VISUALIZATION and REPORTING of the IMPACTS of the 2015 FLOODING on SOUTHERN MALAWI

Information and Data Analytics Foundation

Datacraft Team

Members:

Pascal Chisom Okechukwu (Okechukwu.Pascal@idaf.ng)

Maryam Omolara Fajobi (Maryam.Fajobi@idaf.ng)

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1.0 INTRODUCTION

1.1 Flooding

According to the Microsoft Encarta dictionary, a flood is an overflow of water that submerges land that is usually dry. In the sense of "flowing water", the word may also be applied to the inflow of ocean tides. Often caused by heavy rainfall, rapid snowmelt or a storm surge from a tropical cyclone or tsunami in coastal areas, floods are the most frequent of all the natural disasters. Owing to their great significant concern in agriculture, civil engineering, and public health, floods are a very dedicated area of discipline in hydrology.

Between 80 - 90% of all documented disasters from natural hazards over the past 10 years had resulted from floods, droughts, tropical cyclones, heat waves and severe storms. Floods are also increasing in frequency and intensity, following the trend of extreme precipitation which is expected to continue rising due to climate change. From 1998 to 2017, floods had affected more than 2 billion people worldwide *(WHO, 2017).*

While drowning accounts for 75% of deaths in flood disasters *(WHO, 2017),* the latter can have medium- and long-term health impacts, which includes:

- Water- and vector-borne diseases such as cholera, typhoid or malaria
- Injuries, such as lacerations or punctures from evacuations and disaster cleanup
- Chemical hazards
- Mental health effects associated with emergency situations
- Disrupted health systems, facilities and services, leaving communities without access to health care
- Damaged basic infrastructure, such as food and water supplies, safe shelter, etc.

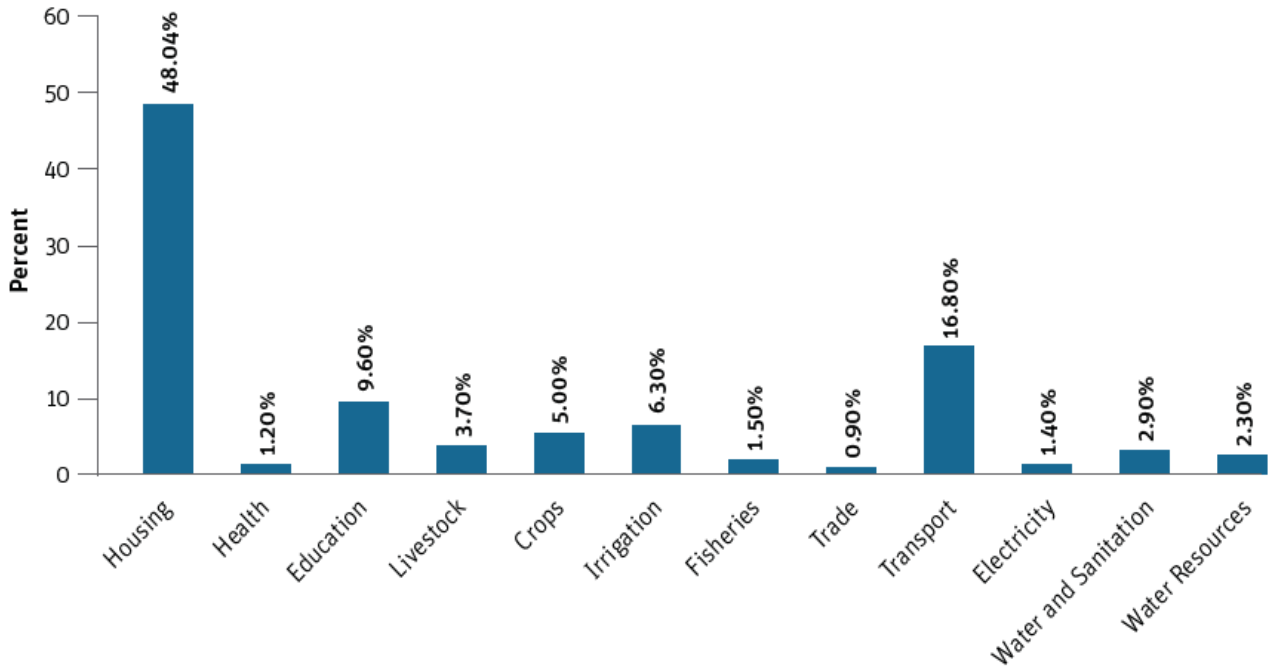
1.2 Flooding in Malawi

Malawi is highly vulnerable to the impacts of extreme weather events given its location along the great African Rift Valley, climate variability and change, environmental degradation, rapid population growth, and unsustainable urbanization. The most common weather-related shocks affecting the country include floods, drought, stormy rains and hailstorms. Over the past five decades, Malawi has experienced more than 19 major floods and seven droughts, with these events increasing in frequency, magnitude and scope. These disastrous events have had a significant impact on people's lives, livelihoods and socioeconomic infrastructure in the affected areas, pushing a large number of people into poverty and food insecurity *(UNICEF, 2019).*

With the events following the floods in 2015, the impact on the affected population has been cumulative. In the pre-disaster period, about 3.3 million people in the flood affected districts were already categorized as food insecure. In 2016/2017, the national poverty rate stood at 51.5%, with most of the poor (59.5%) living in rural areas. In Malawi, the level of inequality is high, with the Gini coefficient standing at 0.433 in 2017. Thus,

disruptions to livelihoods resulting from natural disasters and other causes are likely to widen the gap between the poor and the well-off *(Malawi Government data, 2019).*

Figure 1: Share of total effects of floods by subsectors.



1.2.1 Flood Warning Procedures in Malawi

There are different models and services put in place by the Malawian Government and people to warn on incoming floods.

a. Department of Climate Change and Meteorological Services: The DCCMS is mandated to monitor, predict and provide information on weather, climate and climate change, that would contribute towards the socio-economic development of the country. Their climate forecast system is categorized as
   - Short-range weather forecasts (24 hours – 3 days)
   - Medium-range weather forecasts (7 days, 10 days, monthly or more)
   - Long-range forecasts (decadal and seasonal weather outlook)

b. Department of Water Resources: Malawi's DWR is mandated to achieve sustainable and integrated water resource management and development that make water readily available and equitably accessible to and used by all Malawians. DWR Flood Warnings Services includes:
   - Provision of tailor-made forecast (as a decision support tool) for planning and preparedness by weather and climate sensitive sectors.
   - Wide range of forecasts for aviation, marine, water resource, agriculture and insurance.
   - Lightening advisory and flash flood guidance, dry spells and drought advisories, flood forecasting & warnings.

