



Peter Caton for Action Against Hunger

The Growing Impact of Physical Geography in Refugee Flow Prediction Modelling

The case of South Sudan

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June 2022

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Thesis title: The growing impact of physical geography in refugee flow prediction modelling: the case of South Sudan.

Submission date: 21 June 2022

Institution: Radboud University Nijmegen

Programme: MSc. Human Geography

Specialisation: Conflicts, Territories and Identities

Supervisors: Dr. Bert Bomert & Dr. Rosanne Anholt

Internship organisation: 106 Inlichtingen Compagnie, Defensie

Internship supervisor: Bas Ooink

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Abstract

Today, 82.4 million people are forcibly displaced worldwide (UNHCR, 2021). In order for humanitarian organisations to provide protection and service delivery for persons of concern in emergency situations, there is a need to know when and where to expect future refugee flows. In order to design a suitable refugee flow prediction model, there is a need to identify the main factors causing refugee flows to arise. According to the literature, political violence and culture serve as the most important risk factors of forced migration. However, according to UNHCR (2021) the impacts of climate change are increasingly triggering forced displacement.

One of the countries that has become victim of the consequences of climate change is South Sudan. Over the years, conflict and extreme economic underdevelopment have caused multiple refugee flows towards neighbouring countries as well as internal displacement. However, violence and poverty are not the only factors causing internal displacement and refugee flows. Flooding and droughts in South Sudan significantly disrupt livelihood patterns and food-security.

Because the awareness of the impact of climate change is relatively new and because the literature mainly focuses on political violence and culture as the main drivers behind refugee flows and internal displacement, refugee flow prediction models have yet failed to include physical geographical factors such as weather and climate. This leads to incomplete and one-sided predictions of when and where refugee flows will occur because there is solely a focus on social geographical factors. This research, however, stresses the importance of linking physical and social geographical factors together in order to make more complete and detailed flow predictions. The main research question guiding this research is therefore: *To what extent do physical geographical factors play a role in predicting South Sudanese refugee flows?*

First, the push and pull factors of South Sudanese migration flows were examined through a qualitative reports analysis. The most important push factors that cause people to move away from South Sudan are violent conflict, extreme economic underdevelopment and natural disaster. Direct triggers for movement are ongoing violence and insecurity, occupation of homes by armed groups, livelihoods and assets being destroyed (both by armed groups or severe flooding) and direct lack of water and food.

To be able to know to what extent these social and physical geographical factors were of importance to refugee flow prediction models, a quantitative analysis of the Flow Monitoring Registries from IOM was done. It appeared that two physical geographical factors were of major impact: food insecurity and flooding. In the first season (January, February and March) many people were internally displaced because of natural disaster induced food insecurity. Because this season is very hot and dry, it is more sensitive to food insecurity. During the third and fourth season (July till December) the opposite takes place. Rivers have to transport too much water because of heavy rainfall which leads to extreme flooding. This causes people to flee from the water, often after their homes are destroyed.

Based on these results it can be concluded that physical geographical factors play a significant role in predicting South Sudanese refugee flows. Flooding and drought, that also both cause food insecurity,

set in motion major refugee flows in 2020. Because the effects of climate change will likely worsen in the future, these factors will gain increasing influence. In the case of this research 'to what extent' cannot be translated into numbers because of the subjective data. However, there are some clear observations that serve as evidence for the significant role of physical geography. If the function of a refugee prediction model is to help humanitarian organisations with providing aid in places and times where it's necessary, it is crucial to incorporate physical geographical factors.

This research was conducted at the request of the 106 Inlichtingencompagnie of the Dutch Defence department.

Acknowledgement

Writing this master thesis is probably one of the most tiring and long-winded things I have ever done in my entire life. My preferred writing and communication style has always been short and to the point, without too much hassle. But with this project there was no way that I was going to be able to avoid “the hassle”.

When I studied to become a geography teacher at the HAN, I very rarely had to use any other theories for my writing. Because when you study HBO, you do things and then write down what you did and why you did it: you are your own source. So, when I came to university, I had to get used to substantiating every sentence I wrote with other research and theories. I really struggled with that in the beginning of my studies for Human Geography. But when I realised, I was not going to get anywhere by constantly being annoyed, I decided to accept it. And when I did, I discovered that university could give me something very valuable: a critical perspective on the world.

This master thesis is the biggest and most interesting research I have done in my life so far. The opportunity to completely dive into a subject of your own interest was a very enjoyable and challenging experience.

First, I would like to thank my biggest support system in this whole process: Bas Ooink, my internship supervisor from the 106 Inlichtingencompagnie from Defensie. I can honestly say that I could not have wished for a better internship supervisor this past year. First, I want to thank you for giving me the opportunity of an internship in times of Covid-19. For many students it was hard to find an internship during this period because students were not allowed at the office because of social distancing. But you gave me the opportunity for an online internship, which I am really grateful for.

I also want to thank you for your constant positivity and support during the writing of my thesis. I enjoyed our meetings so much because we always spend the first half hour talking about absolutely nothing and that really made my day. After sharing experiences, jokes and irritations about life and people we would get into discussing the progress of my thesis. Sometimes I made a lot of progress and sometimes none at all. But that was okay for you. I also want to thank you for looking out for me in times I had a lot of stress and helping me through it. Taking a part-time job as a geography teacher at a high school while still having to finish my master thesis was not the best decision I ever made, but you got me through it! What I really admire about you is your ongoing ability to think only in solutions and not in problems. That is something I am going to carry with me for the rest of my life. THANK YOU.

Second, I would like to thank my first supervisor: Bert Bomert, who is now retired and probably enjoying life in the best way possible. You helped me build the foundations of my research and critically reviewed my ideas to make sure I had a good start.

Third, I would like to thank my other first supervisor Rosanne Anholt, who started supervising me in October 2021 when Bert retired. Even though we did not have a lot of contact because I was already in a later stage of writing my thesis, you provided me with clear and to the point feedback that I needed to finish this thesis.

Fourth, I would like to thank Henk van Houtum, my second supervisor, who provided me with the critical feedback I needed to link my research to the ongoing academic debates about refugees and refugee movement. Thank you for helping me get through the final steps and the finishing touches.

Fifth, I would like to thank Derek Groen, who allowed me to build further research on the FLEE-model he designed a few years ago and helping me get in touch with a few valuable contacts for my research.

Lastly, I want to thank my friends and family. Who, when every time I said: 'I am going to finish this thesis in one month', were still there for me and supported me when I didn't finish it for the fifth time. My parents supported me every step of the way and gave me the freedom to take as much time as I needed to finish my studies. I am grateful to have you in my life.

Thank you.

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1. Introduction

Today, 82.4 million people are forcibly displaced worldwide (UNHCR, 2021). This means that 1 in every 95 people on earth has fled their home as a result of conflict or persecution. Around 48 million people are internally displaced and 68% of this group originates from just five countries: Syria, Afghanistan, Myanmar, Venezuela and South Sudan (UNHCR, 2021). The 1951 Refugee Convention and its 1967 Protocol founded by the United Nations defined the term 'refugee' and outlined the rights of refugees, as well as the legal obligation of States to protect them. The core principle of the Convention is non-refoulement, which means that a refugee should not be returned to a country where they face serious threats to their life or freedom (UNHCR, 2021). The road towards a safer life can be just as dangerous as the situation in the country of origin itself, especially for women, children and unaccompanied minors. That is why, in order for humanitarian organisations like United Nations High Commissioner for Refugees or the Defence department to provide protection and service delivery for persons of concern in emergency situations, there is a need to know when and where to expect future refugee flows.

A suitable method for predicting refugee flows in the future is early warning modelling. This is a method of forecasting humanitarian crises before their onset by identifying the underlying causes of past refugee flight. 'In order to anticipate, assist or prevent refugee flight, we need to identify and monitor those causes and triggering events of flight.' (Apodaca, 1998, p. 81). Therefore, in order to design a suitable refugee flow prediction model, there is a need to identify the main factors causing refugee flows to arise. Shellman and Stewart (2007) state that 'a model that predicts migration well but fails to be able to predict the variables that cause migration, will be of less use than a model that can predict violence and other risk factors associated with migration.' Understanding the push factors of a certain refugee crisis will at the same time provide information on the pull factors of neighbouring countries, since pull factors mainly consist of the opposite or absence of the push factors. This allows the possible direction of the refugee flows to be predicted. Various scholars argue that migration is a function of various domestic and international political, economic, and cultural factors. According to the literature, political violence and culture serve as the most important risk factors of forced migration. In addition, the domestic economic situation at home and abroad may affect internal displacement and refugee flows (Shellman & Stewart, 2007).

However, according to UNHCR (2021) the impacts of climate change are increasingly triggering forced displacement and worsen living conditions or hamper return for those who have already been displaced. 'Crops and livestock struggle to survive where conditions become too hot and dry, or too cold and wet, threatening livelihoods. In such conditions, climate change can act as a threat multiplier, exacerbating existing tensions and adding to the potential for conflicts.' (UNHCR, 2021, p. 1). Examples of natural disaster affecting populations are abnormally heavy rainfall, prolonged droughts, desertification, environmental degradation, or sea-level rise and cyclones. In general, there is more evidence that climatic conditions influence short-distance temporary displacement than international migration (Schutte et. al., 2021). Because displacement is associated with high risks and costs, citizens in conflict-affected countries not directly threatened by the fighting typically see to stay and wait out the conflict.

However, when the physical environment can no longer sustain their mode of living, citizens are forced to leave (Schutte et. al., 2021). The UNHCR has argued that adverse effects of climate change and natural disasters may produce valid claims for refugee status. The European Union is currently exploring a potential European framework for “climate refugees” (Schutte et. al, 2021).

One of the countries that has become victim of the consequences of climate change is South Sudan. Today, South Sudan is confronted with the third largest refugee crisis in the world (after Syria and Afghanistan) (Mercy Corps, 2019). Like various other African countries, South Sudan has a (long) history of civil war, economic underdevelopment, malfunctioning governing structures, widespread corruption and shortages of food, as well as a lack of drinking water and healthcare. Over the years, the country’s devastating environment has caused multiple refugee flows towards neighbouring countries as well as internal displacement. However, violence and poverty are not the only factors causing internal displacement and refugee flows. Flooding and droughts in South Sudan significantly disrupt livelihood patterns and food-security. Such shocks exacerbate vulnerabilities and weaken the resilience and adaptive capacity of agriculture-dependent communities; they heighten competition over natural resources, sometimes leading to cattle raiding and communal conflict (CPSR, 2021). The risk of floods can trigger temporary, or more permanent population displacements. South Sudan has a history of flooding, but floodings have become more frequent. Over 700 000 people were affected by severe flooding in the Jonglei and Eastern Nile states in 2020. The floods destroyed crops and displaced almost 85 000 people in Jonglei, what the World Food Programme (WFP) described as the worst flooding in 60 years. Resulting displacement eroded community resilience and governance capacities to respond (CPSR, 2021).

Because the awareness of the impact of climate change is relatively new and because the literature on refugee studies mainly focuses on political violence and culture as the main drivers behind refugee flows and internal displacement, refugee flow prediction models like the FLEE-model (Suleimenova, Bell, & Groen, A Generalized Simulation Development Approach for Predicting Refugee Destinations, 2017) have yet failed to include physical geographical factors such as weather and climate. This leads to incomplete and one-sided predictions of when and where refugee flows will occur because there is solely a focus on social geographical factors like outbreaks of (political) violence. This research, however, stresses the importance of linking physical and social geographical factors together in order to make more complete and detailed flow predictions.

Because refugee flow predictions are highly contextual, this research focusses on one country: South Sudan. Particularly for the case of South Sudan, a flow prediction model, the FLEE model, was tested in 2020 by researchers Derek Groen and Diana Suleimenova from Brunel University London and University College London. The model predicts the distribution of refugees across South Sudan by using so-called agent-based modelling (ABM). The goal was to help governments and other actors predict where humanitarian help is needed in the near future, so that they are able to anticipate and improve the situation of refugees while fleeing. However, the model does not include physical geographical factors like extreme flooding or drought. As was previously mentioned, flooding has caused thousands of South Sudanese people to be internally displaced. This situation stresses the necessity to examine

the role of physical geography in refugee flow prediction models. The research will further dive into this in later chapters.

This research follows and tests the refugee flow prediction model that was created by Derek Groen (2017). In the discussion section (chapter 6.2) the model will be judged on its merits.

1.1 Societal & scientific relevance

Gathering more knowledge about where peacekeeping forces and the provision of humanitarian aid will be most needed, will reduce the risk of refugees becoming a victim of violence, hunger and human trafficking. In order to do so, flow prediction models should represent all the geographical factors that can serve as a trigger for movement. With a complete overview and incorporation of all these geographical factors, refugee flow predictions used by humanitarian organisations will be more detailed and specific. This gives policy makers the opportunity to design more efficient and context specific guidelines for intervention which in turn will lead to humanitarian organisations to provide help based on the context specific demands from the internally displaced or refugees. For example: if we know when and where floods are most likely to occur in South Sudan on a yearly basis, and whether floods are a significant trigger for movement in that specific place and in that specific time, humanitarian organisations will be able to plan their provision of shelter, food and security in advance.

This research was conducted at the request of the Dutch Defence department, specifically by the 106 Inlichtingencompagnie. Which is a department that collects geographical data on conflict areas around the world. 106 is part of the Joint Intelligence, Surveillance, Target Acquisition & Reconnaissance Commando (JISTARC) which collects and analyses information about the operation area in order to provide commanders with a complete and up to date view. JISTARC is part of the Ondersteunings Commando Land (OOCL), which is part of the Koninklijke Landstrijdkrachten (CLAS). As an executive body on behalf of the United Nations, Defence is often either involved in humanitarian operations or confronted with the humanitarian consequences of conflict. Therefore, Defence wants to have a better grip on the situation. The results of this research will provide my internship organisation with more specific data on when and where to expect South Sudanese refugee flows in the near future. When a prediction can be made, Defence will be able to provide help and support for refugees more quickly and may even help prevent problems like for example violence and human trafficking.

This research is scientifically relevant because it rethinks the variables on which current refugee flow prediction models are based. Theories on refugee flows contain a lot of information on what variables scientists think are valuable to a refugee flow prediction model. However, is it not often put to the test. Moreover, in the case that the relevance of these variables is tested (Suleimenova, Bell, & Groen, A Generalized Simulation Development Approach for Predicting Refugee Destinations, 2017), there is a mere focus on social geographical factors like conflict and violence. The relevance of physical geographical factors has not been tested extensively. A possible explanation could be that the importance of physical geographical factors is something that only gained popularity over the past few years because of the increasing effects of climate change. This provides ground for further research on the role of physical geographical factors as possible variables in refugee flow prediction models.

1.2 Research objective and questions

Based on the above considerations, the research objective is to get a better understanding of the physical geographical factors influencing internal displacement and refugee flows in South Sudan. The goal of the research is to provide refugee flow prediction models with a physical geographical dimension. This leads to more detailed and context specific guidelines for intervention of humanitarian organisations which gives them the opportunity to assist and protect refugees along their way to safety. Because refugee flow prediction is highly contextual this research aims to find proof of the importance of physical geographical factors in refugee flows in the case of one country: South Sudan. Because the effects of climate change have a great impact on the country and its citizens, South Sudan is a relevant case for researching the significance of physical geographical factors like droughts and flooding.

The main research question guiding this research is therefore: *To what extent do physical geographical factors play a role in predicting South Sudanese refugee flows?*

This main research question is supported by a number of sub-questions:

- a. What push and pull factors drive the South Sudanese refugee flows?
- b. To what extent do different social and physical geographical factors influence refugee flows in South Sudan?

First, to get a better understanding of the drivers of migration in South Sudan, the push and pull factors must be examined. Second, the different social and physical geographical factors that influence South Sudanese refugee flows must be researched. Since social and physical geography are always intertwined it is necessary to examine them both, so that possible connections and relationships between these factors can be found. For example: flooding causes food shortage which causes conflict. Also, by comparing social and geographical factors it is possible to analyse the degree of importance of physical geographical factors, which will be necessary to answer the main research question.

