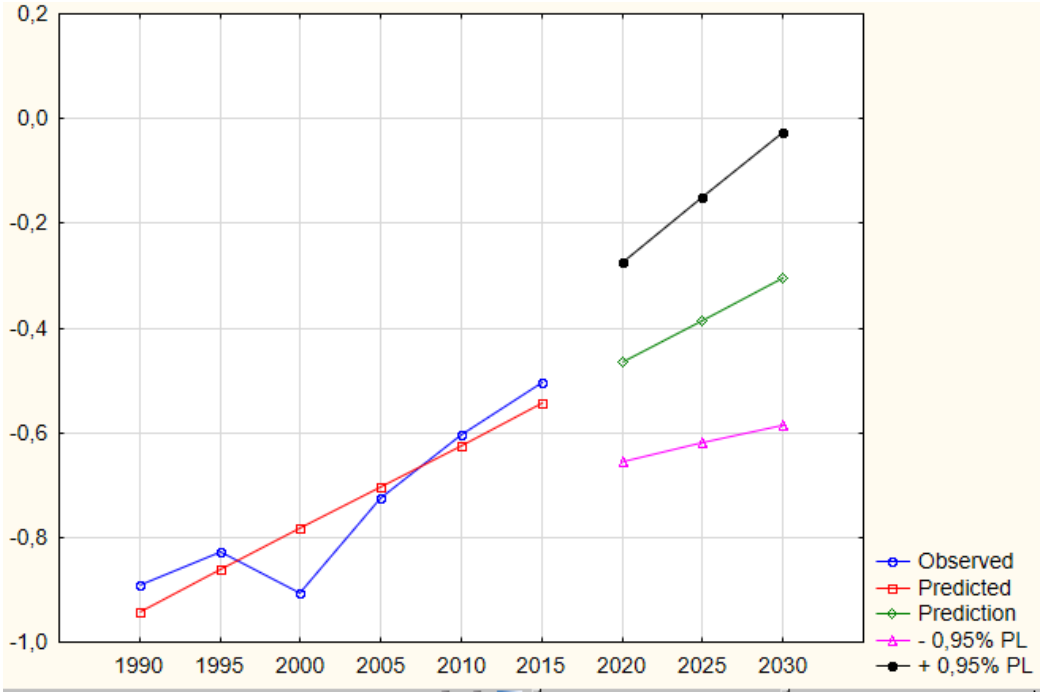
Graph 11 Cambodia -trend



Source: own work

On the graph 12, it can be observed that, even though the progress of the food security indicator is positive, with 95% confidence interval, Cambodia will not achieve the values of the world´s average in 2030 if there will not be any significant change. The worst possible prediction shows return to the values from 2010.

Graph 12 Cambodia -prediction



Source: own work

4.4.2 Laos

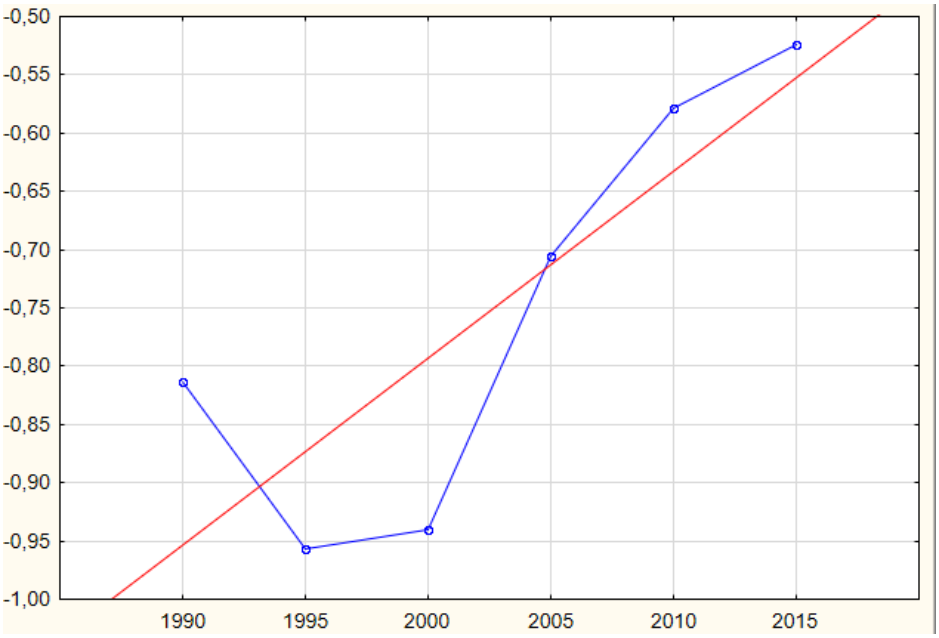
In Laos, there can be seen a drop of the indicator in 1995 and 2000 but overall the food security indicator has growing trend.