1.3 Data Visualization

According to Wikipedia, Data visualization is the graphic representation of data. It involves producing images that communicate relationships among the represented data to viewers of the images. This communication is achieved through the use of a systematic mapping between graphic marks and data values in the creation of the visualization. This mapping establishes how data values will be represented visually, determining how and to what extent a property of a graphic mark, such as size or color, will change to reflect changes in the value of a datum. According to Vitaly Friedman (2008) the "main goal of data visualization is to communicate information clearly and effectively through graphical means. It doesn't mean that data visualization needs to look boring to be functional or extremely sophisticated to look beautiful. To convey ideas effectively, both aesthetic form and functionality need to go hand in hand, providing insights into a rather sparse and complex data set by communicating its key-aspects in a more intuitive way.

The common visualization techniques are divided into three categories: data visualization, information visualization, and interactivity (Khan & Khan, 2011). Data visualization is the study of the visual representation of data, which means information that has been abstracted in some schematic form, including attributes or variables for the units of information. In contrast, information visualization concentrates on the creation of approaches for presenting abstract information in intuitive ways (Thomas and Cook, 2005).

1.4 Objectives of This Report

The primary objective of this challenge is to interpret and generate insights from available data on the 2015 flooding and its aftermath specifically in southern Malawi, using original visualization and relevant stories.

- To explore the impact of the 2015 floods on the Southern Malawian society
- To generate a powerful report that effectively tells not just the story but unravels all the possible perspectives of the flooding event using quality visualizations.

2.0 Data and Methods

2.1 Data Understanding

We were provided a variety of data comprising healthsites, demographic and health surveys, food prices, food security indicators, demographic, weather data, socio-economic indicators and spatial data (shapefiles, etc.), and performed preliminary analysis to understand what may be relevant to us. We narrowed our focus to data having moderate to high informativeness concerning southern Malawi,

1. food prices dataset containing collated prices of major food items exported, imported, and cultivated in Malawi. This dataset also reported the prices by markets in the country's regions.
2. Weather dataset that covered the precipitation records for Malawi from 1991 to 2016.
3. Healthsites data sheet containing 284 records of healthcare services rendering institutions.
4. Food security indicators.
5. All available demographic and health data consisting of the historical and current observations relating to vital indicators.

Addition information was gathered from news sites, blogs, research papers, articles and public data given by the Malawian Government. Sources of these information are properly cited.

2.2 Data Preparation

We carried out series of exploratory analysis and preprocessing on most of the data provided. Starting with the food prices; we calculated the median values for the individual food items and grouped the results by country region and food category. This approach was most suitable because the median prices were not affected by any outliers.

For the rest of the datasets, we removed ambiguous variables that offered little or no information to the purpose of the generating insights. These variables include table keys, ids, DHS codes for indicators, etc. We also removed columns with duplicate values and rows with very sparse information, dropped data having very old survey years of collection, and generally data that weren't informative enough for reporting on the flood disaster.

2.3 Methodology

Tableau is a powerful and easy to use data visualization tool. It helps create interactive graphs and charts in the form of dashboards and worksheets to gain business insights. And all of these is made possible with gestures as simple as drag and drop. The charts in this report were mostly done using Tableau.

3.0 Food and Agriculture

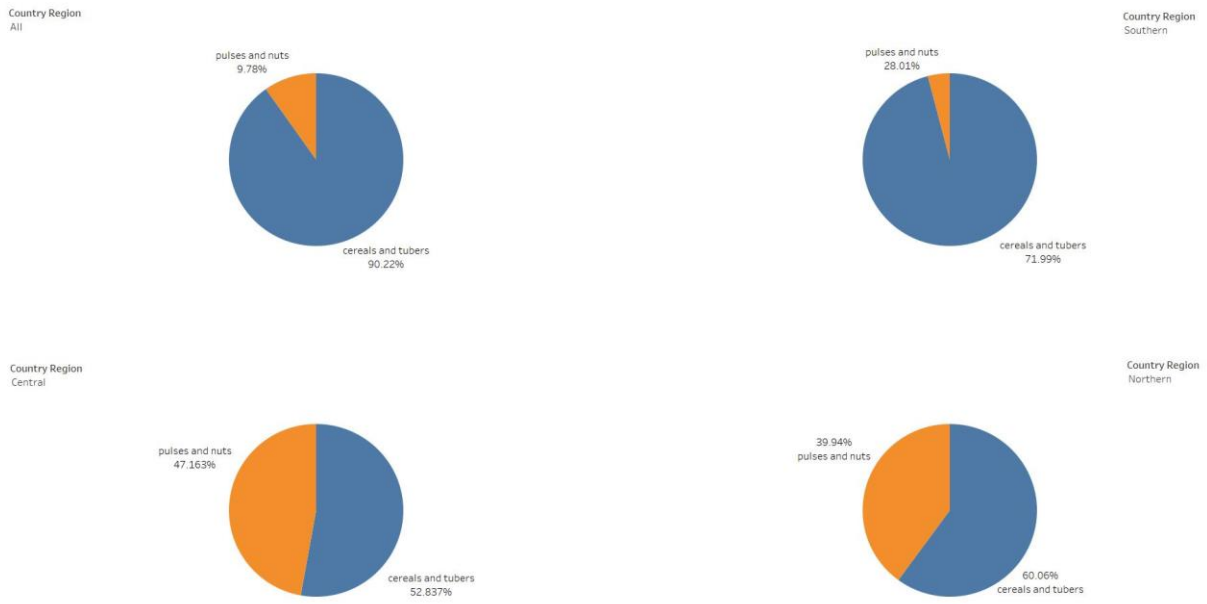
Malawi is a small country with an estimated land area of 11.8 million hectares, of which Lake Malawi occupies one-fifth of the total. Out of 9.4 million hectares of land, approximately 5.3 million ha, or 56 percent, is cultivable. The Malawi economy is characterized by a high dependence on agriculture, a narrow industrial base and weak intersectoral linkages. The agricultural sector currently accounts for about 42 percent of GDP and 81 percent of export earnings (FAO). The country's largely rural population depends heavily on crop production for its livelihood, most notably the production of maize, which accounts for three-fifths of daily calorie consumption (Ecker 2009). Agriculture and downstream agro-processing generate half of gross domestic product (GDP) and four-fifths of total export earnings and employment (Benin et al. 2008). Climate shocks therefore have a potentially profound direct effect on the agricultural sector and farm households while also indirectly affecting other economic sectors and nonfarm households through price and production linkages.