1.3 Thesis overview

The thesis will first introduce the different theories about migration, migration models, migration drivers and refugee flow prediction models. The theories serve as the foundation for this research. This section is followed by a chapter that sets the context for this research. Since there is a focus on South Sudan, it will discuss a short history of South Sudan, the impact of conflict and climate change and South Sudan's current state in terms of refugee numbers, conflict, food shortages and flooding

Next, the methodology of this research is explained. This research used both qualitative and quantitative methods. First the qualitative reports analysis will be discussed, followed by an explanation of the quantitative statistical analysis. In the next chapter, the results are presented. First the results of the qualitative reports analysis will be discussed. These results serve as an answer to sub question A. Second, the results of the quantitative statistical analysis will be presented. They serve as an answer to sub question B.

Lastly, in the conclusion, all the results will be reviewed to answer the main research question: *To what extent do physical geographical factors play a role in predicting South Sudanese refugee flows?* Then, the discussion chapter will elaborate on and evaluate the research findings. Lastly, some recommendations for further research and for policymakers and practitioners will be discussed.

2. Theoretical Framework

In this chapter, relevant theoretical debates that this research is concerned with, are addressed. In order to answer the main research question – *To what extent do physical geographical factors play a role in predicting South Sudanese refugee flows?* – the concept of migration itself must be explored and understood. This research is based on four key issues: migration, migration models, migration drivers (including physical geographical / environmental drivers), and refugee flow prediction modelling.

2.1 Migration

2.1.1 Migration: a definition

Population movement can be described in terms of *migration*: a long-distance move to a new location. Mobility, the ability to move from one place to another, allows processes of migration to take place. 'Migration involves a permanent or temporary change of residence from one neighbourhood or settlement to another.' (Knox & Marston, 2014, p. 97).

There is no universally accepted definition for "migrant". However, the International Organization for Migration (IOM) uses the following definition for its own purposes:

'A person who moves away from his or her place of usual residence, whether within a country or across an international border, temporarily or permanently, and for a variety of reasons. The term includes a number of well-defined legal categories of people, such as migrant workers; persons whose particular types of movements are legally-defined, such as smuggled migrants; as well as those whose status or means of movement are not specifically defined under international law, such as international students.' (IOM, Who is a migrant?, 2021).

Moving away from a location is referred to as *emigration*, whereas moving to a particular location is described as *immigration*. Population movement or migration can take place from one country to another, which is called *international migration*. But it can obviously also occur within a country or region, which is referred to as *internal migration* (Knox & Marston, 2014). A change of residence, both permanent and temporary, occurs for varying reasons. However, most often they include a desire for economic improvement or an escape from adverse political conditions like war or oppression.

2.1.2 Forced migration

Most migrations are voluntary, which means an individual chooses to move. When migration takes place against the individual's will, push factors can create forced migration (Knox & Marston, 2014). Some of the most common reasons for migrants to flee from a particular area are war, famine, life-threatening environmental degradation or disaster, or governmental coercion or oppression. *Refugees*, individuals who cross national borders to seek safety and asylum, are a significant global phenomenon. In the 1951 Refugee Convention founded by the United Nations a "refugee" is officially defined as:

'A person who, owing to a well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of

his nationality and is unable or, owing to such fear, is unwilling to avail himself to the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it.' (IOM, 2021, p. 1).

In addition, the number of individuals who, because of conflict or human rights abuse, are displaced within the borders of their own country (*internally displaced persons, IDPs*) is growing globally (Knox & Marston, 2014) from 21.3 million internally displaced people in 1990 to 48 million in 2020 (UNHCR, 2021). Internally Displaced Persons are defined as:

'Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural human-made disasters, and who have not crossed an internationally recognized State border.' (IOM, Who is a migrant?, 2021).

The fundamental difference between refugees and IDPs is that refugees cross an international border whereas IDPs stay within the borders of their country (UNHCR, Internally Displaced People, 2021). IDPs stay in their country because, for example, they want to stay close to home hoping for the situation to get better soon. Others may not have the means to travel to such distances. More often than not IDPs are stuck in conflict areas where violence or other threats cut them off from reaching a border. Another main difference between refugees and IDPs is that often refugees are protected by international law when they seek safety in another country. IDPs have to rely on their own government for protection from violence (UNHCR, Internally Displaced People, 2021). In many cases governments are not capable or willing to provide such protection. That makes IDPs among the most vulnerable displaced persons in the world. Like refugees, many IDPs lose their jobs, property and livelihoods and may even get injured or lose family and friends.

This research will mostly refer to 'refugees' and 'refugee flow prediction modelling'. To provide a good connection to other research discussing refugee flow prediction modelling, it is more efficient to use the term 'refugee' than 'IDP'. Although this research focuses mainly on IDP's, the push and pull factors that set these flows in motion are often similar to those of refugee flows. The movement of people discussed in this research takes place within the borders of South Sudan and is therefore the first stadium of movement. However, because many IDP's will cross the border in a later stadium they are in this research referred to as 'refugees'.

2.2 Migration models

2.2.1 Three migration models

The concept of migration is complex, characterised by many features. One of the best-known researchers who designed a basic model for migration is Everett S. Lee from the University of Pennsylvania. According to his model (1966), migration flows are driven by four factors: *push factors*, *pull factors*, *intervening obstacles*, and *personal factors* (see Figure 1). *Push factors* represent reasons for migrants or refugees to leave their country of origin, for example unemployment or war. *Pull factors* represent the attracting features of the country of destination, for example education or safety. While migration may result from a balancing of push and pull factors, it does not decide the act of migration. 'The balance in favour of the move must be enough to overcome the natural inertia which always exists.' (Lee, 1966, p. 51)

Next, there is a set of *obstacles* that migrants encounter during migration which can either be small or insurmountable; for example, a lack of water and/or food, rebel groups and human trafficking. However, as Lee (1966) argues, different people are affected in different ways by the same set of obstacles; that is where *personal factors* come into play.

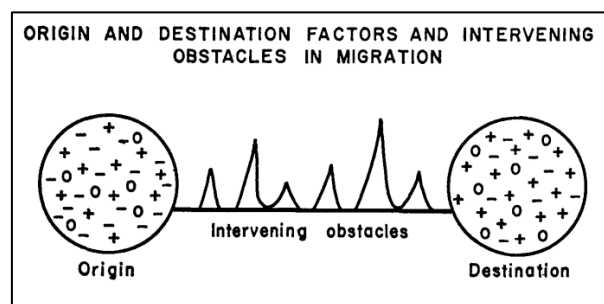


Figure 1: Lee's Migration Model (Lee, 1966)

In their model, Neumann and Hermans (2015) also include personal factors as an important driver of migration (see Figure 2). They argue that the perception of regional differences is highly personal and is influenced by the individual's characteristics (education, age, marital status, gender, etc.). Their model also includes two other drivers: drivers at a regional level and spatial-temporal differences between various drivers in two locations. In their review of drivers, Neumann and Hermans (2015) show that people compare the local context (e.g., the socio-economic situation) of their place of origin with the anticipated local context of their expected destination. (Neumann & Hermans, 2015) This corresponds with Lee's (1966) migration model where people weigh the push factors of the country of origin with the pull factors of the country of destination to base their decision on.

The third relevant model is Castelli's (2018) migration model. As depicted in Figure 3, it is divided in macro, meso and micro factors. Macro factors represent reasons for leaving the country or region just like the push factors do in Lee's migration model. Meso factors are either intervening obstacles or facilitators of travelling to another place, while micro factors represent the individual characteristics, which also both Neumann and Hermans (2015) and Lee (1966) argue to be important in making the final decision to migrate.

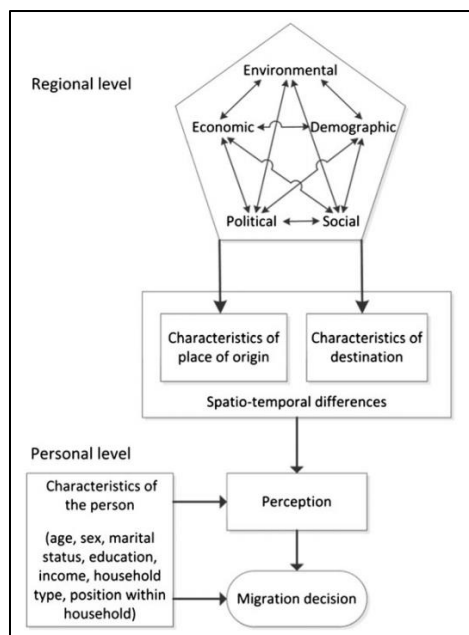


Figure 2 – Drivers of migration (Neumann & Hermans, 2015)

2.2.2 Comparing the models

In order to get a better understanding of the central components of the various migration models, it is important to compare them and see what similarities and differences can be found. First, they all include an element that represents the reasons for leaving. In Lee's model they are referred to as push factors, whereas in Neumann & Herman's (2015) model they are presented as the regional context. Castelli's (2018) model refers to these components as macro, meso and micro factors. However, Castelli's model differs in that it does not take into account features of the country of destination. There is merely a focus on what drives people away from the country or region of origin, not what draws them to another place. Lee (1966) and Neumann and Hermans (2015) do take into account the differences between the place of origin and destination. Lee (1966) stresses the importance of pull factors in order to calculate how the characteristics of the place of origin weigh up to those of the place of destination. Neumann and Hermans (2015) refer to this comparison as 'spatio-temporal differences' between the place of origin and destination. However, since this research focusses specifically on refugees and not on migrants, pull factors will be less relevant. Still, pull factors like security and food security can influence the direction in which refugees will flee from one place to another.

The second element standing out in the comparison is that in their model Neumann and Hermans (2015) do not include intervening obstacles. Both Lee (1966) and Castelli (2018) stress the importance of intervening obstacles, or meso factors, as they can make or break the decision to leave because they might be too great to overcome. For example, a lack of money, travelling with livestock or a lack of water and food along the way will all influence whether leaving is a sensible decision. However, fleeing isn't always preceded by a sensible decision. Instant violence or flooding can force people to flee even though there might be intervening obstacles. That is why it is so important for humanitarian organisations to provide security, food and shelter.

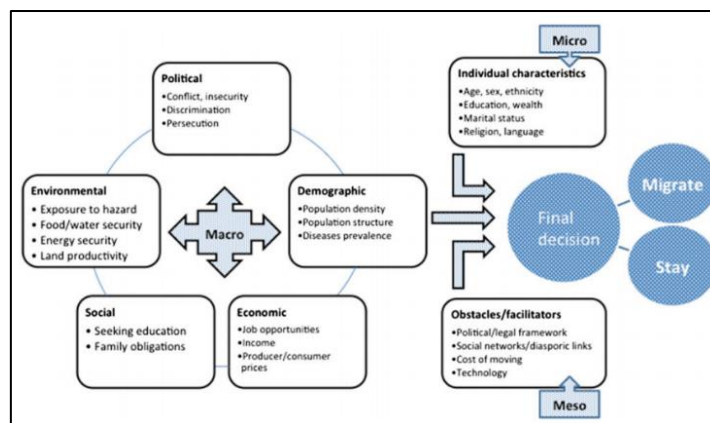


Figure 3 –Castelli's migration model (Castelli, 2018)

Personal factors also play an important role in the way in which push and pull factors as well as intervening obstacles are perceived. All three models include the personal factors, or micro factors in Castelli's (2018) case. Lee (1966) gives the following example to explain the role of personal factors:

'A good climate is attractive and a bad climate repulsive to nearly everyone; but a good school system may be counted as a + by a parent with young children and a – by a houseowner with no children because of the high real estate taxes engendered, while an unmarried male without taxable property is indifferent to the situation.' (Lee, 1966, p. 50)

Based on this comparison of the various models, four components turn out to be important for modelling migration: (1) there are reasons for people to leave the place of origin (push factors / macro factors), (2) the place of destination has features that attract people (pull factors), (3) along the way, migrants may encounter intervening obstacles that are sometimes known beforehand or can either come as a surprise, and (4) the way in which the country of origin, the country of destination and the intervening obstacles are perceived is dependent on personal factors.

What is most important for this research are the push factors that drive people away from a place. Push factors are triggers for fleeing and in order to know what social and physical geographical factors play a role in causing refugee flows there is a need to understand the concept of push-factors. Pull factors play a less important but still significant role in this research. The research mainly focusses on the causes of refugee flows, but in order to predict future refugee flows it is also meaningful to know what might attract refugees to a particular place or country. Features like the availability of food and security might lead refugee flows into a certain direction. Also, knowledge on what intervening obstacles refugees might encounter along the road is crucial to the intervention of humanitarian organisations. If there is no information on these intervening obstacles, humanitarian organisations are unlikely to provide for refugees. Lastly, personal factors will probably play the least important role in this research since situations that cause people to flee are often not linked to any personal characteristics. Both men and women, children and elderly are affected by violence, food insecurity and natural disaster.

2.3 Migration drivers

Let us zoom in on the push and pull factors that are included in the migration models that were just discussed. To get a better understanding of what circumstances trigger people to move away, we need to take a look at the drivers of migration. Both Neumann and Hermans (2015) and Castelli (2018) present five main categories of drivers: economic, social, political, environmental, and demographic. The reason(s) for migration can be created by either one or multiple drivers at the same time. In the following paragraphs we will analyse these drivers in more detail.

2.3.1 Economic drivers

Poor human development is one of the most important drivers of migration in the world. It can be analysed by using the Human Development Index (HDI), as proposed by the United Nations Development Program (UNDP). For every country in the world, it calculates life expectancy at birth, years of schooling and GNI per capita. The lower the index number, the poorer the human development

in a country. Looking at the Human Development Index Ranking (UNDP, 2021), one can clearly see that most West European countries, along with the USA, Canada, Japan and Singapore score very high. On the other hand, most African countries score extremely low with some countries having an average life expectancy of just 53 years, two or three years of mean schooling and a GNI per capita of less than 1,000 dollars. However, these are the most extreme cases and there is quite some difference between the countries with a lower HDI.

According to Pitovsky et al. (2021), the unemployment rate is often linked to out-migration from a country of origin and negatively related to in-migration to a country of destination. Many jobs in developing countries are still in the informal sector, with a low salary and little social protection. This motivates people to find better job conditions elsewhere. 'Low performances in the health, education and economic sectors are a reflex of the vulnerability of the health, education and productive systems which is caused by the lack of economic and human resources.' (Castelli, 2018, p. 3) These situations provide little professional and economic motivation for qualified professionals to stay in their country of origin. As they leave, a phenomenon known as 'brain drain' takes place and creates a vicious circle. (Castelli, 2018) In a country with poor health services, a small educated and qualified workforce and high levels of poverty, people are very motivated to leave in search for a better life. Especially with today's technology, which exposes people to the luxurious Western lifestyle, it only makes sense that people want to escape from their poor living conditions.

2.3.2 Demographic drivers

Over the last two centuries, the world's population has increased from around 1 billion people in the year 1800 to an estimated 11 billion by the year 2100. The greater part of this increase is taking place in Asia and Africa, 'where high fertility rates, driven by infant mortality, and poor birth control programmes result in high annual population increase rates.' (Castelli, 2018, p. 3) On the other hand, the fertility rate in Western industrialized countries is decreasing. Consequently, the population of Western countries is reducing in size and is getting older, while the young working-age population in developing countries is quickly increasing. Especially on the African continent, the rapidly increasing young population will transcend the improving economy, causing the so-called 'jobless generation' phenomenon. (Castelli, 2018) This motivates the working-aged citizens to look for jobs outside the borders of their country. As a result, it will encourage migration flows from developing countries to developed countries. However, in reality, over the years this particular type of migration flow appears to be quite stable, contradicting the stereotype of 'mass' invasion of rich countries by migrants from low-income countries. (Castelli, 2018)

2.3.3 Environmental drivers

Nowadays, even though the concept of a 'climate refugee' is not legally recognized, discussions concerning this definition are mounting, which is mainly due to the intensification of global climate change (Berchin et. al., 2017) 'A climate refugee is one who has been forced to leave their home or country, due to the effects of severe climate events, which exposes them to the perception of insecurity

and force them to seek asylum in other regions or countries. They are forced to rebuild their lives in other places, despite conditions through which they are submitted.’ (Berchin et. al., 2017).