The model is described as: **Y= -1,0341 +0,083*X,** the plus sign shows growing trend of food security, we can confitm the hypothesis about improvement of food security in Laos

R=0,82732793 - strong positive relationship, the food security grows over time

R2= 0 ,68447151 – 68,4% of dependent variable is explained by the independent variable, it is not really high but none of the other models (quadratic, exponencial, logarithmic) had better results (R2 was lower)

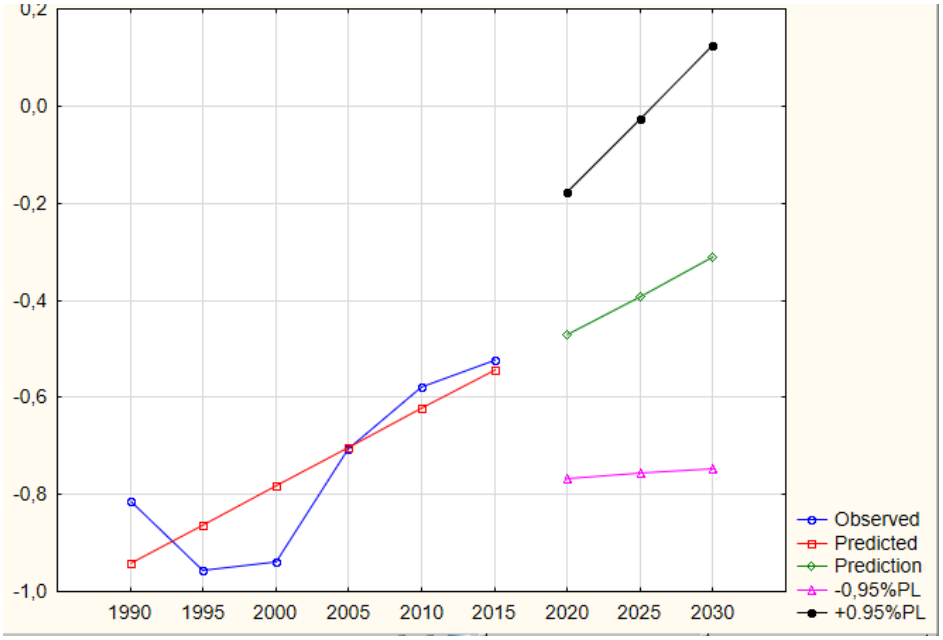
Graph 13 Laos -trend



Source: own work

In the prediction model, relatively high variance of the results can be observed due to the low value of the coefficient of determination. There is 95% chance that Laos will achieve world´s level of food security by 2030.

Graph 14Laos -.prediction



Source: own work

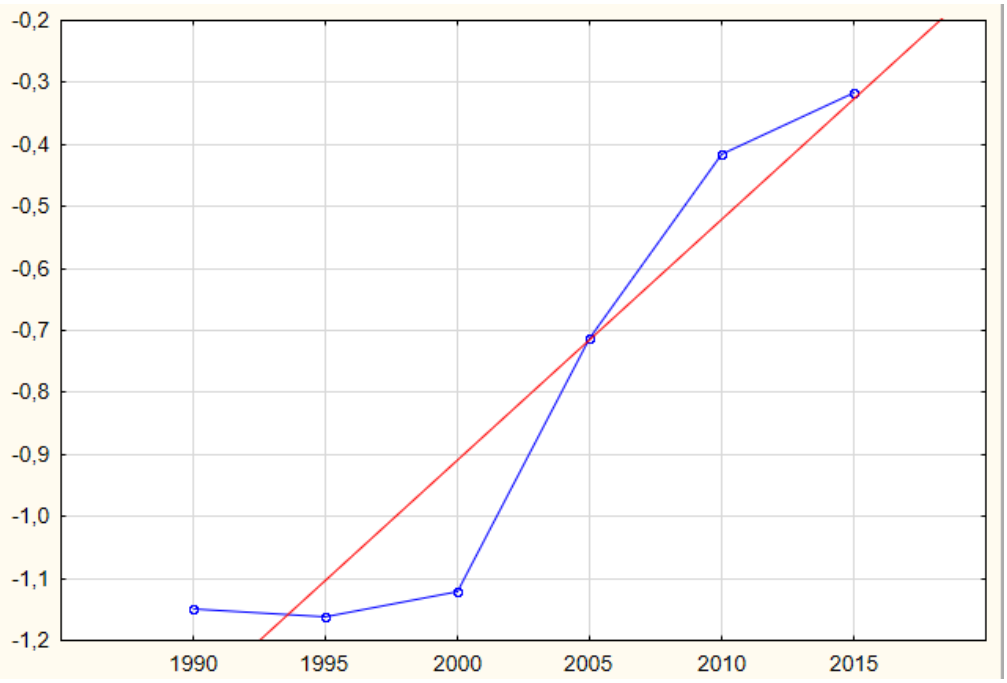
4.4.3 Myanmar

The trend of the food security indictor is growing for the Myanmar, rapid growth can be seen between 2000 and 2015. The model **Y= -1,4934 + 0,1954*X** shows gorwing trend (the plus sign), we can confirm the hypothesis about improvement of the food security in Myanmar.