3.1 Food Prices

The prices analyzed in this report were recorded median price values across markets in the three regions of the country. With more emphasis on items that constitute majorly in Malawi's trade and consumption, the food crops were generally grouped under;

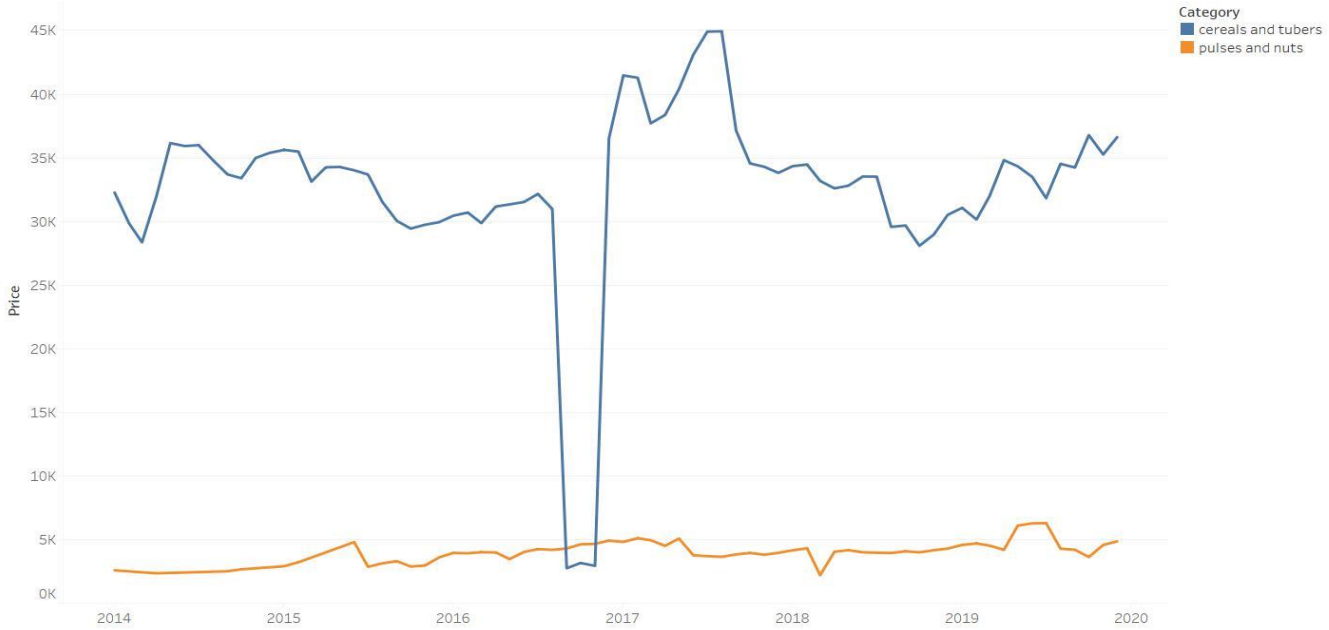
a. Pulses and Nuts
b. Cereals and Tubers

Figure 3.1.1 **Sum of median prices in food category by region, described by the percentage in total**



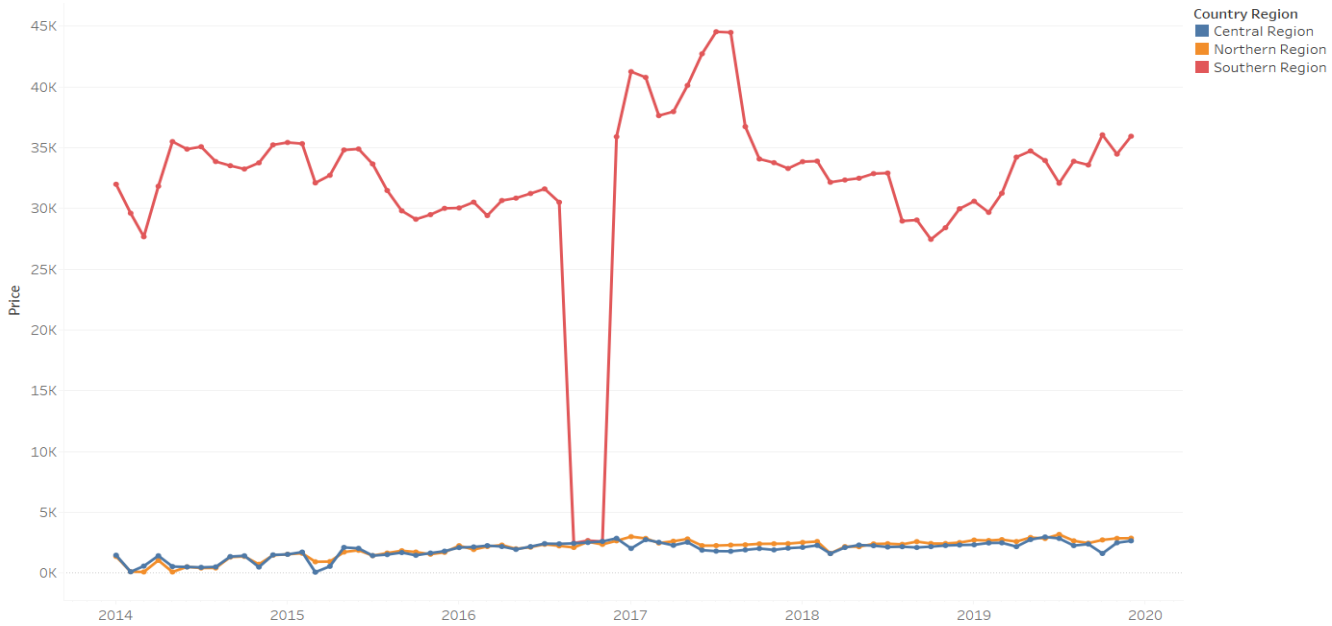
From the chart above, it was very evident that cereals and tubers constituted most of Malawi's food crop production, exports and imports for the time frame considered. With the southern region contributing most of the overall 90.22% for cereals and tubers. The trend for this is shown below in figures 3.1.2 and 3.1.3

Figure 3.1.2 **Sum of food category trend over the years from 2014 to 2020**



The sum of prices for pulses and nuts did not exceed MWK 7,500 while cereals and tubers reached an all-time high of MWK 45,000 in July – August 2017.