The impact of climate change is of growing importance, as the International Organisation for Migration expects ‘climate migrants’ to reach a number of 200 million by the year of 2050. Drought and flooding can directly impact the access to water and food and indirectly impact economic agricultural revenues. The shortage of water, food and agricultural resources forces people and livestock to move to a less hostile environment. Land degradation induced by climate changes are a growing problem and forces people to migrate because of food insecurity. (Castelli, 2018)

Ninety percent of refugees under UNHCR’s mandate, and 70 percent of people displaced within their home countries by conflict and violence, come from countries on the front lines of climate emergency (UNHCR, 2021). They are vulnerable not only to extreme weather like floods and cyclones, but also seeing their livelihoods dry up due to drought and desertification. Outbreaks of violence and extreme weather push people who have already fled once to flee again. But even if peace is restored, displaced people cannot go back if their home areas have been made uninhabitable by droughts, floods or rising sea levels (UNHCR, 2021).

2.3.4 Political drivers

In many areas of the world, bloody conflicts and social instability still prevail. In over 70 countries (International Crisis Group, 2022), armed groups are fighting, and unsafe dictatorships still exist, many of them denying basic human rights and education to their population. (Castelli, 2018) What is important is that the majority of people who have been displaced in warring nations by either themselves or authorities, are relocated within national borders and are therefore not considered international migrants, but rather internally displaced persons (IDPs).

The causes of political conflict are different for every country or region. However, sometimes correlations can be found between causes of conflict of different countries that are either neighbouring countries or countries in the same continent. Since most countries in Africa were shaped in the same way, by new imperialism, they often have similar causes of conflict. Since the focus of this research is on South Sudan, it is interesting to research the main causes of conflict in Africa. According to Akuey (2018), the primary causes of conflict in Africa are economic problems, unresolved social and national questions, election-related violence and rivalries among or between ethnic groups. Akuey (2018) argues that a lack of proper governing structures and institutions, in combination with ethnic manipulation by political elites is very prominent in the case of South Sudan. Moreover, as the military is the key political factor, it permeates all aspects of peoples’ lives. ‘Extreme economic underdevelopment, predatory governance and rent seeking by state agencies especially the military, has led to lawlessness and disorder to the extent that the centre cannot guarantee minimum security to the civilians.’ (Akuey, 2018, p. 221)

2.3.5 Social drivers

Social migration drivers are often linked to the migrant’s characteristics and personal preferences, for example religion, sexual identity, education, and the willingness to migrate. In the past, many cases of

mass population movements were caused by religious persecution or by the search for a country where individual faith could be freely expressed. (Castelli, 2018) The freedom to express yourself is also important for the LGBTQ+ community. Members of this community might live in countries that have quite restrictive policies on sexual identity, which drives them towards countries where they can express their sexual identity freely.

Education also plays an important role as a driver of migration. In their research on the relevance of migration drivers, Pitosky et al. (2021) find that the higher the education level in a country or region, the higher the out-migration. Often, migrants in search of a better future are more educated than their peers left behind in their country of origin. (Castelli, 2018) Sometimes, they are even more educated than their peers in the destination country. Furthermore, individuals from families or communities that already positively experienced migration in previous years are more prone to migrate because travelling abroad is seen as a possible benefit to the country of origin. (Castelli, 2018) The presence of ethnic or family links in the destination country reinforces this driver even further; Pitosky et al. (2021) call this the network effect: the greater the community of the country of origin in the country of destination, the greater the inflow of new migrants from the same country to that destination.

Driving the final choice to migrate, is the personal willingness to do so. The influence of the ethnic group and family support are very important elements for a specific individual to make the final choice to either migrate or stay. Factors like education level, access to financial means to make migration travel possible and ethnic and social customs are important. According to Pitosky et al. (2021), distance also appears to be an important factor: the greater the physical distance between countries or regions, the lower the migration between these countries or regions.

In her research, Zwick (2020) explores the role of various factors that influence refugees' and asylum seekers' intentions to migrate from Egypt, by using a decision-making process model based on the so-called Motivation-Opportunity-Ability (MAO) framework. These are refugees from a war-torn country who first go to Egypt and then opt for migration onwards to another country. Motivation in this respect refers to the intrinsic and extrinsic considerations that encourage someone to consider migrating in the first place. Opportunity can be both physical (time, location, resources) and social (cultural attitudes and behaviours that are considered normal). Opportunity is what enables the act of migration. Finally, ability refers to performance experience, self-efficacy, imaginal experience, and vicarious experience. Zwick (2020) concludes – based on a comparison of the motivations, opportunities, and abilities of Syrian, Libyan and South Sudanese refugees – that the importance of MAO factors varies across different countries of origin (see Figure 4).

		<i>Syria</i>	<i>Libya</i>	<i>South Sudan</i>
Motivation	<i>Intrinsic</i>	High	Low to medium	Low
	<i>Extrinsic</i>	Low	Low to medium	High
Opportunity	<i>Physical</i>	High	High	High
	<i>Social</i>	Medium	Medium	High
Ability	<i>Performance experience</i>	Low to medium	Low to medium	High
	<i>Social persuasion</i>	Medium	Low to medium	High
	<i>Imaginal experience</i>	High	High	High
	<i>Vicarious experience</i>	Low	Low	High

Source: Author's computation.

Figure 4 - Degree of importance of MOA factors by type and by origin country – Zwick (2020)

The information on migration drivers that was collected in this sub chapter gives the research a foundation on what different drivers are important in migration models. In the next section, we will discover what drivers are actually implemented in a refugee flow prediction model.

2.4 Refugee Flow Prediction Models

A suitable method for predicting refugee flows in the future is early warning modelling. This is a method of forecasting humanitarian crises before their onset by identifying the underlying causes of past refugee flight. If researchers can identify and predict the risk factors that cause population displacement, they can create contingency plans for future emergencies (Shellman & Stewart, 2007). 'Contingency planning is a specific activity whereby a group of relevant agencies get together to plan potential response for a particular scenario of mass human displacement which is probable but has not yet happened.' (Dunkley, 2004, p. 4). Knowing reasonably accurate and time-specific answers to questions like when, where and how many can enable planners to develop a comprehensive response strategy catered to those answers (Shellman & Stewart, 2007).

A model that predicts migration also needs to be able to predict the risk factors which predict migration. Shellman & Stewart (2007) argue that migration is a function of various domestic and international political, economic, and cultural factors. Violence and cultural networks seem to be the biggest predictors of forced migration. Variables representing violations of human rights abuses, guerrilla attacks, and genocide and politicide have a statistically significant, positive impact on numbers of forced migrants (Shellman & Stewart, 2007). Networks and cultural communities provide people with information about migration possibilities.

Weather and climate can also influence refugee flow predictions. In general, there is more evidence that climatic conditions influence short-distance temporary displacement than international migration (Schutte et. al., 2021). Because displacement is associated with high risks and costs, citizens in conflict-affected countries not directly threatened by the fighting typically see to stay and wait out the conflict. However, when the physical environment can no longer sustain their mode of living, citizens are forced to leave (Schutte et. al., 2021). 'The availability of reliable data concerning environmental change (such as the increased availability of satellite and other remote-sensing imagery), and access to the field in environmentally-sensitive places often unafforded in conflict zones fill critical data needs, whereas such data for acute displacement crisis are comparatively limited.' (Edwards, 2008, p. 357)

According to their research, Shellman and Stewart (2007) state that time-series case specific forecasts will prove more value to a policymaker dealing with contingency planning for a specific case than large N-models, which look at forced migration at the country-year level throughout the world. However, modelling displacement requires more than representations of people and space. In order to create sufficiently accurate predictive models of forced displacement, the rules that agents use in navigating around their space must sufficiently represent how people behave in reality (Edwards, 2008). Agent-Based-Modelling (ABM) holds the potential to account for any type of geography, populated by any number of people with any number of characteristics, and can account for a wide range of individual experiences and adaptive behaviours (Edwards, 2008).

In their research, Suleimenova et al. (2017) present a generalized simulation development approach (SDA), the FLEE-model, to predict the distribution of refugee arrivals across camps, given a particular conflict situation (Figure 5).

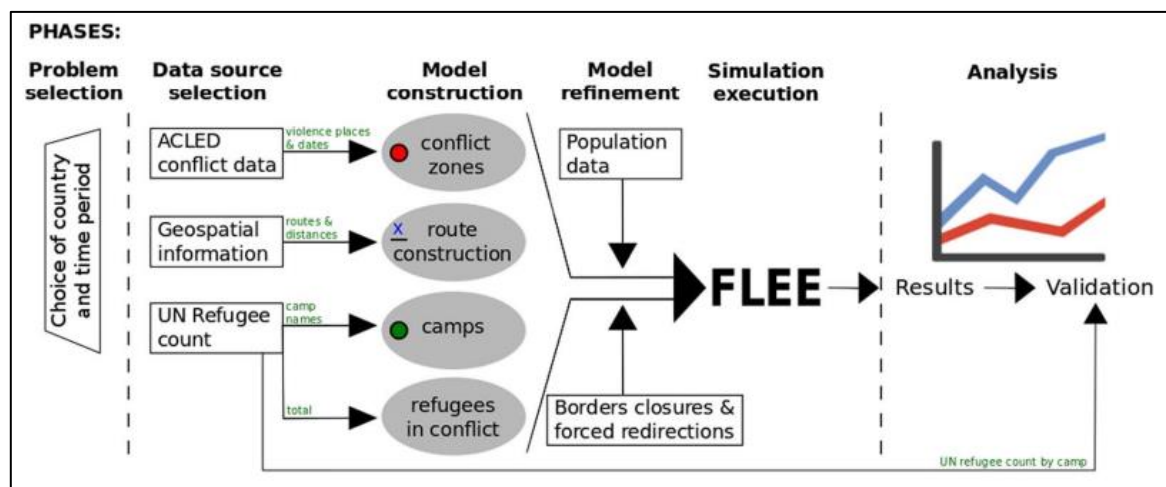


Figure 5: The FLEE-model (Suleimenova, Bell, & Groen, 2017)

The study has reproduced the key refugee movement patterns (through the use of ABM) in three conflicts (Burundi, Central African Republic, and Mali) and correctly predicted at least 75% of the refugee movement destinations in all the conflicts after the first 12 years. Data sources used for the prediction of refugee flows are the so-called ACLED conflict data (violence, places, and dates), geospatial information (routes and distances) and UN refugee count (camp names and total of refugees). The model construction contains conflict zones, route construction, camps, and the number of refugees in the conflict. Population data, and forced redirections are used for refinement of the model (Suleimenova, Bell, & Groen, 2017). In 2020, the effect of policy changes, for example border closures, was included in this study. The conclusion was that 'border closure and a reduction in camp capacity induce fewer refugee arrivals and more time spend travelling to other camps.' (Suleimenova & Groen, 2020, p. 1).

Comparing this model to Castelli's (2018) drivers of migration, it can be seen that it only includes political drivers of migration, such as conflict data and refugee numbers. Economic, environmental, social and demographic drivers are excluded from the FLEE-model. However, there is no evidence that these drivers do not play a role in the case of South Sudan or any other case. As said before, the FLEE model correctly predicted at least 75% of the refugee movement destinations, so political drivers do play an important role. But what about the other 25%? To find out, the push and pull factors that influence South Sudanese refugee movements must be researched. When all the migration drivers that play a significant role in the case of South Sudan are presented, they can be included in flow prediction models like the FLEE-model. This will lead to more precise and detailed predictions that can be used by humanitarian organisations.

3. Setting the context

As was mentioned in the previous chapters refugee flow predictions are highly contextual because every case has a different set of geographical factors of influence. Spellman and Stewart (2007) also stated that time-series, case specific forecasts prove more valuable to policymakers than large N-models that look at the country-year level throughout the world. Because every refugee flow has its own specific push and pull factors, a case specific forecast can provide more detailed policies. Therefore, it was decided that this research on refugee flow prediction models should focus on one case only. Since the FLEE model, and therefore the influence of social geographical factors was already tested on the case of South Sudan, it seemed like a good opportunity to discover the influence of physical geographical factors for this case. Chapter 4 will explain how South Sudan was divided into different regions and how the year of 2020 was divided into different seasons as a means to be able to be as specific as possible with refugee flow predictions.

But first, a description of the context is needed to understand the necessity of this research for the specific case of South Sudan. The chapter will first introduce a short history of South Sudan and will be followed by an explanation of the impact of climate change in South Sudan. Lastly, the chapter presents an overview of the current situation of South Sudan and the major factors playing a significant role in South Sudanese refugee flows.

3.1 A short history of South Sudan

South Sudan, also known as the newest country in the world, was founded in the year of 2011. Before becoming independent South Sudan was part of Sudan. Naturally, the two countries have always known their differences before splitting apart. Opposed to Sudan, South Sudan has always had a population that predominantly existed out of African cultures who tend to adhere to Christian or animist beliefs. South Sudan contains many different ethnic groups (Collins, 2021). Sudan, however, has always had a population and government that was largely Muslim and Arab.

In 1820, when Sudan was still one country, the region was invaded by Muhammad Ali, the de facto ruler of Egypt between 1805 and 1848. Also, southern Sudan was plundered for slaves (Collins, 2021). By the end of the 19th century, Sudan was under British-Egyptian rule. The northern part of Sudan accepted British rule relatively quickly while there was greater resistance in the south. This led the British to focus on modernization efforts in the North. While in the South, their energy was put into simply maintaining order. This led to a dichotomy of development between north and south that continued for several decades (Collins, 2021).

In the years after Sudan gained its independence from Britain in 1956, the government tried to win general acceptance from the country's diverse political constituencies. A conflict arose between the northern leaders who had hoped to impose the Islamic law and culture to all parts of the country and those who opposed this policy. The opposers included the majority of southern Sudan's population, who feared that the south would be further marginalized by the northern-based government. These fears

eventually led to a long civil war from 1955 till 1972 (Collins, 2021). After a few years of peace, the second civil war broke out which lasted from 1983 till 2005.

In 2005, the Comprehensive Peace Agreement ended warfare and generated an outline of new measures to share power, distribute wealth and provide security in South Sudan. The agreement also granted southern Sudan a semiautonomous status and guaranteed that a referendum on independence for the region would be held in six years. (Collins, 2021) In January 2011, with help of the UN and international community, the referendum took place. Nearly 99% of the South Sudanese voted in favour of independence. (Vox, 2021) This led to the independence of South Sudan on July 9, 2011.

However, after South Sudan gained its independence, everything fell apart. South Sudan contains more than 60 ethnic groups. During the civil war with the north, these groups put their differences aside to fight for independence. The two largest ethnic groups in South Sudan are the Dinka and the Nuer. The new president Salva Kiir was a Dinka and in an expression of unity he asked Riek Machar, a Nuer, to be his vice president. (Vox, 2021) In December 2013, following a political struggle between Kiir and Machar that led to Machar's removal as vice president, violence erupted between presidential guard soldiers from the Dinka and Nuer ethnic groups. (Council of Foreign Relations, 2021) Violence spread quickly to Jonglei, Upper Nile, and Unity States. From the outbreak of conflict, armed groups targeted civilians along ethnic lines, committed rape and sexual violence, destroyed property and looted villages, and recruited children into their ranks. (Council of Foreign Relations, 2021)

After signing and breaking several peace agreements between 2015 and 2018, the Revitalized Agreement on the Resolution of the Conflict in South Sudan was signed by both Kiir and Machar in August 2018. The agreement ended the civil war and included a new power-sharing structure that reinstated Machar as vice-president. (Council of Foreign Relations, 2021) Unfortunately, reports of continued attacks and violations, coupled with the collapse of multiple previous peace deals, raise concerns that the fragile peace may not hold.

3.2 Security and climate change in South Sudan

In order to get a complete view of the context of South Sudan, the effects of climate change should not go unreported. Climate change has an important role in either causing or exacerbating conflicts (Tiitmamer et. al., 2018). In their research, Busby et. al (2013) coupled innovative geospatial mapping techniques with insights about governance and political violence in Africa. They developed an approach to map subnational security vulnerability to climate change, which they define as situations in which large numbers of people are put at risk of mass death as a result of climate-related phenomena. By combining four different baskets of vulnerability – physical, demographic, household, and governance – they created a composite index of subnational climate security vulnerability (Figure 6) (Busby et. al., 2013).