R = 0,94314737 means perfect positive relationship, the food security grows over the time

R2= 0,88952695 – 88,9% of the dependent variable is explained by the independent variable

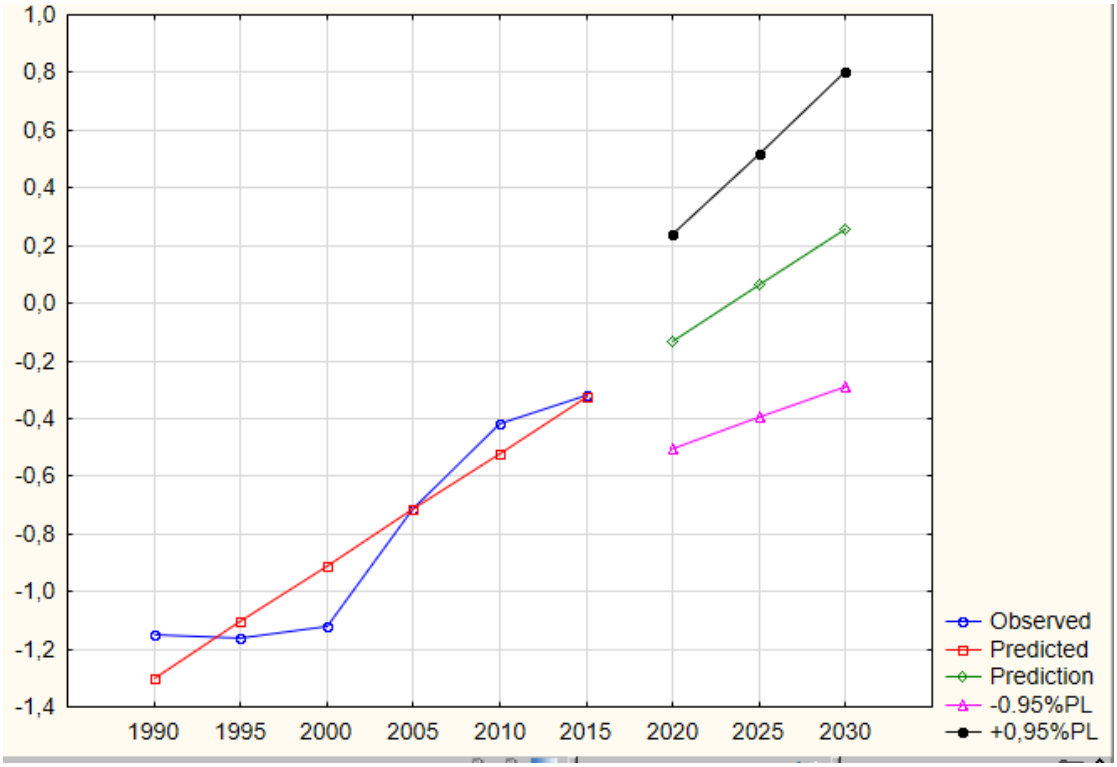
Graph 15 Myanmar - trend



Source: own work

The prediction´s variance is relatively high, but it shows possible achievement of the world´s average line in 2020 or 2025.