Figure 3.1.3 **Sum of food prices by country region over the years 2014 to 2020**

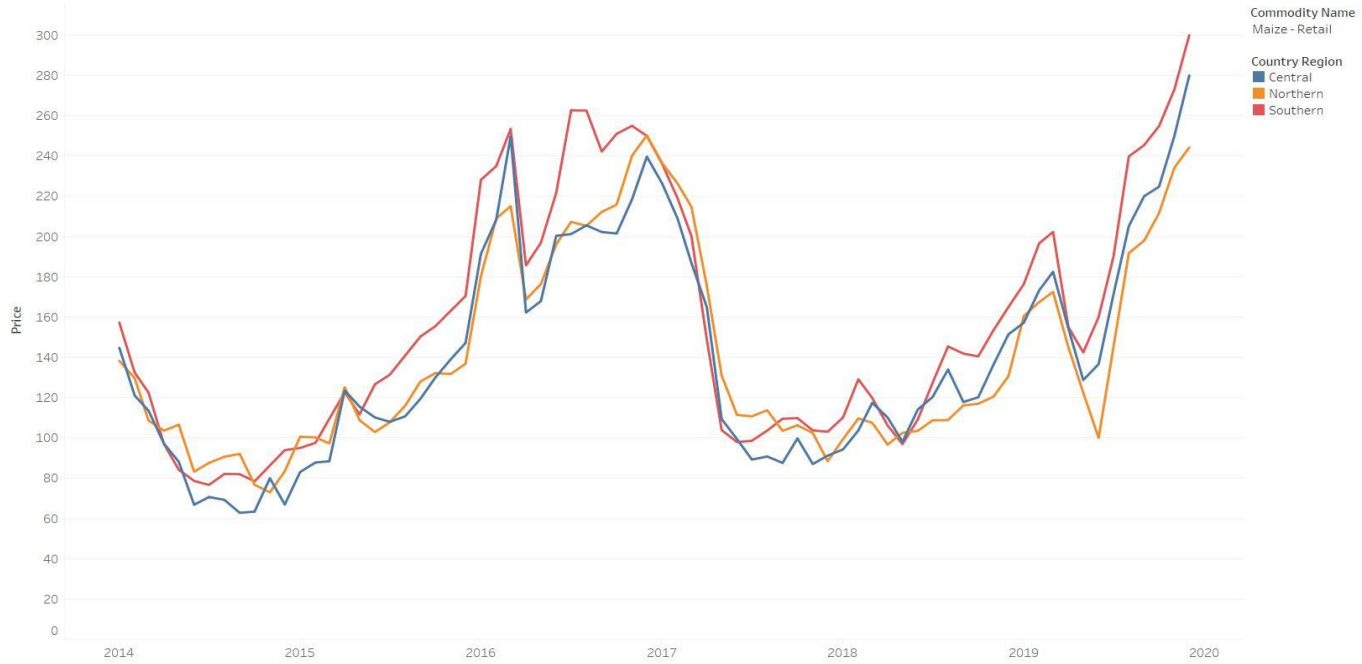


Looking at the chart by quarter of years it is immediately observed that there was no significant change in total prices for southern Malawi from the second quarter of 2014 to the second quarter of 2015, which covered the period of both the extreme rainfall and flooding of the southern region. There was however, a steep plunge from MWK 102,000 in the second quarter of the flood year to just below 90,000 in the fourth quarter of the same year.

Fig. 3.1.4 **Sum of food prices by country region in quarter of years 2014 to 2020**

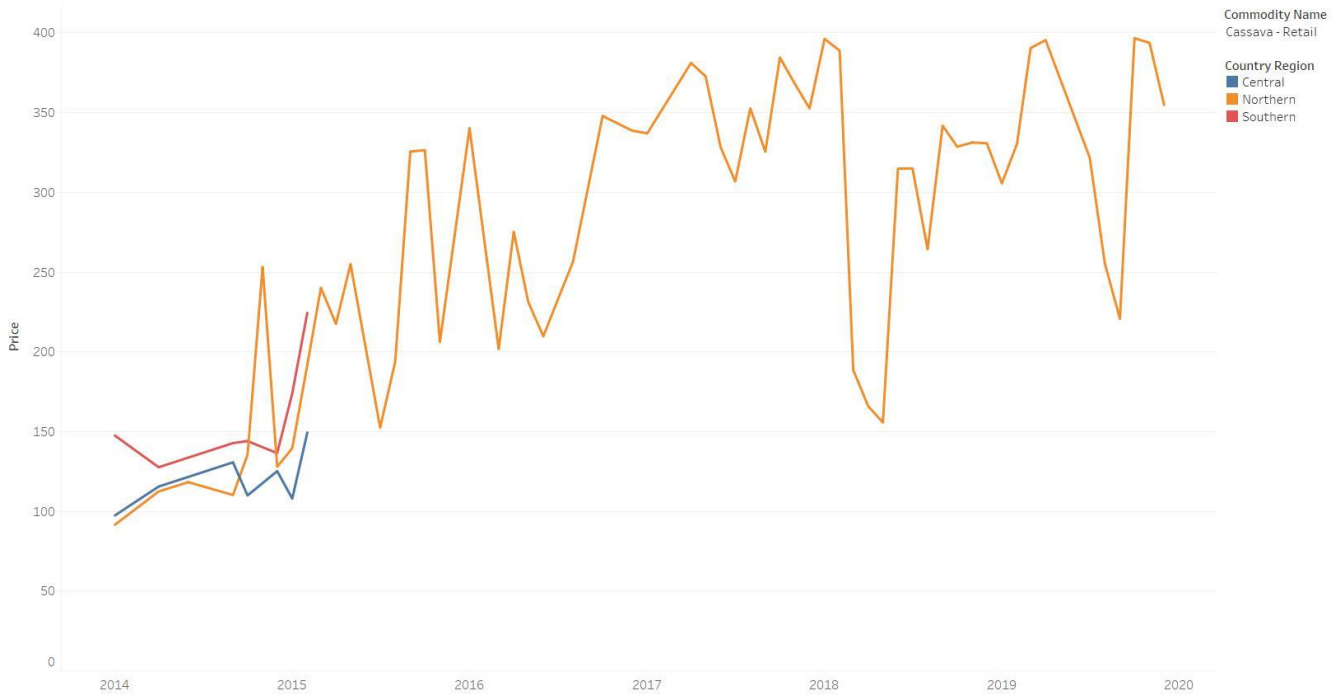
Some of the trends of the individual food crops are shown below

Figure 3.1.5 **Maize (retail) median prices trend from 2014 to 2020**



Maize has been the major food crop in terms of the policy agenda and hectarage planted. From the chart above, the median price for maize in markets of the southern region significantly rose from October in 2014, up to the first quarter of 2016, only dropping briefly once from April to May 2015. Therefore, we can conclusively claim the flood impacted the price of Maize.

Figure 3.1.6 **Cassava (retail) median prices trend**



The trend chart for Cassava reported no values for the southern and central regions from February 2015. This could be as a result of incompleteness of data.