First the physical exposure to climate-related hazards was examined. South Sudan was among the countries with the highest physical exposure. Second, the population density was researched. South Sudan has a relatively dense population in the Unity, Warrap and Lakes states (Busby et. al., 2013). Third, household and community resilience were examined. South Sudan was among the countries with

medium household and community resilience. This means that in South Sudan some people have no access to health care and basic amenities. Also, people with less education may have less information to avoid climate hazards or minimize their effects. Lastly, whether or not individuals experience the worst effects of climate-related events will partially depend on the quality of governance in the country in which they live. Government support can enable communities to prepare for and adapt to the expected impacts of climate change, and it can help them to respond when extreme weather events do occur. Unfortunately, South Sudan scores extremely low in this area. In sum, this means that South Sudan has a high composite vulnerability to climate and security (Busby et. al., 2013).

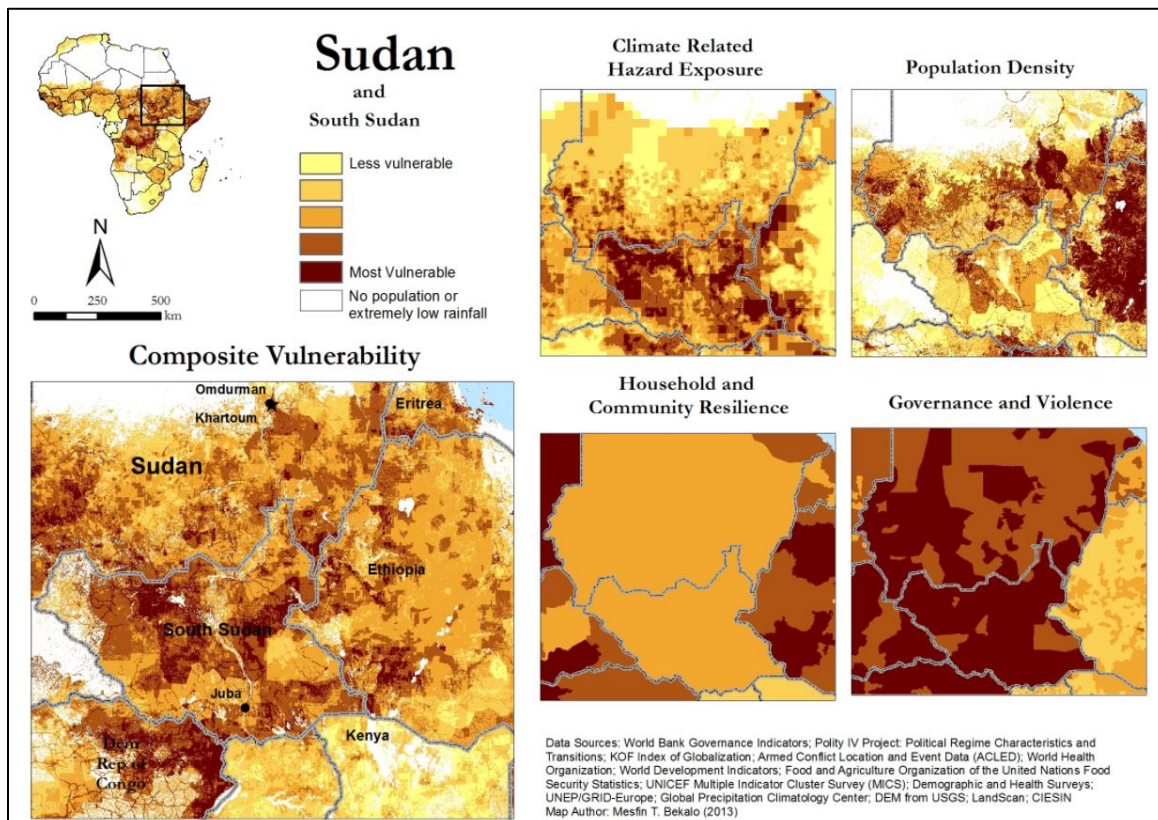


Figure 6: Vulnerability in South Sudan (Busby, Smith, White, & Strange, 2013)

Climate change and the government's inability to respond effectively can either cause conflicts or worsen them. South Sudanese agrarian communities face unpredictable rains and floods, with delayed farming or destruction of already planted crops as a result (Tiitmamer et. al., 2018). These conditions vary regionally, with the northern territories of the country, especially the flood plains ecological zones, experiencing more floods and severe droughts than before (Figure 7). These climatic patterns enormously affect communities' relations, especially in areas whose availability of natural resources depends on rainwater. Climate extremes, especially floods and droughts, influence the level of available resources, thus predictably motivating resource conflicts (Tiitmamer et. al., 2018).

What Tiitmamer et. al. (2018) conclude from their research is that areas prone to floods and droughts are the same areas that are also prone to conflicts. In particular, flood plains appear to have more conflicts and floods and droughts compared to other areas. This suggests the importance of environmental conditions to stability.

The research of the NUPI and SIPRI (2021) presents four pathways to navigate the complex relationship between climate, peace and security in South Sudan. The first pathway is livelihood deterioration. Climate change exacerbates existing vulnerabilities and grievances which can increase the risk of cattle raiding, looting and communal conflict. South Sudan's vulnerability to climate change is linked to food insecurity, which is driven by long-standing conflict but also by droughts and floods, all of which weaken community resilience. Conflict, displacement and economic collapse have also meant that farmers are less likely to invest in building climate-resilient livelihoods, leaving them more exposed to environmental shocks. Second, as of March 2021, over 1.6 million South Sudanese are internally displaced by factors including conflict and weather. The increasing number of floods and droughts is triggering temporary, or more permanent, population displacements (Figure 8) (CPSR, 2021).

Third, the involvement of armed civil defence groups in subnational violence reflects the growing militarisation of communal conflicts and increases the risk that resource conflicts become more deadly and harder to resolve through local dispute resolution. This violence also weakens communities' resilience to the adverse effects of climate change (CPSR, 2021). Fourth, research indicates that political leadership deficits and economic mismanagement have played a key role in South Sudan's water-related and other resource conflicts, highlighting the importance of climate-sensitive development. Low capacity, unclear roles and responsibilities for local government and customary authorities, and Government absence have often impeded the design of lasting solutions for local resource conflicts (CPSR, 2021).

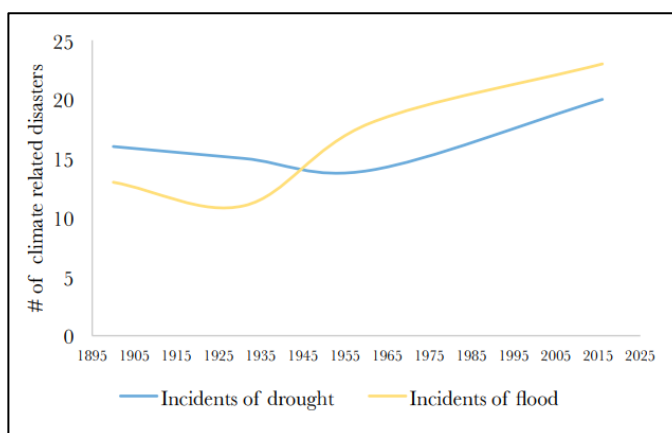


Figure 7: Incidents of floods and droughts in South Sudan, 1900 – 2017 (Tiitmamer et. al., 2018)

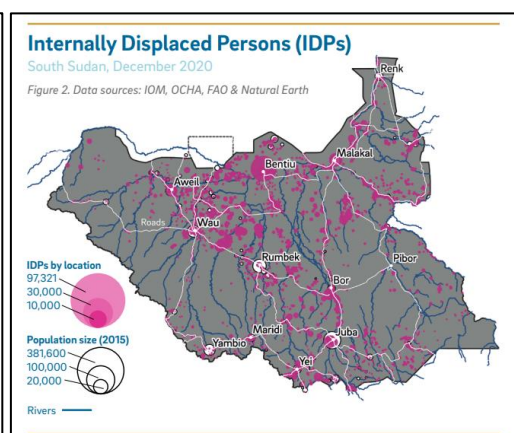


Figure 8: Internally Displaced Persons in South Sudan, December 2020 (CPSR, 2021)

3.3 South Sudan's current state

South Sudan's population is currently living in what the World Food Programme calls a 'triangle of despair'. (Berlanga, 2021) Over the past few years, conflict, climate change and hunger have caused large groups of internally displaced persons and refugee flows. A total of 2.27 million South Sudanese refugees are hosted in 5 neighbouring countries and 1.62 million people are internally displaced (Figure 9) (WFP, 2021; UNHCR, 2021). Since the signing of the peace agreement in 2018, battles and violence

against civilians are still an ongoing phenomenon and the security situation remains fragile (Figure 10) (ACLED, 2021).

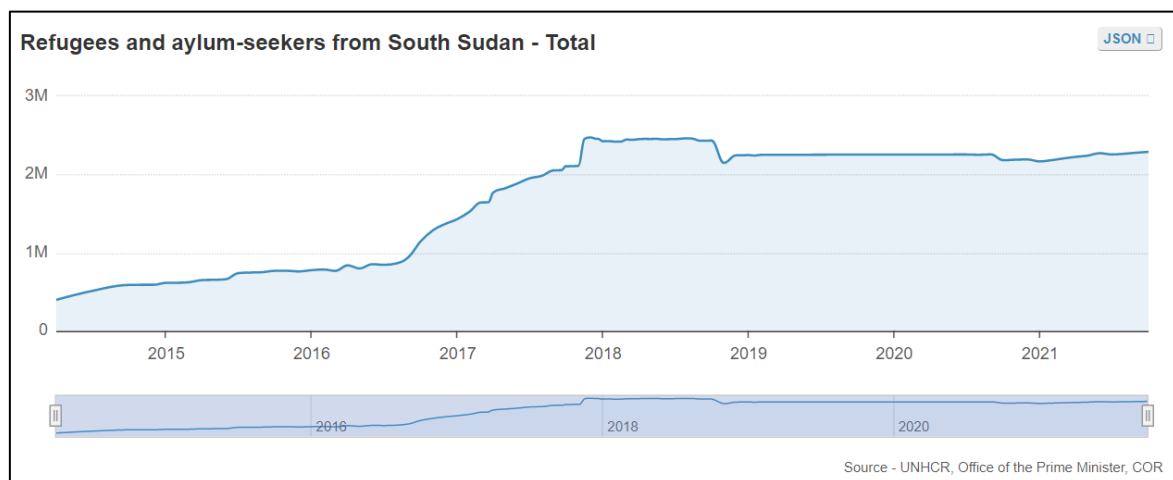


Figure 9: Refugees and asylum-seekers from South Sudan between 2014 and 2021 (UNHCR, 2021)

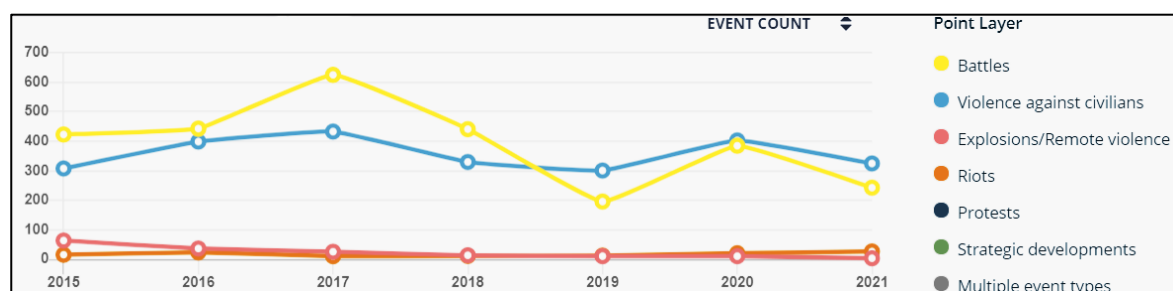


Figure 10: Conflict related events in South Sudan between 2015 and 2021 (ACLED, 2021)

The lack of security also affects the distribution of humanitarian aid that so many people are in need of. At this moment in time, 8.3 million South Sudanese are in need of humanitarian assistance of which 4.4 million children. It is expected that 1.4 million children suffer from acute malnutrition (WFP, 2021). The most severe acute food insecurity situations are experienced in regions where chronic vulnerabilities have been exacerbated by a combination of shocks, including: the impact of floods on livelihoods, diseases and pests, and persistently poor macroeconomic conditions that only have limited access to basic services (Figure 11) (WFP, 2021). Flood-affected areas might see their situation further affected as agriculture in these areas may at the same time be characterized by rain deficits in the upcoming planting period, which will likely reduce yields (WFP, 2021).

Since May 2021, an estimated 600,000 people were affected and displaced by floods in South Sudan (WFP, 2021). Above average and early seasonal rainfall have caused rivers to overflow dikes and banks, submerging entire settlements including farmlands and precious harvests (Figure 12) (Berlanga, 2021). Many people have escaped to higher ground and now face severe food shortages, a lack of clean drinking water and the threat of mosquito-borne diseases. 'The effects of the floods, such as damage to homes, harvests and livestock, as well as human displacement, threatens to compound the food insecurity of an already vulnerable population.' (Berlanga, 2021, p. 1)

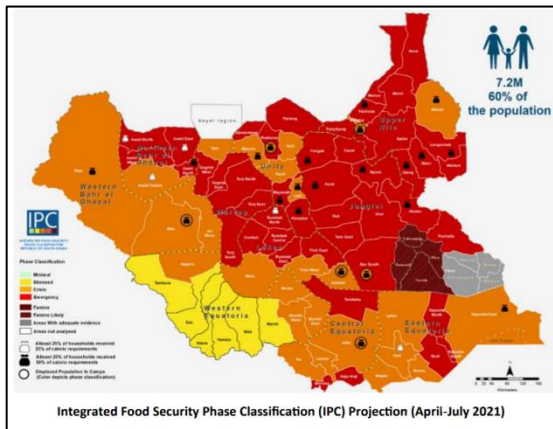


Figure 11: Food Insecurity across South Sudan from April till July 2021 (WPF, 2021)



Figure 12: Flooded villages in South Sudan (*Berlanga*, 2021)

From this information it is clear that the effects of climate change are exacerbating the already poor conditions in South Sudan. The country has a high composite vulnerability to climate and security. Floodings and droughts worsen food insecurity and therefore the living conditions of the South Sudanese people. These poor living conditions serve as a driver behind internal displacement. This leaves one to wonder why factors like flooding are not yet implemented into a refugee flow prediction model. Therefore, this research seeks to find the significance of these events as possible drivers of migration.

4. Methodology

This research was divided into two phases: a reports analysis and a statistical analysis (figure 13). Therefore, this research consists out of mixed methods: qualitative and quantitative. To identify the relevant migration variables (for refugees) in the case of South Sudan, a qualitative reports analysis was executed in Atlas.ti. Next, to test the relevance and significance of the migration variables (for refugees) that are important according to the theory, a statistical analysis was done in Excel. Because there was no access to SPSS on the university computers because of COVID-19, it was decided to use Excel.