Graph 16 Myanmar - prediction



Source: own work

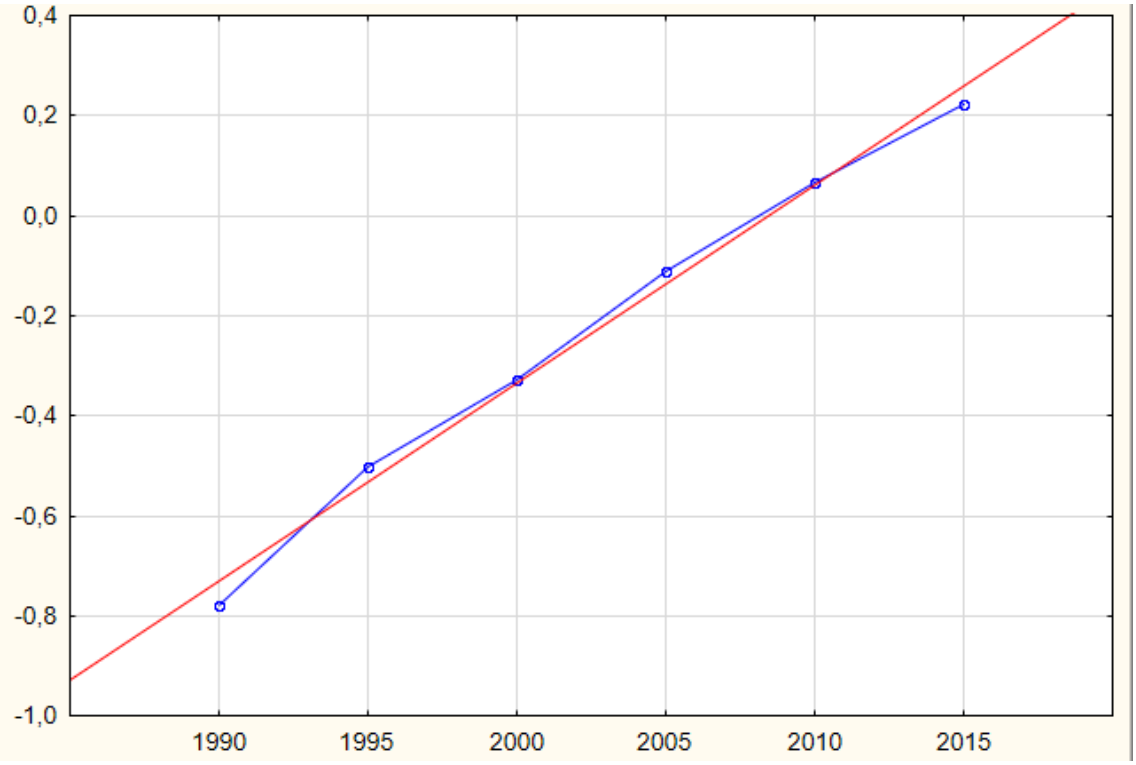
4.4.4 Vietnam

Vietnam is the only country that achieved the level of the food security above world´s average. Vietnam is no longer referred as developing country according to several indicators. The model **Y=-0,9301+0,1978*X** also shows positive development of the food security indicator, the hypothesis about improvement of the food security can be confirmed.

R = 0,99613098 - the correlation coeficient is almost equal one, it means perfect positive relationship, the food secuity gorws over time

R2= 0,99227694 – 99,2 % of the dependent variable is explained ba the independent variable.