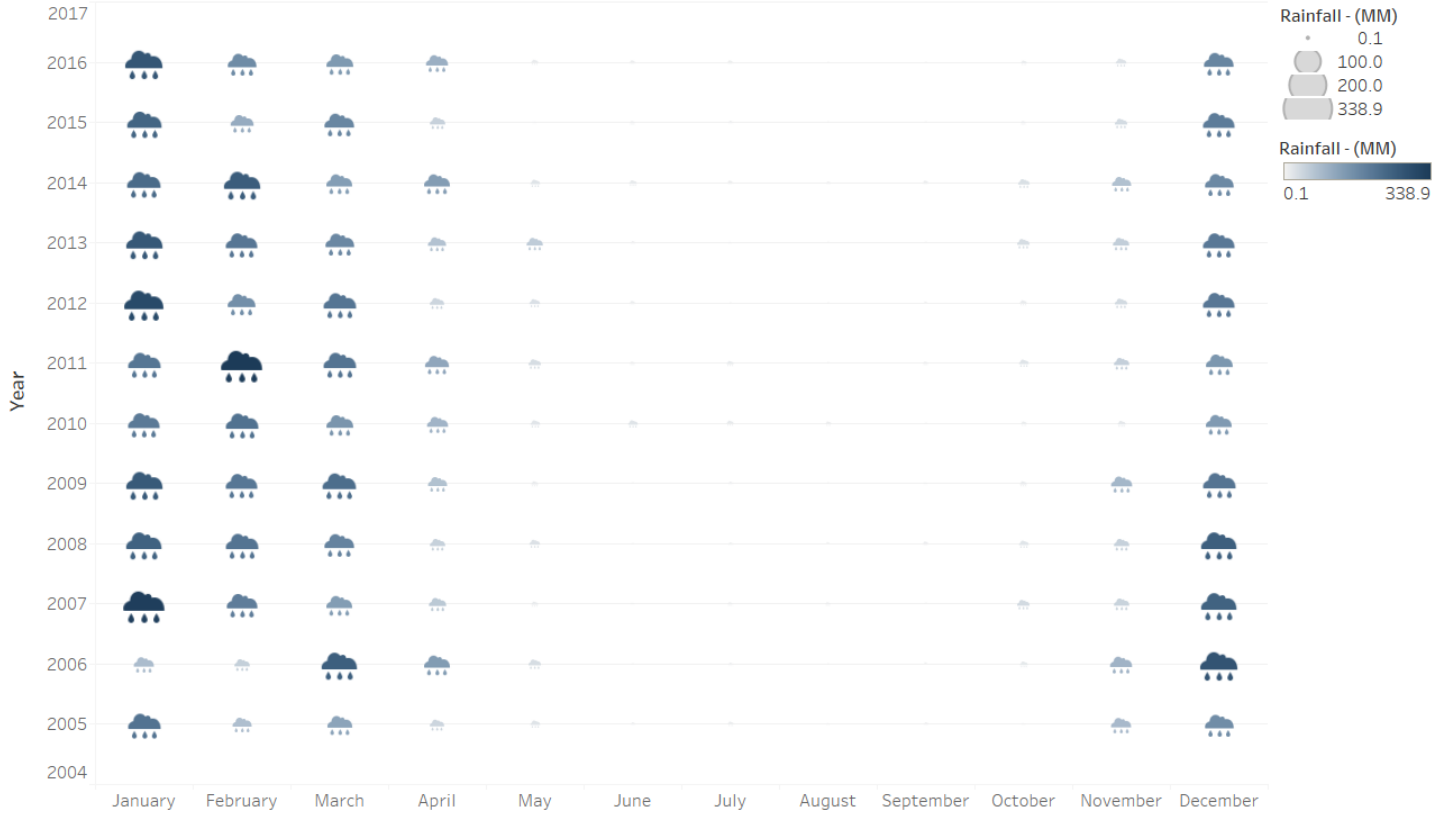
3.2 Climate and Agriculture

Malawi agriculture is composed of two main subsectors: small-scale farmers and estates. Smallholder farmers comprise an estimated 2 million farm families and cultivate about 4.5 million hectares of land. Smallholder production is highly subsistent. It is characterized by low levels of input and low output levels. Approximately 25 percent of smallholder farmers cultivate less than 0.5 ha on average; 55 percent cultivate less than 1.0 ha; 31 percent cultivate between 1.0 and 2.0 ha; and 14 percent cultivate more than 2.0 ha. But despite being resource-poor, smallholder farmers produce about 80 percent of Malawi's food and 20 percent of its agricultural exports.

The most immediate impact of erratic rainfall on rural livelihoods is on crop production. Droughts and floods undermine farm yields and the national harvest, reducing household and national food availability, and agricultural income derived from crop sales. Poor harvests threaten food security and livelihoods from household to national level, to varying degrees according to the extent that the family or nation depends on agriculture for

its food and income. Households and economies that are more diversified are less vulnerable to these direct impacts of droughts and floods, provided that their alternative income sources are neither correlated with rainfall nor directly or indirectly dependent on agriculture (i.e., vulnerability falls to the extent that complementary sources of income and food are non-covariate). The figure below shows the trend for average rainfall in Malawi from 2005 to 2016.

Figure 3.2.1 **Malawi monthly average rainfall from 2005 to 2016**



It is noted that precipitation in the country generally follows from November to April in each season, with more of the wet weather occurring during the December – March window. This tends to be a very steady pattern in the country's climate as even the 2015 floods followed as the result of heavy rainfall during November in the previous year.

3.3 Arable Land and Food Production

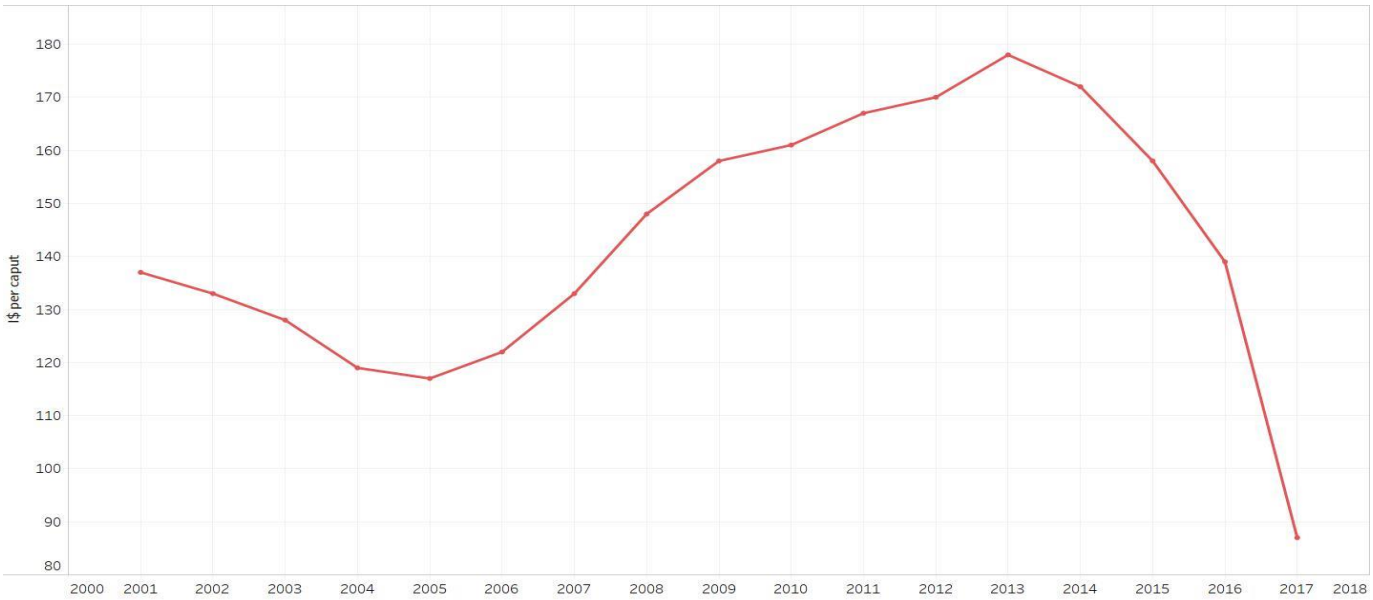
The percent of arable land equipped for irrigation is a ratio between arable land equipped for irrigation to total arable land. Arable land is defined as the land under temporary agricultural crops (where multiple-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is however not included in this category, it is important to note that data for arable land are not meant to indicate the amount of land that is potentially cultivable. Total arable land equipped for irrigation is defined as the area equipped to provide water (via irrigation) to crops. it includes area equipped for full and partial control irrigation, equipped