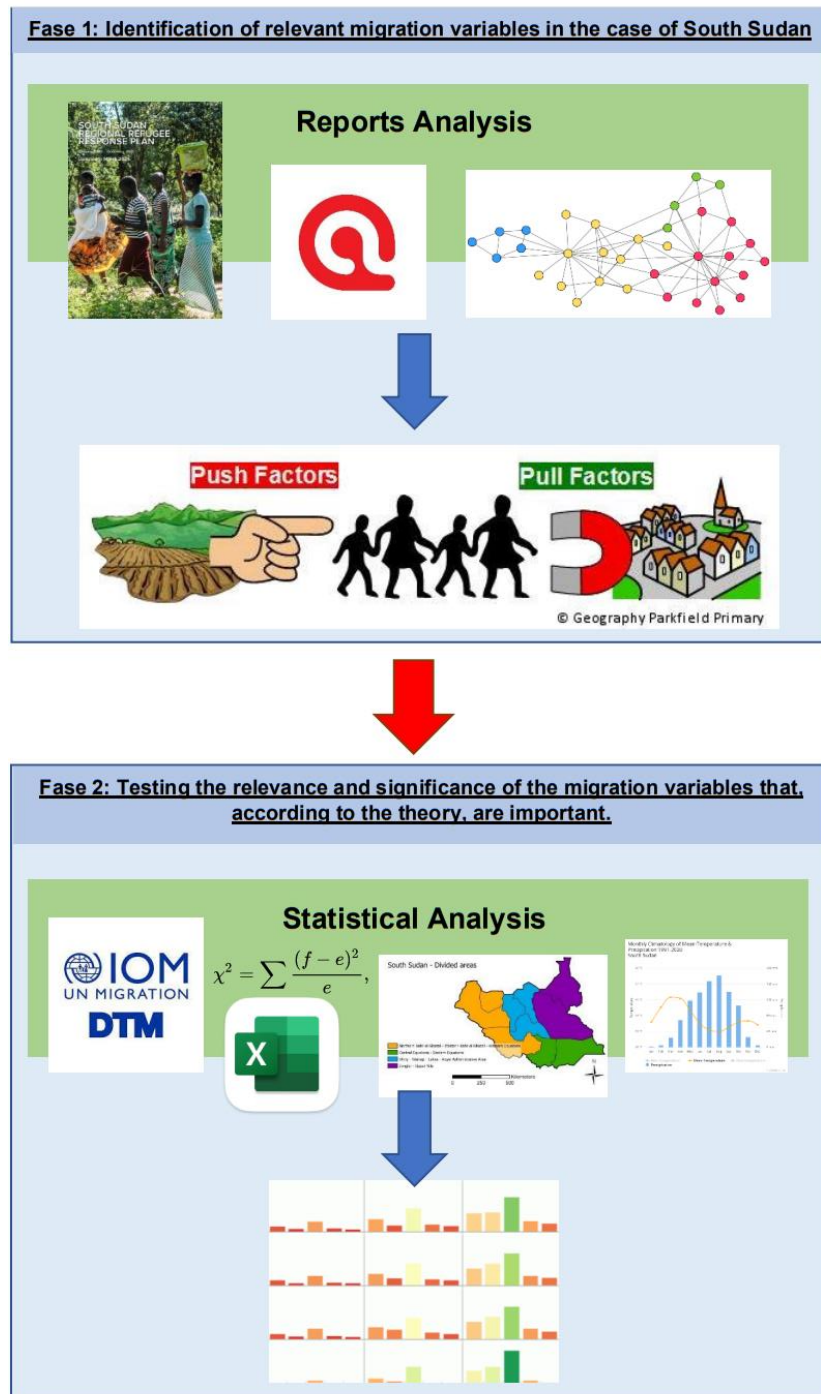


Figure 13: Workflow

4.1 Qualitative research: Reports Analysis

In order to know how physical geographical factors play a role in the South Sudanese refugee crisis, first there is a need to know what geographical factors/migration variables play a role in this case. To discover the push and pull factors of the South Sudanese refugee crisis, a reports analysis was executed. The reports used for this analysis are from organisations like the International Organisation for Migration (IOM), the United Nations High Commissioner for Refugees (UNHCR), and several other organisations related to migration, refugee flows and internal displacement. The reports include information on displacement trends, humanitarian response plans, event tracking, migration policies, etc. In total 16 reports were analysed in Atlas.ti. The reports were selected by publication date, relevance of the organisation and the emphasis on the subject of refugees and internally displaced persons. The reports used were written between 2015 and 2021. The use of older reports might not emphasize the impact of climate change, since it is a very recent problem.

All the push factors of South Sudan and pull factors of the neighbouring countries (for example Uganda) were coded and later on collected in a mind map (Figure 24) to get a good overview of the South Sudanese refugee crisis. The codes were later divided into code groups representing push factors, pull factors, needs, intervening obstacles and direct triggers for movement. Through the use of mind mapping, it was possible to visually create a migration model for the case of South Sudan using the left side as push factors and the right side as pull factors. By using arrows, linkages between different factors and aspects could be presented.

4.2 Quantitative research: Statistical analysis

As the qualitative reports analysis provided information on the migration variables for refugees, it was then necessary to research to what extent the different social and geographical factors influence refugee flows. This part of the research examines the degree of importance of social and geographical factors. To understand the reason why people flee from one place to another it is necessary to examine the degree of importance of these geographical factors. Because the aim of the research is to find out to what extent physical geographical factors influence the South Sudanese refugee crisis, both the social and physical geographical factors need to be researched. That way the social and physical geographical factors can be compared which enables the researcher to say something about the degree of importance of the psychological geographical factors.

One factor might have a greater influence than the other, so to prove that the role of physical geographical factors is significant in the South Sudanese refugee crisis, there is a need to look for statistical significance. There was only one source to be found that documented refugee flows in South Sudan: the Flow Monitoring Registries from the Displacement Tracking Matrix created by IOM for the case of South Sudan.

The International Organisation for Migration uses the Displacement Tracking Matrix (DTM) to 'gather and analyse data to disseminate critical multi layered information on the mobility, vulnerabilities, and needs of displaced and mobile populations that enables decision makers and responders to provide these populations with better context specific assistance.' (IOM, Displacement Tracking Matrix, 2021)

For the case of South Sudan, IOM has gathered information by conducting surveys among both migrants and internally displaced persons in different places of the country for every month of the year 2020. The results are collected in the so-called Flow Monitoring Registries (FMR). The goal of these registries is to survey people's movement through key transit points within South Sudan and at its borders. The purpose is to provide updated information on mobility dynamics and traveller demographics, intentions and motivations. Data is collected on both internal and cross-border flows. Flow Monitoring Points (FMPs) are positioned at strategic border crossings and transport hubs, as determined by a preliminary assessment of high-transit locations.

Disclaimer: the data collected in the Flow Monitoring Registries is highly subjective. The FMR methodology aims to track all non-local traffic passing through an FMP between 8:00-17:00, during the week and on weekends. Trained enumerators briefly survey each group of travellers and collect disaggregated information about individual demographics and vulnerabilities. Participation in the survey is voluntary and children under 15 are not directly interviewed. FMPs are not active overnight as a result of security constraints and operations may be temporarily suspended in periods of increased risk. Due to staffing constraints, full coverage may not be possible at times of exceptionally high movement through the FMP. Therefore, the Flow Monitoring Registries do not represent the actual situation for all times and for all places in South Sudan. Nonetheless, the data will still provide information about the relevance of the different geographical factors that play a role in the South Sudanese refugee crisis.

The quantitative analysis aims to find an answer to the question how different social and physical geographical factors influence refugee flows in South Sudan. Because natural disaster occurs in specific places and in specific seasons the research aims to prove that time and place play an important role. Natural disaster causes displacement and food insecurity and is therefore important to examine. By comparing different places and seasons of departure with different reasons for departure it can be seen where and when different factors play a significant role. First, by using the chi-square analysis, the different places of departure and the different seasons of departure were compared to the different reasons for departure to see whether place and time had a significant influence on the reason of departure.

As time and place appeared to influence the different reasons of departure, the second part of the analysis focussed on finding what reasons for departure were most prominent in different places of departure and different seasons of departure. This was done through the use of bar charts. The longer the bar of a specific reason, the more prominent it was in that specific area or time. Lastly, all results were combined in a large matrix that presents the most prominent reasons of departure for every different place of departure in every different season of departure. The matrix shows to what extent different social and physical geographical factors play a role in the South Sudanese displacement crisis. This then provides an answer to the main research question: *To what extent do physical geographical factors play a role in predicting South Sudanese refugee flows?* 'To what extent' cannot be translated into specific numbers since the data is subjective. However, the results can serve as proof for the important role of physical geography in refugee flow prediction modeling.

Since the quantitative data analysis only provides information on the year of 2020, it does not say anything about previous years or the years to come. IOM does not provide Flow Monitoring Registries from earlier years. In order to have an up-to-date image of what factors play a continuing role in the South Sudanese refugee crisis, the research should be repeated annually. Also, since the data from the Flow Monitoring Registries is highly subjective, more researchers should be deployed to collect data in South Sudan to be able to represent a situation as close as possible to the real-life situation. Nonetheless, this research provides a guide to mapping the relevant social and physical geographical migration drivers in a refugee crisis. It can therefore be used in different cases since the methodology can remain the same.

4.2.1 The Flow Monitoring Registry

The goal of this research is not to predict any specific refugee flows in South Sudan in the future, but rather to provide significant proof of the importance of physical geographical factors. The data from the Flow Monitoring Registries is therefore used as a test to see whether the physical geographical factors indeed play a significant role. The data is also used as an example to show how the degree of influence of these factors can be calculated for different places of departure and different seasons of the year.

1 st Filter	2 nd Filter	Factors
Forced Displacement: yes	Period 1: January – February – March 2020	- Place of departure - Departure from camp: yes / no
	Period 2: April – May – June 2020	- Place of destination - Destination is camp: yes / no
	Period 3: July – August – September 2020	- Reason for departure - Reason subtype
	Period 4: October – November – December 2020	- Transport - Nationality

Table 1 – Data from the Flow Monitoring Registry used for the analysis

Table 1 presents all data used for this research. The data was first categorised through the filter of forced displacement (= yes) and was then divided into four time periods (each consisting out of three months). Next, all the factors that were not relevant as factors of influence were left out. This resulted in a collection of eight factors that do play an important role in examining refugee flows in South Sudan: the place of departure, whether the department is from a refugee or IDP camp, the place of destination, whether the place of destination is a refugee or IDP camp, the main reason for departure, the specific reason for departure, the transport that was chosen, and the most common nationality of the group that was surveyed. In the following sections the choice of filters and factors is explained in more detail.

4.2.2 Filtering the data

Since the focus of this research is on refugees and internally displaced persons, the decision to move must be involuntary. The research is about people who initially did not plan to move and have therefore also not planned their journey. That is why all the data was first filtered through the filter of forced displacement. This means that all the data that remained after applying the first filter (forced displacement = yes) is based on involuntary movement.

Secondly, to find out whether different time periods have any influence on the reason for travelling, the dataset was divided into four time periods:

- Period 1: January – February – March 2020
- Period 2: April – May – June 2020
- Period 3: July – August – September 2020
- Period 4: October – November – December 2020

The division of these periods is based on the climate graph of South Sudan (Figure 14). The division was made through examining the similarities between rainfall and temperature in different months. January, February and March are all characterised by increasing temperatures and low rainfall. April, May and June are characterised by decreasing temperatures and quickly increasing rainfall. July, August and September are the coldest months of the year and also the wettest months of the year. October, November and December have a near to equal temperature and quickly decreasing rainfall. Also, because the Flow Monitoring Registries all came from 2020, it would be inconvenient to make December, January and February a period, since the registries would then not be in chronological order.

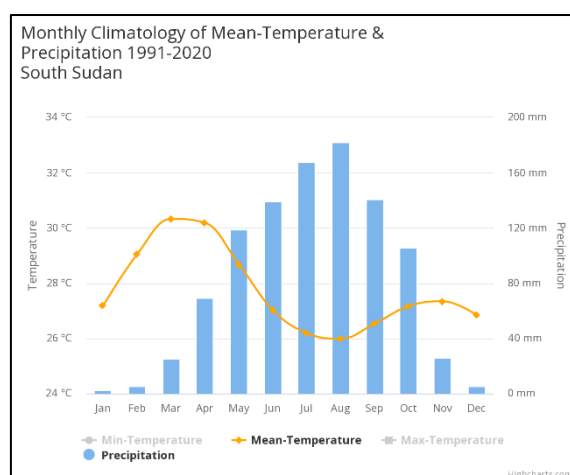


Figure 14 – Climate Graph of South Sudan (*Climate Change Knowledge Portal, 2022*)

	Period	Rainfall	Temperatures
1	January – February – March	Relatively limited rainfall, but slowly increasing. Driest period of the year. Between 5 and 30 mm.	Highest temperature of the year. Between 27 and 30 °C.
2	April – May – June	Heavy and increasing rainfall. Between 70 and 140 mm.	Temperature decreasing over time. Between 27 and 30°C.
3	July – August – September	Heavy rainfall. Peaks in August but decreases in September. Between 140 and 180 mm.	Lowest temperatures of the year. Between 26 and 27°C.
4	October – November – December	Quickly decreasing levels of rainfall. October is still relatively wet. November and December are quite dry. Between 10 and 110 mm.	Average temperature around 27°C.

Table 2 – Average rainfall and temperatures in South Sudan

Chapter 3, Setting the Context, shows that natural disaster is an important factor for forced displacement. Especially during months of heavy rainfall, flooding is a very common problem as it causes the destruction of homes and livelihoods. However, it has not yet been statistically proven whether and how physical geographical factors influence the place and reason of departure. This is important because policy makers need to have a detailed view of the amount of displaced people caused by physical geographical factors in a specific area and at a specific time in order to provide the right guidelines for humanitarian help.

The climate graph presents the average temperature and rainfall over the time period of one year, based on data from 1991 to 2020. As climate change has caused rainfall and drought to become more severe over the recent years, they are playing an increasingly important role in the case of involuntary migration. Table 2 provides an overview of the weather conditions for each period.

4.2.3 Relevant factors

Place of departure and destination

To determine what geographical factors play a role in the South Sudanese refugee crisis, it is necessary to get information about where refugees flee from and what their place of destination is. The Flow Monitoring Registries contain information on the country, state and city or village refugees flee from. They include the same degree of information of the places of destination, or at least the places refugees are planning to go to. To narrow down the number of places of departure and destination, the data set was divided in ten different places of departure and places of destination. (Table 3)

Places of departure and destination	
-	South Sudan Region 1: Northern Bahr El Ghazal – Western Bahr El Ghazal – Western Equatoria
-	South Sudan Region 2: Central Equatoria – Eastern Equatoria
-	South Sudan Region 3: Unity – Warrap – Lakes – Abyei Administrative Area
-	South Sudan Region 4: Jonglei – Upper Nile
-	Sudan
-	Uganda
-	Kenia
-	Ethiopia
-	Congo
-	Central African Republic

Table 3 – Places of departure and destination

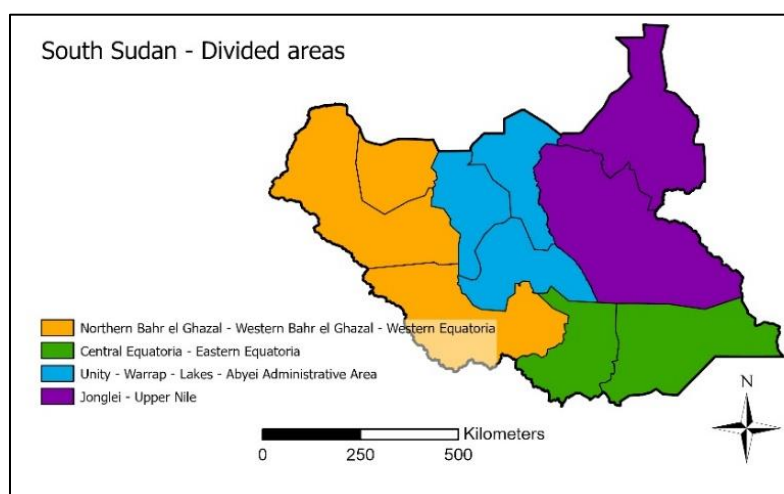


Figure 15 – South Sudan research division

Because the Flow Monitoring Reports are very specific regarding the various states and cities, it was decided to divide South Sudan into four different areas to make the analysis a bit more comprehensible (Figure 15). The four regions were divided on the basis of three factors: the number of conflicts, the flood risk and the food insecurity over the year 2020. As these three factors form the three main reasons for leaving the area (as described in the FMRs), it is suitable to divide the country into four regions based on these factors (Figure 16 and 17).

Figure 16 combines the three variables on which the division in Figure 15 is based. The first variable is conflict density, and it is based on data from ACLED (2020). The conflict density on this map represents the number of attacks against civilians in the entire year of 2020 (Figure 18). The darker the colour on the map, the more attacks took place in that particular area. It shows that in 2020 region 2 and 3 experienced the highest number of attacks.

The second variable used for making a distinction in this research is food insecurity. Figure 19 represents the average food insecurity over the year 2020 for every South Sudanese county. The map is based on data from the World Food Programme (2020). Region 1 includes areas of relatively low food insecurity in the south but also high food insecurity in the north. Regions 3 and 4 both experienced extreme food insecurity in 2020.

The third variable is flood risk. Figure 20 is based on 2020 OCHA flood risk map. In particular areas in the northern and eastern part of the country are highly sensitive to flooding during the wet seasons. In this respect, regions 3 and 4 are at risk of extreme flooding.