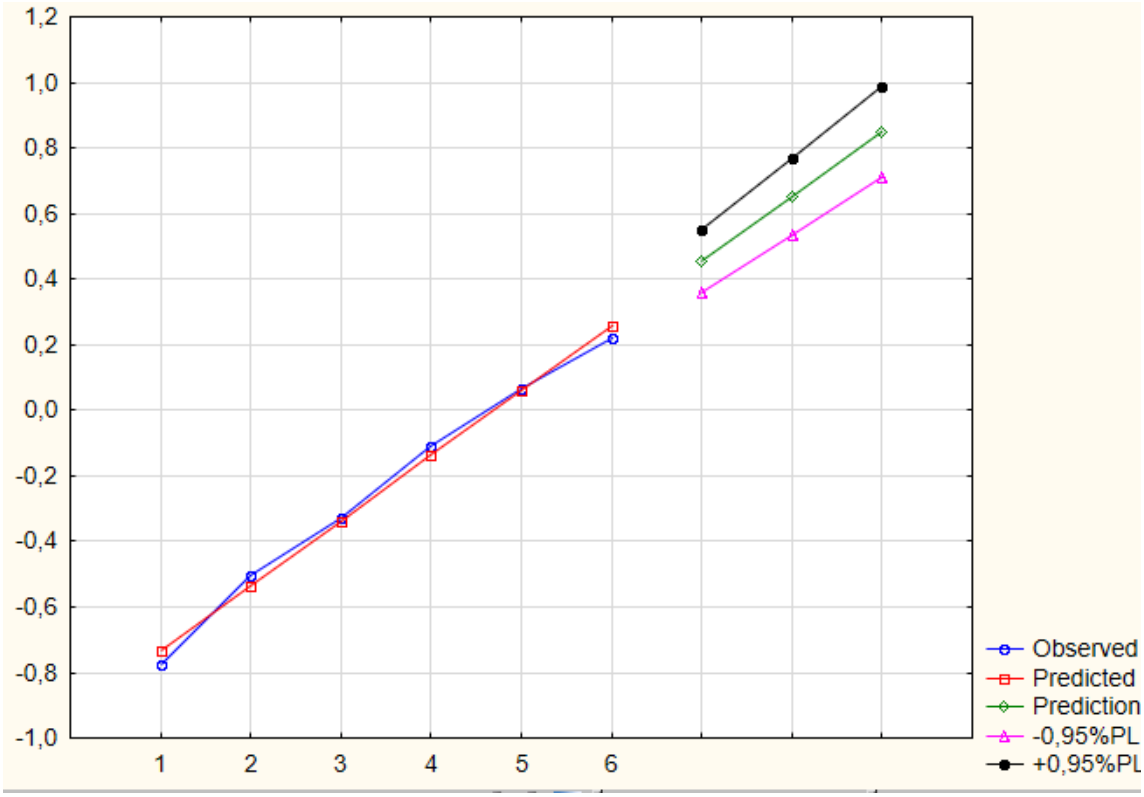
Graph 17 Vietnam -trend



Source: own work

Due to the strong linear relationship, prediction has relatively small variance. The increase of the of the food security indicator is expected in all cases. It can be seen that indicator could approach the value of 1 in 2030.

Graph 18 Vietnam . prediction



Source: own work

For the better analysis of the situation, the analysis of the pillars of the food security was made, to reveal weaknesses in each country. For this analysis, data from 2010 were used, because data from 2015 are partly estimated.

4.5 Pillars of food security

4.5.1 Cambodia

According to the Table 16, the best performing pillar is Stability. In comparison with the worlds mean, the performance is still under the average, but the value is relatively close to it. The worst performing pillar is Utilization. This is caused mainly by high prevalence of Anaemia among pregnant women that is almost 2 x higher that

the world´s average and also the highest from the monitored countries. The Cambodians should focus on increasing food intake with all the vitamins and micronutrients necessary for the healthy life.

Table 15 Pillars of food security - Cambodia

Availability	Access	Stability	Utilization
-1,07315	-0,41699	-0,23387	-3,11924

Source: own work

4.5.2 Laos

In Laos, the situation is similar to Cambodia, as shown in Table 17. The stability pillar is the best preforming of the pillars. Laos has almost average performance in the Stability pillar in the comparison with the outside world. The worst pillar is Utilization, which is probably caused by relatively small proportion of people with the access to the improved water sources, that is far behind the world´s average. This situation should be taken seriously by Laos government, because improved water sources can not only help with food security, but also with the hygiene and diseases.

Table 16 Pillars of food security - Laos

Availability	Access	Stability	Utilization
-1,56365	-1,35838	-0,13630	-1,56817

Source: own work

4.5.3 Myanmar

Myanmar ´s best pillar, according to the Table 18, is utilization. The prevalence of Anaemia in the country is under the critical value and almost on the world´s average. There is still place for improvement in the access to the water sources that is still under the average. The worst pillar is Access, in comparison with Laos, the results are significantly better, but both, Prevalence of undernourishment and depth of food deficit are far from the average.

Table 17 Pillars of food security - Myanmar

Availability	Access	Stability	Utilization
-0,85895	-1,01781	-0,79511	-0,64778

Source: own work

4.5.4 Vietnam

In Vietnam, the worst pillar is availability, the value in this pillar Is though the highest from the monitored countries. The availability should not be problem for Vietnam as one of the highest exporters of rice in the world, yet both indicators are under the world´s average. The best performing pillar is Utilization, the access to the improved water sources has more than 90 percent of population, that is comparable with developed countries. Also the prevalence of Anaemia is almost 50 % lower than in Cambodia.

Table 18 Pillars of food security - Vietnam,

Availability	Access	Stability	Utilization
-0,40202	-0,11633	0,03465	1,01921

Source: own work

5 Discussion

The main hypothesis of this theses is whether the Food security improved in Cambodia, Laos, Myanmar and Vietnam after millennium development goal. Based on the results from the Global hunger index, Millennium development goals and composite indicator of food security, created specifically for this theses, the answer is: Yes, it did.

The Global hunger index decreased in all monitored countries which means that there is less children suffering from undernourishment, wasting, stunting and death. This is only one approach to measure food security, however it shows that the situation in countries is moving with the right direction.

The indicator of the millennium development goals targeted to the food security show significant improvement in the eradication of hunger and poverty. The situation in the Southeast Asia has improved the most from the monitored regions. The MDG1 goal was met or almost met in all CLMV countries.

The composite indicator of the food security showed that food security improved in all 4 countries between years 1990 and 2015 and that all countries are on the right way to improve the food security in the future even more.

Nevertheless, there is still the place for improvement in the field of food security. Except Vietnam, all the countries are under the world´s average and their performance in all 4 pillars of food security is not satisfactory. Each country should focus on their worst pillars but also pay attention to raising living standards as a whole.

With this situation the new Sustainable development goals could help as a guideline. These 17 goals adopted by countries on September 25th 2015, are focused to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years. For the goals to be reached, everyone needs to do their part: governments, the private sector, civil society and also the citizens of each country.