lowland areas, pastures, and areas equipped for spate irrigation. This chart follows for a period of 2001 to 2016 for this report.

Figure 3.3.1 **Percent of arable land equipped for irrigation**

The percent of arable land equipped for irrigation was at level of 1.9 % in 2016, unchanged from the previous (flood) year, but followed a steep fall from 2.0% in 2014. We can see just how much the floods affected agriculture, but this would be made very clear by the next visualization on value of food production.

Figure 3.3.2 **Average value of food production in Malawi**

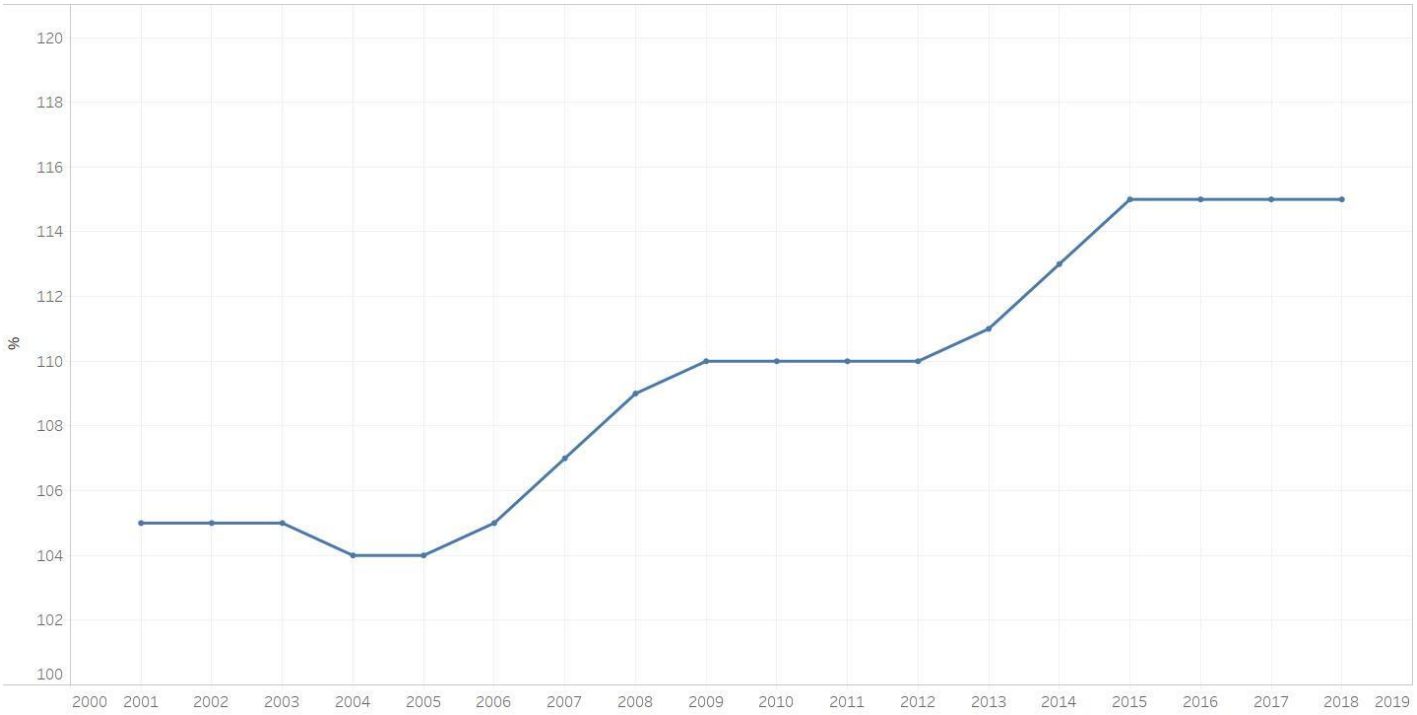


4.0 NUTRITION

4.1 Average Dietary Energy Supply Adequacy

This indicator expresses the dietary energy supply as a percentage of the average dietary energy requirement. Each region's average supply of calories for food consumption is normalized by the average dietary requirement estimated for its population to provide an index of adequacy of the food supply in terms of calories. The figure below shows this trend for the period of 2001 – 2018.

Figure 4.1 **Average dietary energy supply adequacy**



Average dietary energy supply adequacy of Malawi increased from 104 % in 2004 to 115 % in 2018 growing at an average annual rate of 0.72%. There was however no positive change following the floods in 2015.

4.2 Prevalence of Undernourishment

The prevalence of undernourishment expresses the probability that a randomly selected individual from the population consumes a number 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.

It is observed that Between 2004 and 2018, prevalence of undernourishment, 3-year averages of Malawi was declining at a moderating rate to shrink from 27.4 % in 2004 to 17.5 % in 2018.