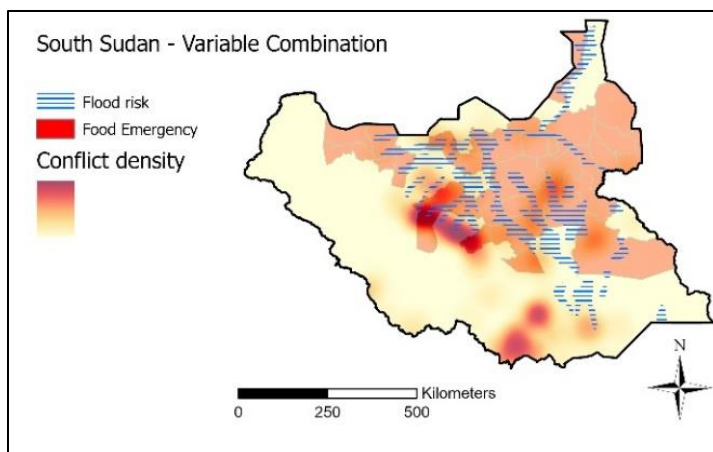


Figure 16 – Conflict density, food emergency and flood risk in South Sudan

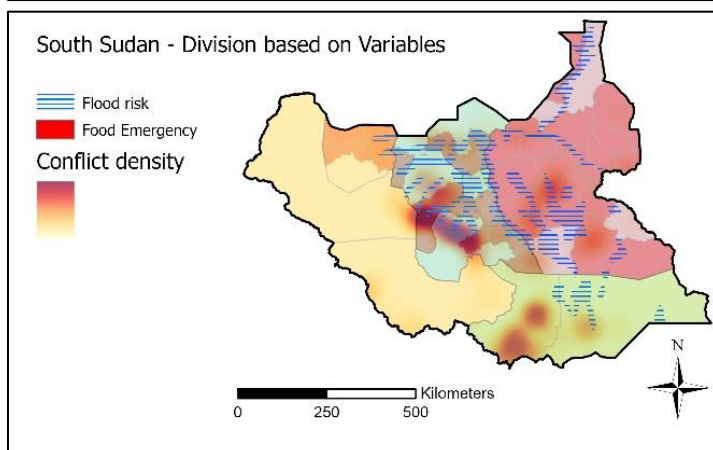


Figure 17 – Research division based on conflict density, food emergency and flood risk

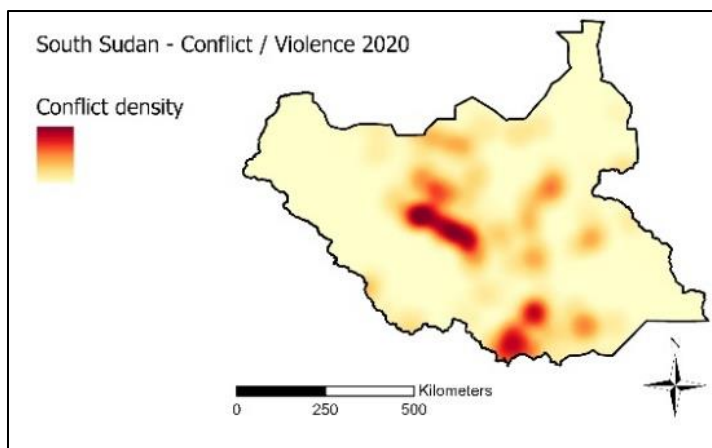


Figure 18 – Conflict density in South Sudan 2020

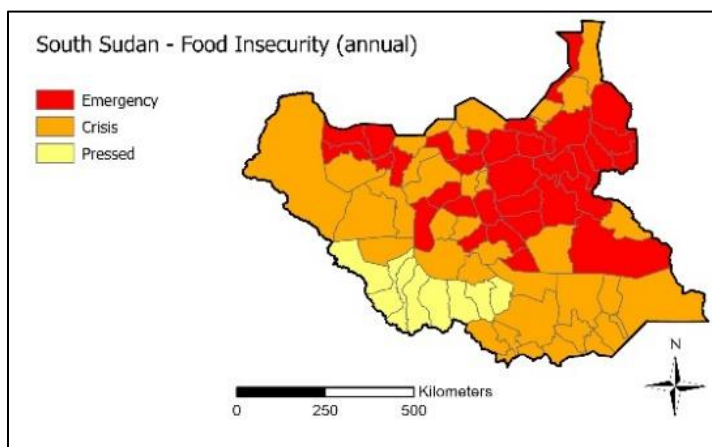


Figure 19 – Food insecurity in South Sudan 2020

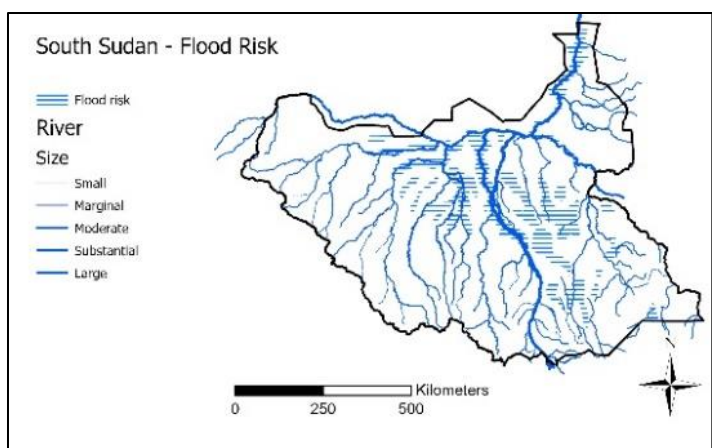


Figure 20 – Flood risk map of South Sudan 2020

On the basis of figure 16, the country was divided into four regions as shown in figure 17. Region 1 experienced almost no conflict and no flooding throughout 2020. Region 2 experienced a lot of conflict and a small amount of flooding. Region 3 experienced a lot of conflict, high food insecurity and extreme flooding. And, finally, region 4 experienced less conflict, but high levels of food insecurity and extreme flooding (Table 4).

	Region	Conflict	Food insecurity	Flooding
1	Northern Bahr El Ghazal – Western Bahr El Ghazal – Western Equatoria	Low	Lower in the south, higher in the north	Low
2	Central Equatoria – Eastern Equatoria	High	Average	Low
3	Unity – Warrap – Lakes – Abyei Administrative Area	High	High	High
4	Jonglei – Upper Nile	Average to low	High	High

Table 4 – Degree of conflict, food insecurity and flooding in different regions

IDP/Refugee camps as departure and/or destination

To get a better picture of whether the places of departure and destination are IDP or refugee camps, it is important to include this information as well. A camp can be a place of departure when there is a lack of food and basic services or when refugees want to return to their former place of residence because the area is now safe. When conflict arises, and armed forces cannot provide protection any longer, it might also be a reason for departure. On the other hand, a camp is often seen as a pull factor because of the security, food and shelter it can provide. These can be reasons to move towards a camp.

Main and specific reasons for department

In the Flow Monitoring Registries, the main reasons for departure are divided in three different categories: conflict displacement, food insecurity displacement and disaster displacement. These main reasons are in turn divided into sub-types. For example, when a person flees because of conflict, there can be different triggers, like communal clashes, insecurity generalized violence, insecurity targeted violence or the occupation or destruction of a home. When a person flees from food insecurity, it can be caused by conflict, by natural disaster or by the reduction in humanitarian food distribution. Lastly, when a person flees from natural disaster it might be caused by either floods or droughts, which both interrupt people's livelihoods. For example, a farmer might lose all his crops due to natural disaster which causes the farmer to lose both food and income.

In analysing the data, it is interesting to see if there are any significant patterns or relations between the area of departure and the reason for departure. The same goes for particular periods or seasons of the year. Are the same areas always linked to the same reasons?

Transport

Another interesting relationship that can be analysed is the one between the places of departure and destination and the transport chosen by the refugees. Also, the relationship between reason for departure and chosen transport can give an insight into whether certain situations lead to choosing a

particular kind of transport. For example, when flooding occurs, it is expected that people travel by boat. This influences the route taken by refugees because they might choose a different path compared to if they would walk. This changes the route and also the direction refugees take and is therefore important for a flow prediction model. Using a certain type of transport also shows the importance of physical geography, especially in regions sensitive to flooding.

Nationality

Nationality can say something about the profile of a refugee. For example, when the refugee comes from another country, but flees within South Sudan, it can say something about the reason for fleeing. For example, when a country is affected by conflict, many people will flee towards neighbouring countries.

Data used for the analysis

This research focuses on the relations between the following factors: place of departure, season of departure and reason for departure. As this research aims to provide significant proof of the importance of physical geographical factors, there is only need to study these three factors. Whether the place of departure or destination is an IDP/refugee camp, the transport chosen, and the main nationality of the group have been left out of this analysis. Not because they were not useful, but because they do not provide any extra information on whether physical geographical factors play an important role. However, to further study what factors influence the route a refugee takes, these factors could provide an interesting base for future research on this topic.

4.3 Analysing the data

The data analysis started with finding whether there was a significant relationship between the reason for departure and the place of departure. This does not directly show whether physical geography plays a role in South Sudanese refugee flows. However, as different parts of the country have different weather and climate conditions, it was necessary to confirm the significant role of place. It was then studied what different reasons for departure were given for every place of departure, so that later a connection could be made between the characteristics of a place and the reason for departure.

Secondly, the relationship between the reason for departure and the season of departure was analysed. This is because different seasons are connected to different weather and climate conditions. Therefore, the significance of this relationship can point out the importance and influence of physical geography. After studying the significance of this relationship, the research continued to see what different reasons were given for every season.

If all the differences appear to be significant, all the results will be combined into a large matrix, showing the reasons most often assigned for every different place of departure in every different season of the year. In the following sections the analysis of the various relationships will be explained, and the results of the analysis will be illustrated.

4.3.1 The relationship between reason and place of departure

Departure from a specific place can be caused by both social and physical geographic conditions. Conflict, food insecurity and natural disaster obviously occur in a specific place. Once the significance of the influence of different places is confirmed, one can look at how reasons vary over different places of departure. As described previously, South Sudan has been divided into four areas based on the common characteristics of the different states looking at conflict data, food insecurity and flood risk.

Through the use of Excel, the data from the Flow Monitoring Registry was separated into the four regions of departure (Table 5). The database contained 11 different reasons for departure (Table 6). Next, all reasons for every place of departure, for the entire year 2020, were collected in a pivot table which showed the number of 'votes' for every given reason in a specific place of departure.

Place of departure	States
1	Northern Bahr El Ghazal - Western Bahr El Ghazal - Western Equatoria
2	Central Equatoria - Eastern Equatoria
3	Unity - Warrap - Lakes - Abyei Administrative Area
4	Jonglei - Upper Nile

Table 5: Places of departure

Reason of departure	
1	Communal Clashes - Communal Clashes / Host Community Frictions - Friction with Host Community / Communal Clashes
2	Conflict Induced Food Insecurity
3	Destroyed Home
4	Fear of Disease - Fear of Disease / Epidemic (COVID-19, EVD, Etc.)
5	Insecurity Generalised Violence - Personal Insecurity Because of Generalised Violence (Area Unsafe)
6	Insecurity Targeted Violence - Personal Insecurity Because of Targeted Violence / Persecution (Area Unsafe for a Specific Group)
7	Interrupted Access to Livelihoods (can't work)
8	Interrupted Livelihoods
9	Natural Disaster Induced Food Insecurity
10	Reduction / Irregularity Humanitarian Food Distribution
11	Other

Table 6: Reasons for departure as presented by the Flow Monitoring Registries

To see whether there is a statistic difference between the reason and place of departure, the chi-square test is used. Such a test is used to compare observed results with expected results. The purpose of this test is to determine if a difference between observed data and expected data is due to chance, or if it is due to a relationship between the variables that are studied. It is conducted by using the following formula:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

In this formula **e** stands for the expected (or average) frequency and **f** for the observed frequency, both summed up over all possibilities. First, all the reasons of the four different areas are put to the chi-square test to see whether overall there are significant differences between different reasons and different areas.

The expected average (e) is calculated by the following calculation: grand total of the reasons chosen in a particular place x the total amount of times chosen for that specific reason ÷ the grand total of all reasons (Appendix 1).

If this outcome appears to be significant, the differences between every place will be tested on significance. For example: is the difference in chosen reasons between place 1 and place 2 significant? And between place 2 and 3? Etc.

4.3.2 *The relationship between reason and season of departure*

As appeared from the qualitative research on push and pull factors in South Sudan, fleeing for natural disasters happens very frequently. However, this is very strongly linked to the different weather and climate conditions and therefore connected to different seasons. As previously described, the year was divided into four different seasons of three months, based on temperature and rainfall characteristics (Table 7). The data from the Flow Monitoring Registry was divided into the four different seasons and then collected into a pivot table, showing the frequency of every reason in the four different seasons.

Season	Months
1	January – February - March
2	April – May - June
3	July – August - September
4	October – November – December

Table 7: Seasons of departure

To see whether there is a statistic difference between the reason and season of departure, again the chi-square test is used. The expected average (e) is calculated by the following calculation: grand total of the reasons chosen in a particular season x the total amount of times chosen for that specific reason ÷ the grand total of all reasons (Appendix 2).

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

First, all the reasons of all the different seasons are put to the chi-square test to see whether overall there were significant differences between different reasons and different seasons. If this outcome appears to be significant, the differences between every season will be tested on significance. For example: is the difference in chosen reasons between season 1 and season 2 significant? And between season 2 and 3? Etc.

5. Results

The first part of this chapter will provide an overview of the main push and pull factors (Lee, 1966) relevant in the South Sudanese refugee crisis. As was earlier described, this part of the research was done through a qualitative reports analysis using Atlas.ti. The push and pull factors found in 16 different reports from organisations like IOM and UNHCR were coded and later on merged into a mind map (see Figure 24). The mind map presents an overview of all the relevant factors in the refugee crisis and will be further explained in this chapter.

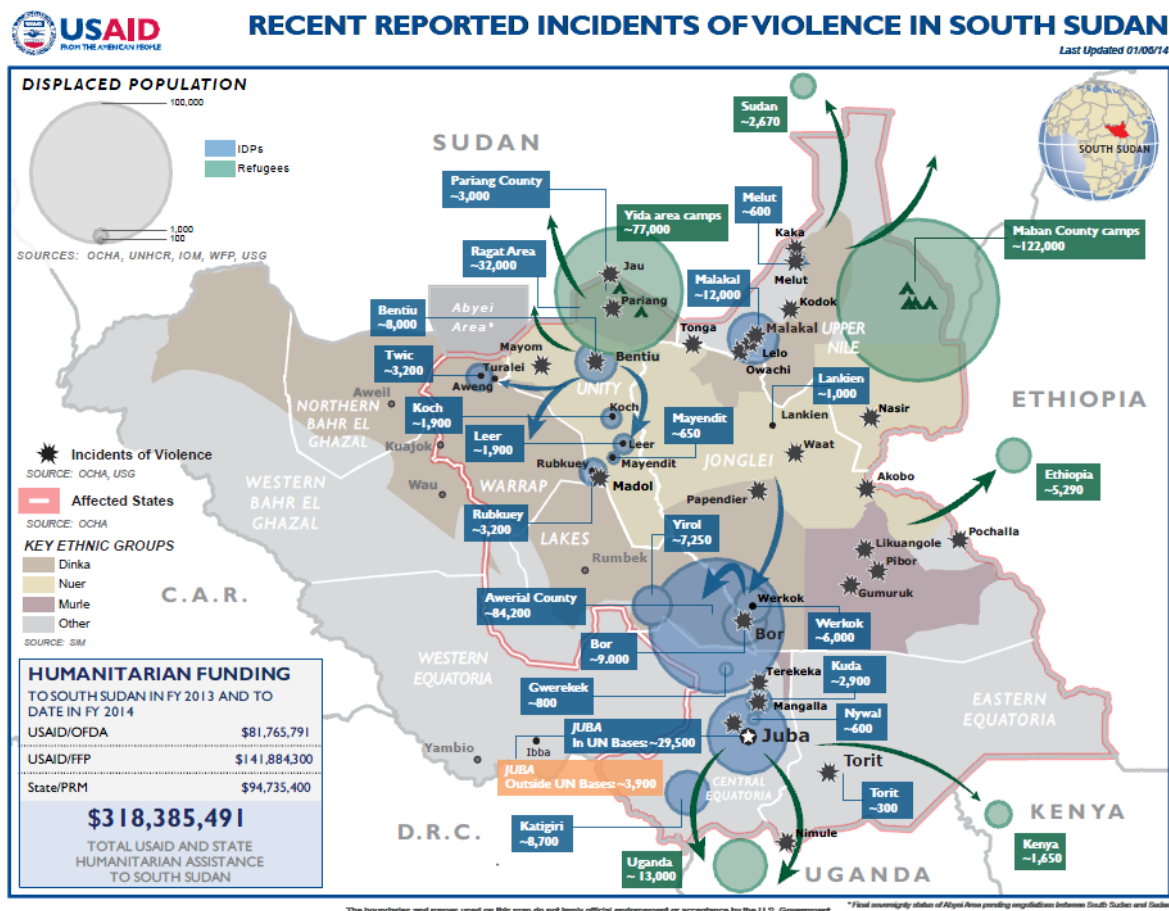
The second part of this chapter will present the results from the statistical analysis in order to decide what social and physical geographical factors trigger movement in different places and during different seasons. The reasons for leaving the place of departure are presented through the use of visual statistics. In total there are 8 different bar charts: 4 for every place of departure and 4 for every season of departure. They were later combined into a large matrix to provide a complete overview of what reasons were chosen in one specific place of departure throughout the different seasons but also what reasons were chosen in one specific season throughout different places.