6 Policy recommendations

Based on the results from the analysis it is clear that all the countries made huge progress in improving food security. Despite this progress, the situation in Cambodia, Myanmar and Laos is still not satisfactory and is behind worlds average. For these countries were proposed these recommendations to accelerate their journey to food security:

- **Focus on the stability of supply** – In countries, the natural disasters as flooding, typhoons and cyclones are occurring quite frequently (IFRC, 2010) and disrupts supply of food and water. The governments of the countries should focus on ensuring the
- **Support local farmers** - governments should focus on providing loans programs, education and health programs to small farmers to higher their harvests and be more food secure on the household level
- **Invest to agriculture** – better technologies such as irrigation systems, storage systems and research in agriculture can bring higher yields of crops
- **Invest to education** – It is necessary to invest to education about healthy lifestyle, food utilization, vitamins etc. of the citizens mainly in rural areas to start changes in their dietary patterns. These changes are necessary to increase the utilization of food
- **Focus on export of crops that countries are self-sufficient in**- it would help to focus on the export of the crops whose need is fulfilled in countries. For example, cereal dependency ratio (World Bank, 2016) shows, that all countries produce enough cereals to satisfy their needs so they can focus on higher exports.
- **Try to reduce influence of the market fluctuation** – after the global financial crisis in 2008 there is a need to focus on the reduction of the influence of the fluctuation of the prices and become more independent

7 Conclusion

This thesis is focused on the food security in the part of Southeast Asia, Cambodia, Laos, Myanmar and Vietnam. The goal of this theses was to determine whether the food security improved in the reported countries after Millennium development goals.

First part of the theses is focused on literature overview of the topic. Basic vocabulary concerning food security and related topics is described as well as approaches of measuring food security. In this part there is also an introduction to the topic of composite indicators and their creation. In the last part of the overview, the current situation regarding food security is described for each country.

Practical part of this starts with the orientation analysis of the topic. In the next part composite indicator of the food security is created for years 1990 – 2015 to show the development of this indicator in the time. Main focus is on the year 2000, when the millennium goals were adopted. For each country the best and worst performing pillar is appointed and compared with other countries.

In the discussion, the results of orientation analysis are compared with the results of the composite indicator to find out the answer to the hypothesis in the title of this theses. Did the food security improve in Cambodia, Laos Vietnam and Myanmar after Millennium development goal? Yes, it did.

In the proposal part of the thesis, general policy recommendations were proposed. These recommendations could help countries to increase their development in the food security field.

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Appendices

A Data matrices 1995 – 2015

	X1	X2	X3	X4	X5	X6	X7	X8
Cambodia	98	126	29,3	187	22	7,3	28,0	60,4
Laos	92	128	44,0	335	15	9,0	39,7	49,8
Myanmar	79	160	60,6	502	23	9,4	59,7	47,2
Vietnam	94	166	35,4	261	7	2,2	68,7	43,7

	X1	X2	X3	X4	X5	X6	X7	X8
Cambodia	99	144	32,0	221	7	4,6	41,6	59,0
Laos	94	175	39,2	294	11	8,3	45,5	46,3
Myanmar	84	191	52,4	430	11	10,4	66,6	43,4
Vietnam	100	198	28,1	206	5	1,2	77,4	36,6

	X1	X2	X3	X4	X5	X6	X7	X8
Cambodia	106	178	20,8	144	6	10,3	52,9	55,7
Laos	99	204	29,5	212	13	6,3	56,8	41,5
Myanmar	94	253	36,9	287	10	2,8	72,3	38,5
Vietnam	108	242	19,0	144	4	4,1	84,5	30,2

	X1	X2	X3	X4	X5	X6	X7	X8
Cambodia	108	249	17,0	118	9	5,3	64,2	52,0
Laos	102	232	22,8	160	10	4,3	67,5	37,1
Myanmar	107	321	20,2	149	8	11,5	78,1	34,0
Vietnam	116	276	14,5	110	7	2,1	91,3	24,4

	X1	X2	X3	X4	X5	X6	X7	X8
Cambodia	113,0	321,8*	14,2	97	3*	7,7*	75,7*	49,0*
Laos	104,0	286,7*	18,5	128	10*	9,3*	77,5*	33,6*
Myanmar	113,0	300,0*	14,2	103	8*	10,4*	81,4*	30,2*
Vietnam	123,0	318,0*	11,0	83	5*	3,3*	97,7*	19,7*