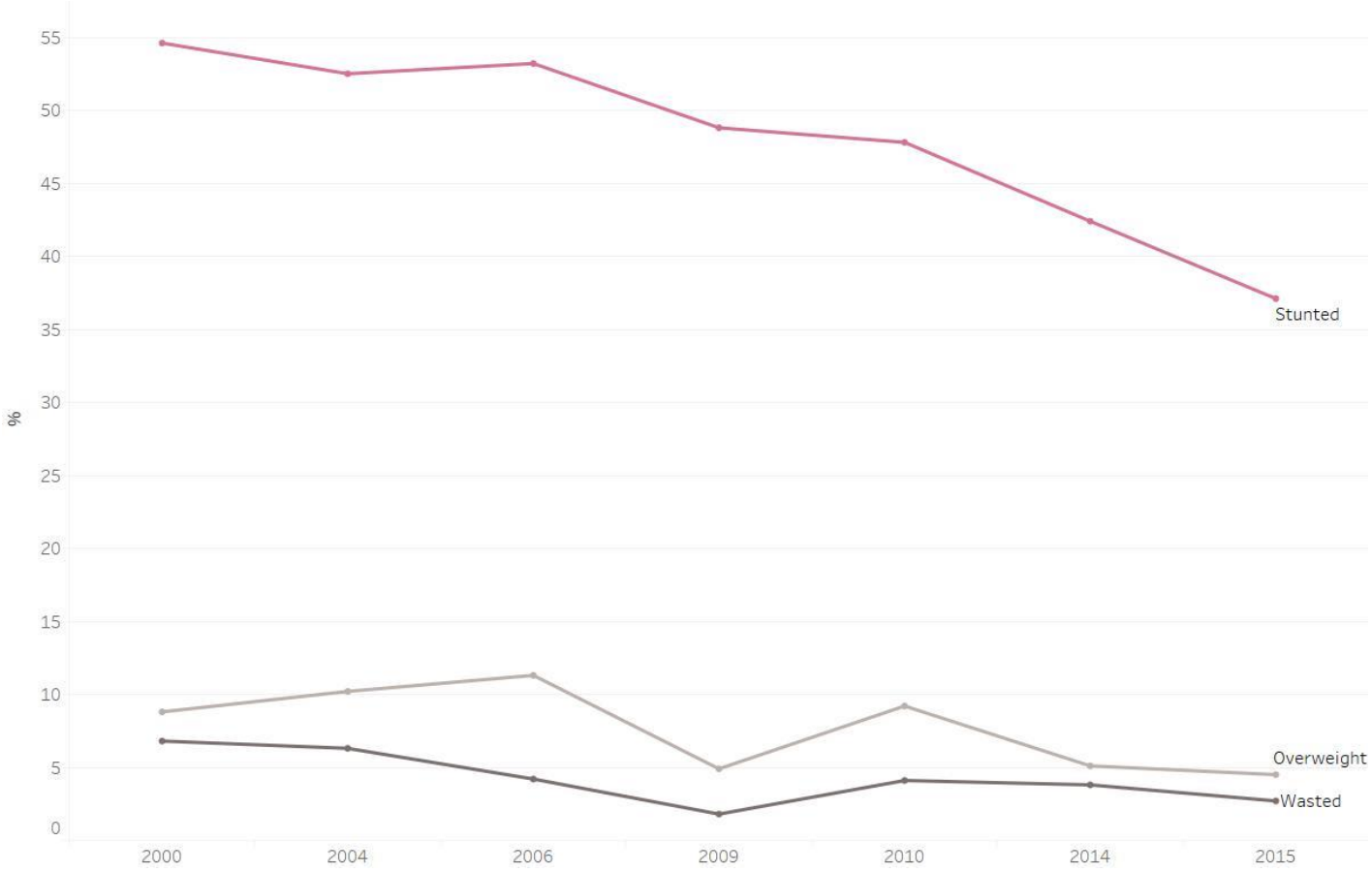
Figure 4.2 **Prevalence of undernourishment**

4.3 Nutritional Status of Children

Anthropometric indicators for young children were collected in the DHS to provide outcome measures of nutritional status. As recommended by WHO, evaluation of nutritional status in this report is based on a comparison of three indices for the children in this survey with indices reported for a reference population of well-nourished children (WHO Multicentre Growth Reference Study Group 2006). The three indices (height-for-age, weight-for-height, and weight-for-age) are expressed as standard deviation units from the median for the reference group. Children who fall below minus two standard deviations (-2 SD) from the median of the reference population are regarded as moderately malnourished, while those who fall below minus three standard deviations (-3 SD) from the reference population median are considered severely malnourished. Marked differences, especially with regard to height-for-age and weight-for-age, are often seen between different subgroups of children within a country.

The figure 4.3 below shows the trend over years 2000 – 2015 of the percentage of children under 5 years of age who are stunted, overweight, and affected by wasting. Note: Stunting reflects chronic malnutrition; wasting reflects acute malnutrition; underweight reflects chronic or acute malnutrition or a combination of both.

Figure 4.3 **Nutritional status of children by years**

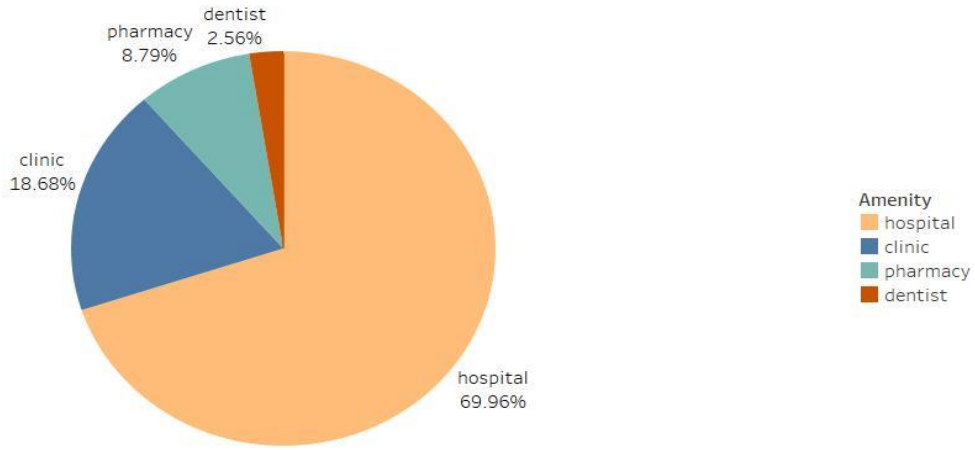


While the percentage of children under 5 years of age affected by wasting was at level of 2.7 % in 2015, down from 3.8% previous year, the percentage who are stunted in growth fell gradually from 54.6 % in 2000 to 37.1 % in 2015. And though the percentage of children under 5 years of age who are overweight fluctuated substantially in recent years, it tended to decrease through 2000 - 2015 period ending at 4.5 % in 2015.