5.1 South Sudan's push factors

In the following section, the most influential push factors that drive people away from South Sudan are discussed (Figure 24). First, the most prominent push factor, South Sudan's civil war will be discussed. Secondly, South Sudan's extreme economic underdevelopment is addressed. Thirdly, the role of natural disasters will be examined.

5.1.1 *Civil war & Poor governance*

Until this day, violence is still prevailing in many parts of South Sudan, mainly in the form of localized conflict caused by clashes between different armed groups or with direct involvement of state actors. (IOM, 2020) The conflict is being sustained by political competition, unaddressed grievances and fractionalisation. It has caused not only insecurity but also violence (often gender-based) against civilians. (IOM, 2020) Throughout 2020, it has resulted in around 130,000 cases of internal displacement between January and June, followed by 78,000 cases between July and September and 31,000 cases between October and December. (IOM, 2020) Internal displacement can eventually transform into refugee flows towards neighbouring countries (Figure 21). According to a report from REACH (2015), the two main push factors that drive people away from their home are (1) ongoing violence and insecurity and (2) assets that are lost or destroyed. Additionally, homes occupied by armed groups and the presence of other ethnic groups are also important triggers for movement. According to recent conflict data from ACLED (2021), South Sudan is still facing everyday cases of armed battles, violence against civilians, explosions and riots. Therefore, violent conflict is one of the most important push factors driving people away from their home.



host communities, that are already struggling to cover their own needs. (IOM UN Migration, 2020) From April to June 2021, 7.24 million people were faced with acute food insecurity and nowadays there are 1.9 million South Sudanese acutely malnourished women and children. (World Food Programme, 2021) Especially the Jonglei and Warrap states in the Northern part of the country have been hit hard by the food crisis. According to REACH (2015), lack of food is the third most important reason for people to leave their pre-crisis home. It is therefore an important trigger that not only can causes internal displacement but also refugee flows across the border in search for food.

5.1.3 *Natural disasters*

South Sudan has traditionally had a highly mobile population, with many shepherds undertaking seasonal migration as a result of cattle grazing. (REACH, 2015) However, climate change has caused natural hazards like rainy seasons and severe flooding to appear in more extreme forms, causing regular internal displacement in regions where the Nile flows through South Sudan. From May till December 2020 442,682 people were displaced across nine states due to flooding. Therefore, flooding is an important trigger movement in the eastern parts of South Sudan. More than three quarters of this displacement was detected during August and September (DTM, 2020).

Flooding not only causes areas to simply fill up with water, but it also hinders the production of crops, which leads to food shortages. Secondly, the local infrastructure is often damaged and therefore impassable. Unusually heavy rains started in July 2020, and the White Nile burst its banks, destroyed all the crops and encroached on farms and villages, affecting Jonglei and other states, leaving people to scramble for a few strips of dry land. (Martinez, 2021) Flooding caused entire villages to be abandoned and large areas turned into swamps. Naturally, this triggers people to seek for higher strips of land while they simultaneously try to avoid getting stranded in areas where there is violent conflict. However, the water itself is not the biggest concern. Instead, the lack of food and hunger will cause people to die first. 'Data from South Sudan suggests that more erratic and unpredictable weather patterns are now the norm.' (Martinez, 2021, p. 1) Therefore, heavy rains and severe flooding will play a growing role in the future reasons for people to leave their home in South Sudan.

On the other side of the spectrum, severe drought has also caused South Sudan to be one of the most food-insecure countries in the world (International Rescue Committee, 2022). Drought can intensify conflict especially when hunger is used as a military strategy. Extended drought also degrades people's livelihoods, creating the bases for future conflicts (Mena, 2019).

This shows that not only social geographical factors will come into play when speaking of push factors, but also physical geographical factors. Especially as the climate is changing, more extreme weather patterns might stimulate environmental migration in the future.

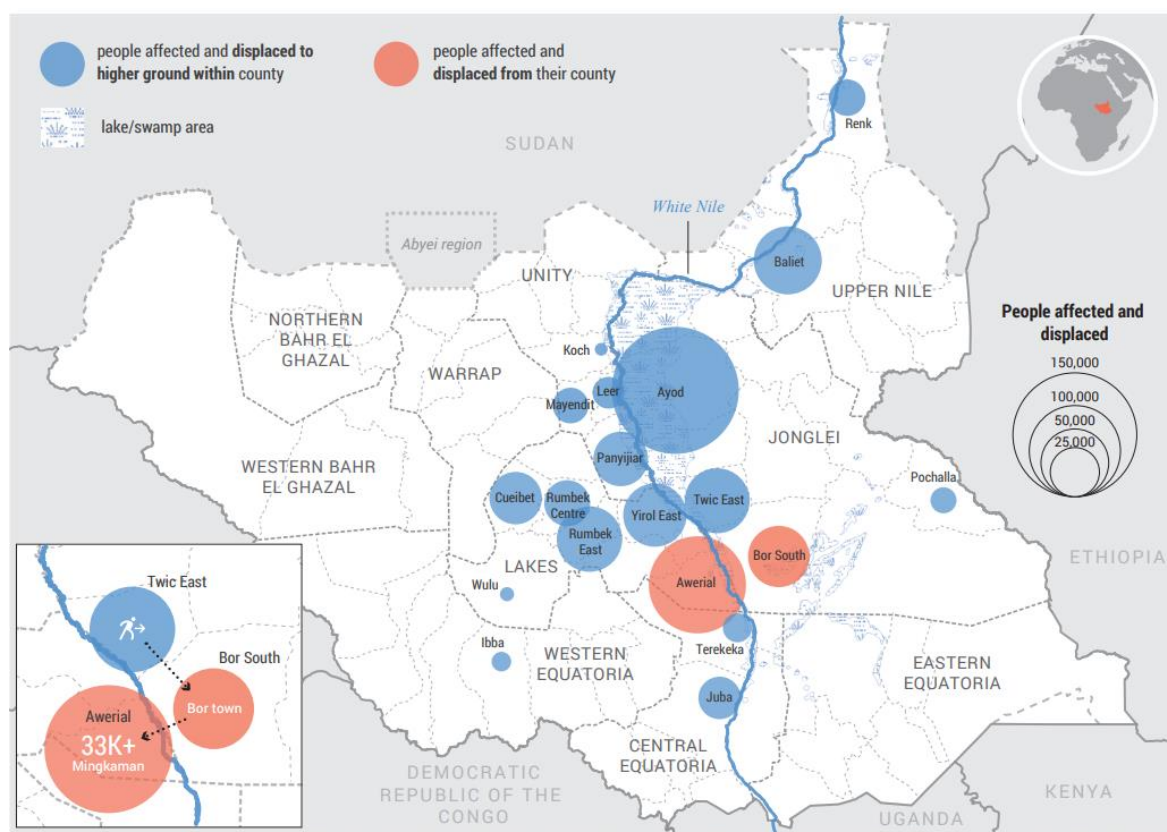


Figure 22: Internal Displacement due to flooding in South Sudan, September 2020 (OCHA, 2020)

In summary, violent conflict, extreme economic underdevelopment and natural disasters make up the three most important reasons for people to leave their homes and flee to safer areas. Direct triggers are the ongoing violence and insecurity (for example explosions or riots), occupation of homes by armed groups, livelihoods and assets being destroyed (both by armed groups, severe flooding or extreme drought) and direct lack of water and food.

5.2 Pull factors attracting South Sudanese refugees

The following section addresses the pull factors attracting South Sudanese refugees to their area of destination (Figure 24). Naturally, these will mainly include basic human needs and the absence of the push factors that drove refugees away from their place of origin. First, the role of security will be discussed. Secondly, the presence of humanitarian aid will be highlighted. And third, the importance of assets and livelihoods will be examined.

5.2.1 Security

Many IDPs and refugees leave their homes as a direct result of (violent) conflict. This naturally leads to the search for security, which in most cases is a displacement location or refugee camp close by. The presence of peacekeeping forces or the physical location of informal settlement sites, are both important factors in a refugee's choice of where to go (Figure 24) (REACH, 2015). Outside of South Sudan, Ethiopia, Uganda, Sudan, Kenya and Congo are the main countries to host South Sudanese refugees.

The largest hosting country in Africa is Uganda as it maintains an open-door policy to refugees. The government's strategy integrates refugee issues into its national planning framework. (Momodu, 2021) The refugee policy of Uganda guarantees freedom of movement and the right to employment, education and health and the right to start a business. Refugees are also provided with plots of land for farming and the construction of shelters. It stimulates refugees to become economically self-reliant, while enjoying the same rights as the Ugandan citizens have. (Momodu, 2021)

Ethiopia also maintains an open-door policy for refugee inflows and allows humanitarian access and protection to refugees seeking asylum. In 2019, Ethiopia changed its national refugee law, making it one of the most progressive refugee policies in Africa. The law provides refugees with the right to work and reside outside of camps, access social and financial services, and register life events. (UNHCR, 2020)

In general, the Democratic Republic of Congo hosts fewer refugees than Ethiopia and Uganda. Humanitarian organisations struggle with the provision of aid due to presence of armed groups. This may hold refugees back from fleeing to Congo. Also, the closure of the Congolese borders due to the COVID-19 pandemic to limit the spread of the virus has greatly impacted the influx of new arrivals. (IOM UN Migration, 2020)

Kenya's government, in turn, does maintain an open-door asylum policy. In several camps there is now a focus on the inclusion of refugees in the socio-economic development plans together with the host community. However, despite progress on inclusion in national services and local development plans, the encampment policy remains in effect. This means refugees must live in the camps and are required to obtain permission to leave the camps. (IOM UN Migration, 2020)

The government of Sudan has also maintained an open-border policy despite the COVID-19 pandemic. The capacity of camps close to the South Sudanese border is currently overstretched. Refugees often live alongside host communities in remote and underdeveloped areas with limited infrastructure and basic services. Political reforms have been made to provide durable solutions for both refugees and host communities. (IOM UN Migration, 2020)

5.2.2 *Humanitarian aid*

According to a report from REACH (2015), the presence of food, shelter and humanitarian aid is the most commonly reported reason for choosing a displacement site (Figure 24). This report focusses mainly on internally displaced persons but is also relevant for refugees as basic human needs are most likely the first thing to look for when fleeing. Especially since South Sudan suffers from high levels of food insecurity, it is logical that people are drawn to places that can provide fresh water and food. These are either IDP camps, established within the borders of South Sudan, or refugee camps in neighbouring countries. However, while many IDPs remain highly dependent on humanitarian aid, the suspension of humanitarian aid at a displacement site turns out to not be a significant push factor on its own. (REACH, 2015) Reasons for choosing a specific displacement site, next to the presence of humanitarian aid, are accessibility (easy to get to), relative safety, lack of money to travel further, relatives or the household itself had visited the site before and limited distance between site and pre-crisis home. (REACH, 2015)

5.2.3 Assets and livelihoods

When homes, land, livestock and businesses have been damaged or destroyed during a war, it often leaves people with no other option than to flee to another area, as they are highly dependent on these assets for their livelihoods. (REACH, 2015) Again, obviously, this draws people to places where livelihoods can be rebuilt. Urban areas are attractive pull factors since they provide the possibility of labour and education. However, as most IDPs reported they would like to return home when the conflict settles down, a displacement site close to their pre-crisis homes gives them the opportunity to check on the status of their homes and assets, which allows them to make a more informed decision about whether they feel safe enough to return home. Many IDPs leave displacement sites during the day to visit the host community which allows them to work, generate income, and reduces reliance on humanitarian aid. (REACH, 2015)

5.2.4 Dry areas

In the central Equatoria and Jonglei states flooding caused a movement of people from lowland to highland areas (DTM, 2020). As can be seen in figure 24, the destruction of homes is a direct trigger for movement. The destruction of homes, crops and livelihoods forced people to seek for shelter elsewhere. Since flooding is the main natural disaster in this area, lowland areas are more sensitive to it than highland areas. Because highland areas provide protection from the water it naturally drives people towards it.

In sum, the presence of peacekeeping forces, presence of humanitarian aid, easy accessibility, the ability to build livelihoods and dry areas are the most important pull factors drawing South Sudanese refugees to a specific site, camp or area.

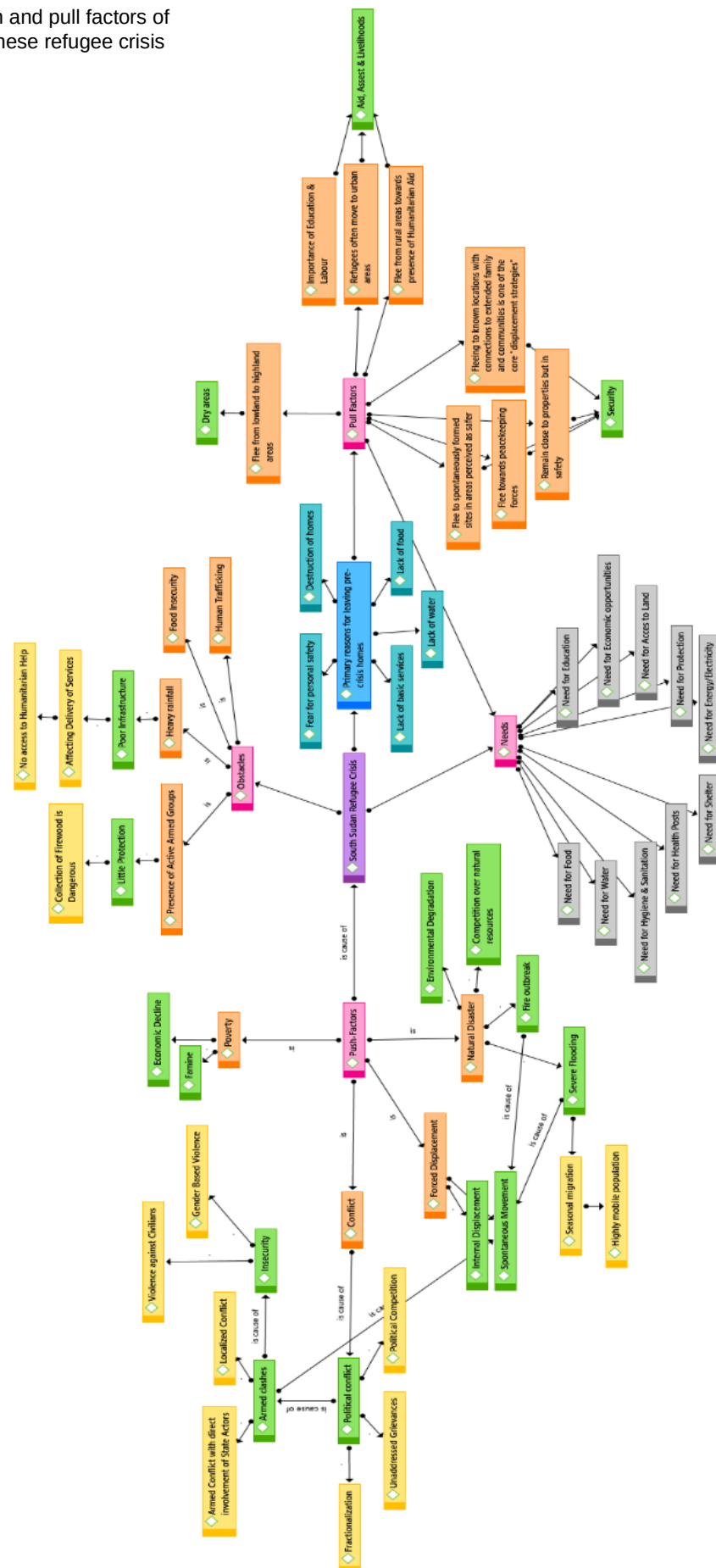
What can be concluded from the reports analysis and the mind map created in figure 24 is:

- **Insecurity**, caused by armed conflict and violence, is a main push-factor that causes people to flee. Fear for personal safety is a direct trigger for movement towards **security**, which is a pull-factor, in the form of the presence of peace-keeping forces or areas that are perceived as safer.
- **Poverty**, caused by extreme economic underdevelopment which in turn causes food insecurity, is a main push-factor that causes people to flee. The lack of basic services, water and food are direct triggers for movement towards the presence of **aid, assets and livelihoods**, which are pull-factors.
- **Natural disaster**, caused by severe flooding and extreme drought, is a main push-factor that drives people away from areas sensitive to it. The destruction of homes is a primary reason for leaving one's home. Flooding causes people to move from lowland to highland areas to seek protection from the water. **Highland areas** are therefore a main pull-factor.