B Basic characteristics 1995 – 2015

	Mean	Median	Min	Max	Var	St. Dev
X1	90,7500	93,0000	79,0000	98,0000	67,58	8,2209
X2	145,0000	144,0000	126,0000	166,0000	438,67	20,9444
X3	42,3250	39,7000	29,3000	60,6000	184,80	13,5940
X4	321,2500	298,0000	187,0000	502,0000	18170,92	134,7995
X5	16,7500	18,5000	7,0000	23,0000	54,92	7,4106
X6	6,9750	8,1500	2,2000	9,4000	10,96	3,3110
X7	49,0250	49,7000	28,0000	68,7000	343,36	18,5299
X8	50,2750	48,5000	43,7000	60,4000	51,81	7,1979

	Mean	Median	Min	Max	Var	St. Dev
X1	94,2500	96,5000	84,0000	100,0000	53,58	7,3201
X2	177,0000	183,0000	144,0000	198,0000	576,67	24,0139
X3	37,9250	35,6000	28,1000	52,4000	114,26	10,6894
X4	287,7500	257,5000	206,0000	430,0000	10470,92	102,3275
X5	8,5000	9,0000	5,0000	11,0000	9,00	3,0000
X6	6,1250	6,4500	1,2000	10,4000	16,53	4,0656
X7	57,7750	56,0500	41,6000	77,4000	291,78	17,0814
X8	46,3250	44,8500	36,6000	59,0000	87,93	9,3771

	Mean	Median	Min	Max	Var	St. Dev
X1	101,7500	102,5000	94,0000	108,0000	41,583	6,44851
X2	219,2500	223,0000	178,0000	253,0000	1196,917	34,59648
X3	26,5500	25,1500	19,0000	36,9000	68,630	8,28432
X4	196,7500	178,0000	144,0000	287,0000	4647,583	68,17319
X5	8,2500	8,0000	4,0000	13,0000	16,250	4,03113
X6	5,8750	5,2000	2,8000	10,3000	10,789	3,28469
X7	66,6250	64,5500	52,9000	84,5000	212,209	14,56740
X8	41,4750	40,0000	30,2000	55,7000	112,776	10,61960

	Mean	Median	Min	Max	Var	St. Dev
X1	108,2500	107,5000	102,0000	116,0000	33,583	5,79511
X2	269,5000	262,5000	232,0000	321,0000	1507,000	38,82010
X3	18,6250	18,6000	14,5000	22,8000	13,189	3,63169
X4	134,2500	133,5000	110,0000	160,0000	577,583	24,03296
X5	8,5000	8,5000	7,0000	10,0000	1,667	1,29099
X6	5,8000	4,8000	2,1000	11,5000	16,227	4,02823
X7	75,2750	72,8000	64,2000	91,3000	149,296	12,21867
X8	36,8750	35,5500	24,4000	52,0000	130,903	11,44126

	Mean	Median	Min	Max	Var	St. Dev
X1	113,2500	113,0000	104,0000	123,0000	60,2500	7,76209
X2	306,6040	309,0000	286,6513	321,7648	267,1474	16,34465
X3	14,4750	14,2000	11,0000	18,5000	9,4758	3,07828
X4	102,7500	100,0000	83,0000	128,0000	353,5833	18,80381
X5	6,5761	6,5000	3,3043	10,0000	8,9797	2,99661
X6	7,6786	8,5072	3,3000	10,4000	9,7361	3,12028
X7	83,0715	79,4529	75,6982	97,6820	100,5496	10,02744
X8	33,1237	31,9131	19,6999	48,9689	146,7186	12,11274

C Correlation matrices 1995, 2000, 2005, 2010, 2015

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,000							
X2	-0,517	1,000						
X3	-0,983	0,407	1,000					
X4	-0,985	0,444	0,976	1,000				
X5	-0,379	-0,389	0,365	0,330	1,000			
X6	-0,479	-0,502	0,567	0,530	0,813	1,000		
X7	-0,494	0,972	0,420	0,459	-0,532	-0,510	1,000	
X8	0,493	-0,815	-0,488	-0,524	0,618	0,367	-0,926	1,000

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,0000							
X2	-0,3394	1,0000						
X3	-0,9940	0,2458	1,0000					
X4	-0,9998	0,3344	0,9952	1,0000				
X5	-0,8121	0,0278	0,8591	0,8225	1,0000			
X6	-0,8952	0,0082	0,9363	0,9023	0,9743	1,0000		
X7	-0,1370	0,8890	0,0276	0,1247	-0,3451	-0,2926	1,0000	
X8	0,1664	-0,9820	-0,0729	-0,1623	0,0906	0,1400	-0,8769	1,0000

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,0000							
X2	-0,3776	1,0000						
X3	-0,9980	0,4300	1,0000					
X4	-0,9821	0,5355	0,9919	1,0000				
X5	-0,8046	-0,0412	0,7701	0,6953	1,0000			
X6	0,4780	-0,9773	-0,5220	-0,6115	-0,1454	1,0000		
X7	0,1293	0,8692	-0,0726	0,0481	-0,4645	-0,7948	1,0000	
X8	0,0632	-0,8565	-0,1038	-0,1951	0,0843	0,8803	-0,8919	1,0000