5.0 Health and Basic Amenities

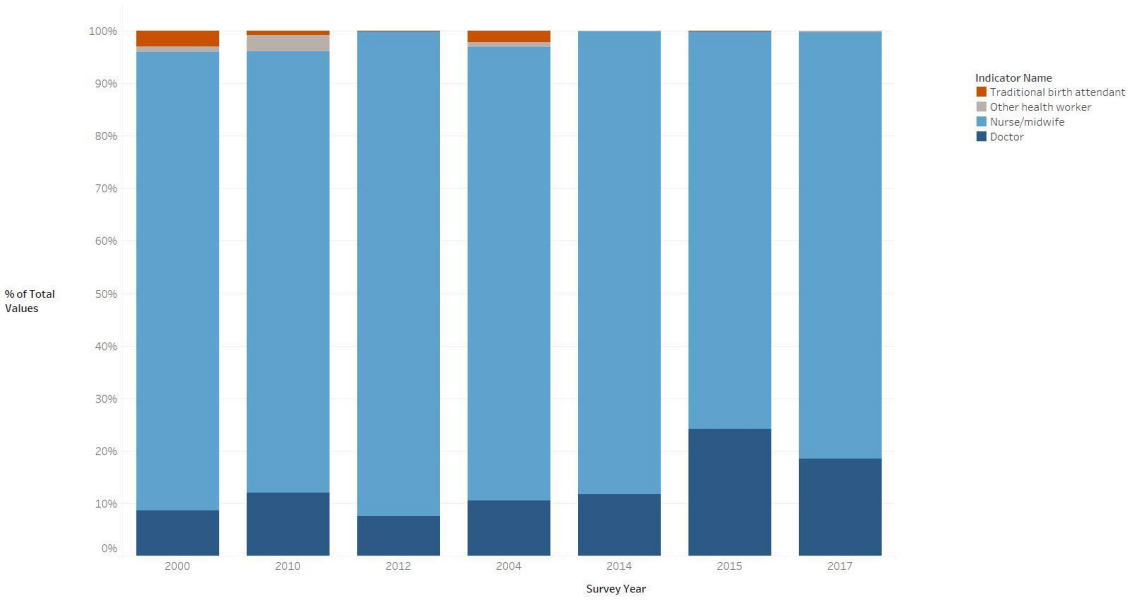
5.1 Malawi Healthsites

Figure 5.1 **Healthsites in Malawi as a percentage of total**



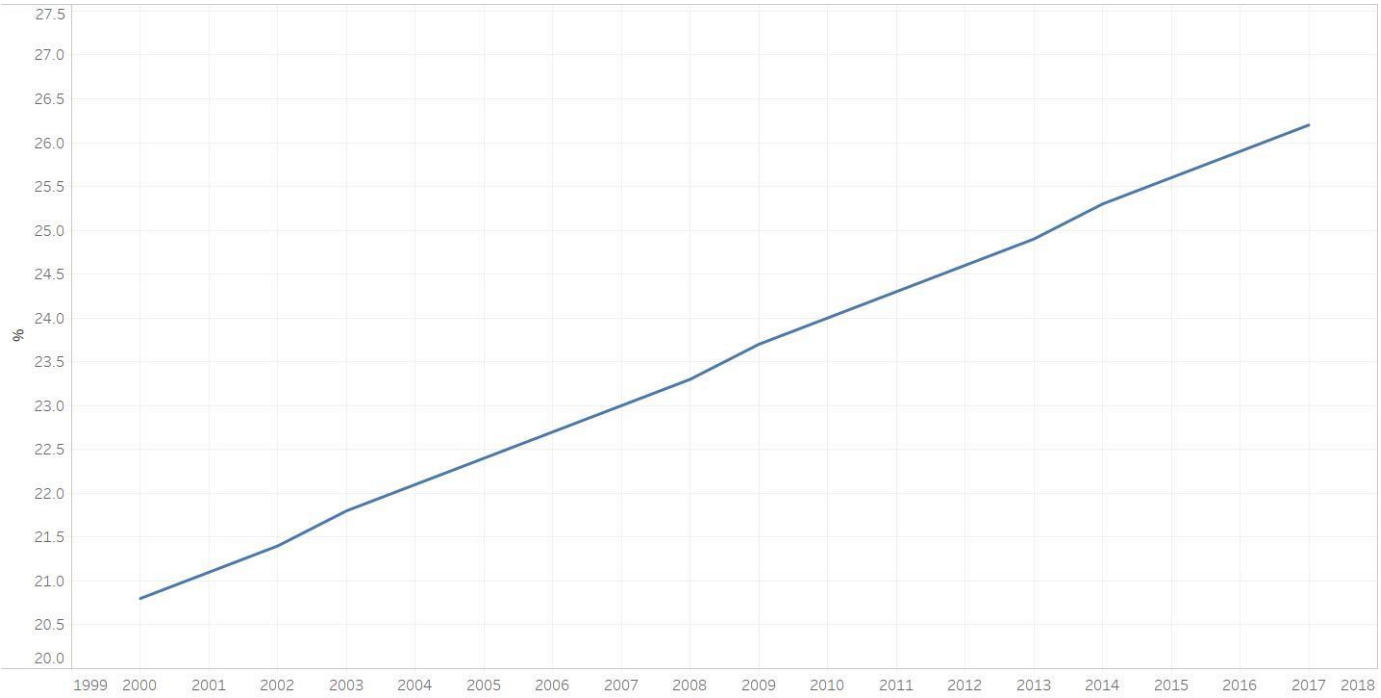
From this pie chart, we saw that hospitals provided most of the healthcare services in the region at approximately 70% of all services. Clinics came close in supporting health services rendering with a contribution of approximately 19%. The rest were completed by pharmacies and dentists.

Figure 5.2 **Antenatal healthcare providers**



In general, nurses and midwives have provided most of the antenatal health care services in Malawi over recent years. Doctors contribute to some significant amount, while traditional birth attendants and other health workers barely contributed.

Figure 5.3 **Population using sanitation services**



The trend for the Malawian population using sanitation services tells that there has been a steady increase since the year 2000. Seeing as this trend continued without interruption suggests that Malawi, and indeed the southern region has seen some improvement in the provision of sanitary services to her citizens, even in the periods of disaster such as the 2015 flood.

6.0 LIMITATIONS

We found variability in results between the regions in Malawi. However, the analysis is limited by data availability, as the DHS samples are too small to look at regions within-country variability. A related limitation is the spatial scale of the analysis. DHS samples are rarely representative within sub-national regions, which limits our ability to examine the flood extents within specific regions of a country. This modest number of clusters means that some areas that are flood or drought prone may not be covered by the DHS data

we have not investigated factors that influence the vulnerability of households to flooding such as the building quality, or other determinants of flood impacts such as flood duration, (Dang et al., 2010; Parker et al., 1987), and its impact on indirect losses such as loss in output and revenue and economic disruption (Lekuthai and 382 Vongvisessomjai, 2001) and flood-related health issues; and flood level rise rate which is especially important in terms of mortality (Jonkman et al., 2009).

7.0 CONCLUSION

The general conclusion of this report is that poor people are disproportionally exposed to rural floods. A particular concern is the fact that some of the regions where poor people are overexposed will also experience more frequent flooding in the future due to climate change. Government should enforce land-use regulation, risk-sensitive land-use policies that protect poor people, such as flood zoning and land entitlement support the access of poor people to opportunities and not stifle them. The results suggest that integrating local knowledge in developing localized and relevant climate change adaptation strategies is essential in Malawi. This can be achieved by creating a forum for interaction between scientists and indigenous knowledge holders.

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