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,0000							
X2	0,3341	1,0000						
X3	-0,9444	-0,1630	1,0000					
X4	-0,8694	-0,0109	0,9822	1,0000				
X5	-0,9134	-0,6784	0,7714	0,6392	1,0000			
X6	-0,3755	0,7162	0,4281	0,4934	0,0128	1,0000		
X7	0,8098	0,5399	-0,5718	-0,4168	-0,9013	-0,1760	1,0000	
X8	-0,4941	-0,4110	0,1869	0,0244	0,6330	0,1582	-0,8996	1,0000

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,0000							
X2	0,7712	1,0000						
X3	-0,9901	-0,8100	1,0000					
X4	-0,9700	-0,8869	0,9892	1,0000				
X5	-0,6675	-0,9888	0,7143	0,8090	1,0000			
X6	-0,8035	-0,6515	0,7282	0,7266	0,5779	1,0000		
X7	0,8405	0,3597	-0,7636	-0,6846	-0,2258	-0,8289	1,0000	
X8	-0,4924	0,1622	0,4038	0,2726	-0,3040	0,4603	-0,8533	1,0000

D Normalized matrixes 1995 – 2015

	X1	X2	X3	X4	X5	X6	X7	X8	Composite indicator
Cambodia	-0,88095	-0,53281	-0,34129	-0,43394	0,148684	-0,3066	-2,49976	-1,76748	-0,82677
Laos	-1,24383	-0,52408	-1,23842	-1,50431	0,083635	-0,42243	-1,94583	-0,85429	-0,95619
Myanmar	-2,03007	-0,38432	-2,2515	-2,7121	0,157977	-0,44968	-0,99896	-0,6303	-1,16237
Vietnam	-1,12287	-0,35812	-0,71356	-0,96912	0,009293	0,04088	-0,57286	-0,32877	-0,50189

	X1	X2	X3	X4	X5	X6	X7	X8	Composite indicator
Cambodia	-0,96236	-0,49644	-0,74330	-0,94082	0,02673	-0,20185	-2,14380	-1,78722	-0,90613
Laos	-1,26485	-0,36820	-1,24342	-1,56518	0,08018	-0,48909	-1,94234	-0,72811	-0,94013
Myanmar	-1,86985	-0,30200	-2,16032	-2,72837	0,08018	-0,65212	-0,85235	-0,48627	-1,12139
Vietnam	-0,90186	-0,27304	-0,47240	-0,81253	0,00000	0,06211	-0,29445	0,08081	-0,32642

	X1	X2	X3	X4	X5	X6	X7	X8	Composite indicator
Cambodia	-0,75653	-0,41342	-0,19259	-0,31844	0,009538	-0,58643	-1,79132	-1,74737	-0,72457
Laos	-1,21068	-0,30906	-0,86704	-0,95532	0,076302	-0,28569	-1,57636	-0,52041	-0,70603
Myanmar	-1,53508	-0,11239	-1,44071	-1,65777	0,047689	-0,02255	-0,72204	-0,26119	-0,713
Vietnam	-0,62677	-0,15654	-0,05305	-0,31844	-0,009538	-0,12029	-0,04961	0,455978	-0,10978

	X1	X2	X3	X4	X5	X6	X7	X8	Composite indicator
Cambodia	-0,85959	-0,21356	-0,1257	-0,29129	0,033628	-0,2675	-1,41682	-1,70242	-0,60541
Laos	-1,28285	-0,2808	-0,63015	-0,72823	0,042036	-0,17833	-1,21786	-0,35031	-0,57831
Myanmar	-0,93013	0,071188	-0,40401	-0,6138	0,025221	-0,82033	-0,57879	-0,069	-0,41496
Vietnam	-0,29524	-0,10678	0,091739	-0,20807	0,016814	0,017833	0,217045	0,802164	0,066939

	X1	X2	X3	X4	X5	X6	X7	X8	Composite indicator
Cambodia	-0,67476	-0,00470	-0,03245	-0,16545	-0,01295	-0,42598	-0,96122	-1,75088	-0,50355
Laos	-1,27644	-0,13821	-0,41672	-0,48601	0,03819	-0,55073	-0,84096	-0,23478	-0,52441
Myanmar	-0,67476	-0,08745	-0,03245	-0,22750	0,02291	-0,63727	-0,58028	0,10655	-0,31669
Vietnam	-0,00623	-0,01901	0,25351	-0,02068	0,00000	-0,07868	0,50604	1,14372	0,22233