Figure 23: Causes of the South Sudanese refugee crisis

Figure 24: Push and pull factors of the South Sudanese refugee crisis



Now that an image is created of the main push and pull factor for the case of South Sudan, there is a need to know how relevant the factors are in a specific area or in a specific season. The main reason for this is that, like mentioned before, refugee flow prediction is highly contextual.

5.3 Place of departure vs reason of departure

As was mentioned in the Methodology chapter, South Sudan was divided into four different areas of research of the bases of conflict, food insecurity and flooding data. The results presented below will give an answer to the question how the different social and physical geographical factors form a reason for departure in the different areas of South Sudan.

As the overall difference appeared to be significant, it was concluded that the place of departure does have a significant correlation to the reason of departure. First, the chi-square test was implemented over every possible combination of different areas to see whether the reasons per region all were significantly different. When the different places of departure were compared with the assigned reasons for departure, it appeared that significant differences could be found between all the various places of departure (Table 8). All the green coloured squares in the table represent p-values below 0.05. This means that at place of departure 1 some reasons for departure statistically occur more often than at place 2, 3 or 4. As all differences appeared to be significant, the next step was to study which reasons occur most in each place of departure.

Chi-square significance	Place of departure			
Place of departure	1	2	3	4
1	x	1,96592E-30	3,08011E-21	4,5048E-197
2	1,96592E-30	x	2,1433E-27	1,4809E-203
3	3,08011E-21	2,1433E-27	x	6,6587E-194
4	4,5048E-197	1,4809E-203	6,6587E-194	x

Table 8: Significant differences of reasons of departure between places of departure

5.3.1 Place of departure 1: Northern Bahr El Ghazal – Western Bahr El Ghazal – Western Equatoria

The first possible place of departure is the most western part of South Sudan. The area consists out of three states: Northern Bahr El Ghazal, Western Bahr El Ghazal and Western Equatoria. As shown in Figure 25, reason for departure 9 (Natural disaster induced food insecurity) and 10 (Reduction/irregularity humanitarian food distribution) are given predominantly by people leaving this area. Apparently, the lack of food in this area, caused by both natural disaster and lack of humanitarian help, is what motivated people to move away. Although Western Equatoria had the lowest level of food insecurity in the year 2020, Northern Bahr El Ghazal suffered from extreme food insecurity all year round. (WFP, Emergency Dashboard South Sudan, 2020) Fleeing from conflict plays a less important role in this region. From all of the 820 conflict-related events that South Sudan encountered in 2020, only 96 (can you also give the percentage) took place in this region, according to ACLED (2021).

5.3.2 Place of departure 2: Central Equatoria - Eastern Equatoria

The second area of departure consists out of the two most southern states of South Sudan: Central Equatoria and Eastern Equatoria. In this region, reason 5 (insecurity generalised violence) seems to be the main reason for fleeing the area (figure 26). According to ACLED, 232 of the 820 violent incidents South Sudan in 2020 took place in this region. Compared to the first region, conflict seems to play a bigger role. Reason 2 (conflict-induced food insecurity) and 6 (insecurity-targeted violence) were also chosen multiple times. Therefore, they confirm the important role of conflict as a reason to flee in this area.

5.3.3 Place of departure 3: Unity - Warrap - Lakes - Abyei Administrative Area

The third region of departure consists out of the four most central states of South Sudan: Unity, Warrap, Lakes and the Abyei Administrative Area. Reason for departure 8 (interrupted livelihoods) is most often mentioned in this region (figure 27). According to the Flow Monitoring Registries database, interrupted livelihoods in this area were caused by both conflict and natural disaster. Reason 2 (conflict-induced food insecurity) is also chosen quite frequently. This is not a surprise since most of the violent incidents (332 in total provide % too) occurred in this area of South Sudan in 2020 according to ACLED (2021).

Another frequent reason for departure is 9 (natural disaster induced food insecurity) which, just like reason 2, shows the important influence of food insecurity on the decision to leave home. According to data from the World Food Programme (2020), the states included in region 3 were confronted with severe food insecurity all year long. When the Flood Risk Map of South Sudan is used (OCHA, South Sudan Flood Risk Map, 2020), one can see that the Unity, Warrap and Lakes states are all very sensitive to flooding. Depending on the season, heavy rainfall can cause flooding and destroy crop production subsequently creating food shortages.

5.3.4 Place of departure 4: Jonglei – Upper Nile

The fourth and final region consists out of the Jonglei and Upper Nile states in the northeast of South Sudan. Figure 28 very clearly shows that there is one reason for departure which is considerably more important than the others, namely reason 3 (destroyed homes). From the Flow Monitoring Registries, it appeared that all cases of destroyed homes were in this case caused by natural disaster. According to the Flood Risk Map (OCHA, South Sudan Flood Risk Map, 2020), this area is highly sensitive to flooding. It is therefore clear that the physical surroundings, together with weather and climate play an extremely important role in causing refugee flows in South Sudan. According to data from ACLED (2021), conflicts played a smaller role in this area in 2020. On the other hand, data from the World Food Programme (2020) shows severe cases of food insecurity in this area all year long. Severe flooding destroyed both homes and crop production leading to extreme food shortages.

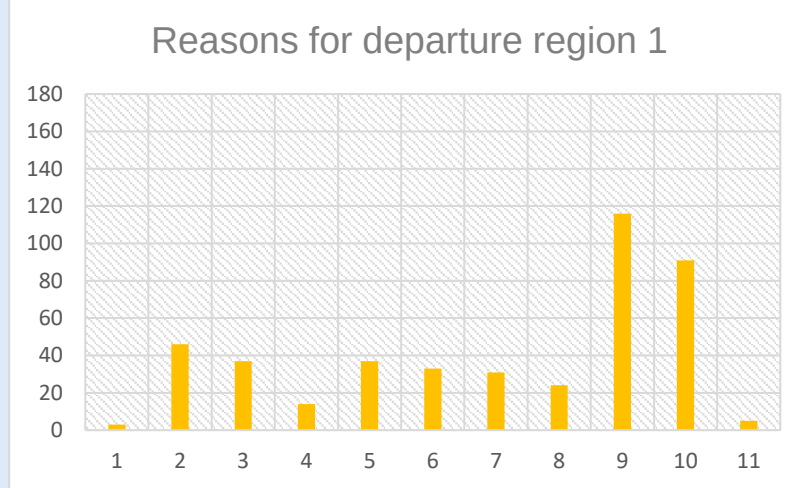


Figure 25 – Reasons for departure in region 1

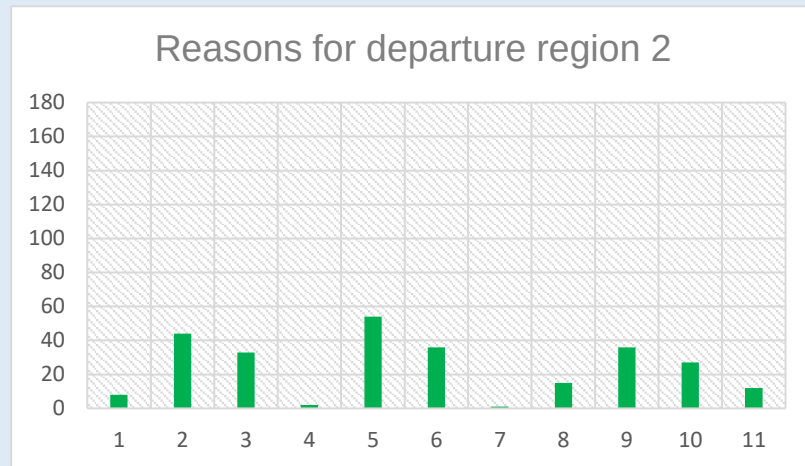


Figure 26 – Reasons for departure in region 2

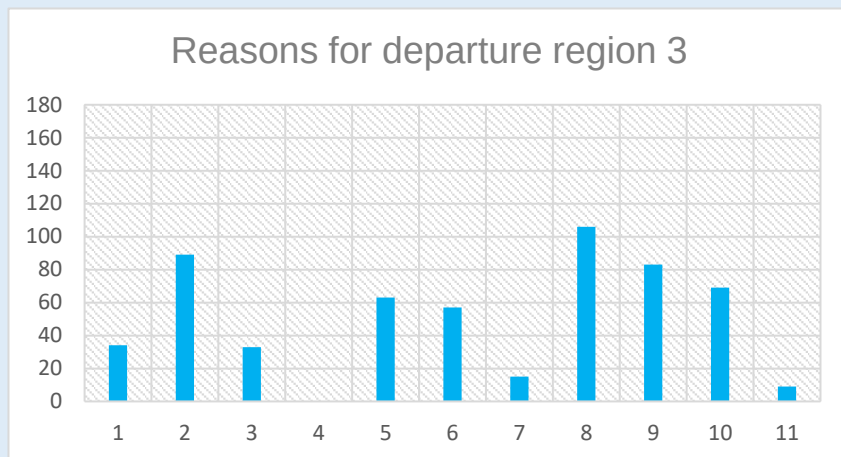


Figure 27 – Reasons for departure in region 3

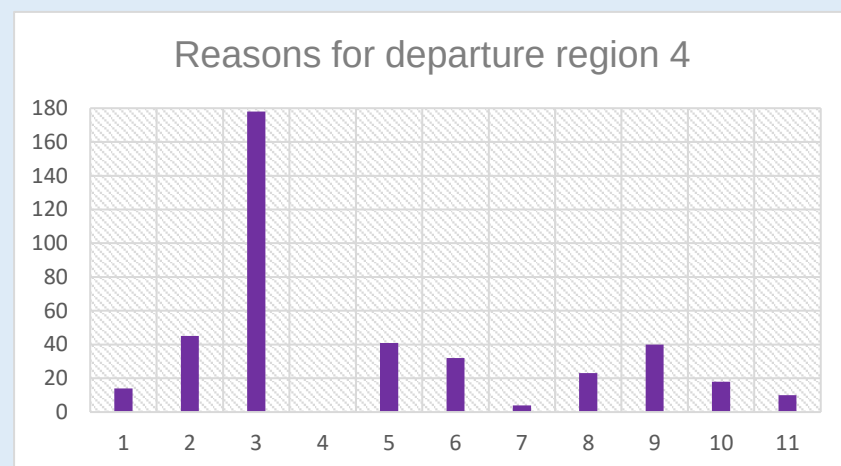
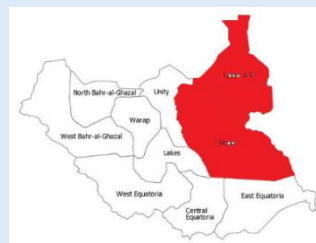


Figure 28 – Reasons for departure in region 4

If we compare the different places of departure and their most common reasons of departure with each other, it is clear that there are significant differences between the chosen reasons for every region. In this case it can be concluded that place matters. It can be both social and physical geographical factors that cause people to flee. Sometimes it is natural disaster in the form of extreme flooding. As flooding can also cause the destruction of crop production, it can lead to food insecurity. Natural disaster can cause food insecurity which can in turn cause conflict, but the other way around, conflict can also cause food insecurity. This explains how all factors are connected to each other and therefore show that social and physical geographical factors are always intertwined. The place people flee from matters as they all have different geographical characteristics. To further explore the role and influence of weather and climate, the next section will focus on the connection between reason of departure and season of departure.

5.4 Season of departure vs reason of departure

To discover whether and how the different seasons of the year influence the reason for departure, the year was divided into four different seasons. The results will provide an answer to the question whether the time of the year influences the triggers for movement.

The overall difference appeared to be significant, which means that the season of departure has an influence on the reason for departure. Then, the chi-square test was implemented for every possible combination of different seasons to see whether the reasons per season all were significantly different. These chi-square tests showed that all differences that were found between the different seasons were significant (Table 9). All the green coloured squares in the table represent p-values below 0.05. In other words, at season 1 of departure some reasons for departure statistically occur more often than at season 2, 3 or 4. In the next chapter, all the different reasons per season will be discussed and illustrated through the use of bar and pie charts.

Chi-square significance	Season of departure			
Season of departure	1	2	3	4
1	x	6,54732E-68	7,77646E-74	4,95541E-94
2	6,54732E-68	x	2,68078E-59	2,03984E-79
3	7,77646E-74	2,68078E-59	x	2,32653E-85
4	4,95541E-94	2,03984E-79	2,32653E-85	x

Table 9: Significant differences of reasons of departure between seasons of departure

5.4.1 Season 1: January, February and March

The first season consists of the first three months of the year: January, February and March. This season has the highest temperatures and the least rainfall of the year. In this relatively dry season, the two most common reasons for departure are 2 (conflict induced food insecurity) and 9 (natural disaster induced food insecurity). The period of November until March is the driest period of the year, which could explain why people flee from food insecurity in this area. To see whether this is a plausible assumption, it is necessary to compare these results to the other seasons. However, according to the Seasonal Floods Analysis (2020), this season is not at all sensitive to flooding, which would in that case point to drought causing food shortages. According to the World Food Programme (2020), there was a high level of food insecurity in South Sudan in this period. However, it does not differ much from the other seasons. According to data from ACLED (2021), this was also a period that included violence against civilians, which can also be seen when looking at the chosen reasons for departure (Figure 29). Reason 5 and 6 both entail violence against civilians and were a significant trigger for movement in this season.

5.4.2 Season 2: April, May and June

The second season of the year includes April, May and June. In this period, rainfall strongly increases, and temperatures quickly decrease over the months. Compared to the previous season, less people seem to be fleeing during this period. Reason 8 (interrupted livelihoods) is the most common reason for

departure in this season. According to the Flow Monitoring Registries (2020), this is caused by conflict as well as by natural disaster, so the reason for interrupted livelihoods may differ for every region. According to ACLED (2020), 279 of the 820 violent incidents in 2020 (34%) occurred during this season. The month of May shows the largest number of incidents of the entire year. However, when we look at the collected data from the Flow Monitoring Registries, it turns out that season 1 had more violent incidents than season 2, because more data was collected regarding people who fled from conflict, not because there was less conflict. It is important to note that because the data set is highly subjective, it might not reflect the results from ACLED.

5.4.3 Season 3: July, August and September

Season 3 consists of July, August and September. Looking at the climate graph, it can be clearly seen that this is the wettest and coldest season of the year. Therefore, it is not surprising that in this season a lot of people were displaced because of extreme flooding. The most frequently given reason for departure in this season is reason 3 (destroyed home) (Figure 31). According to the Flow Monitoring Registries (2020), the destroyed homes in this particular time of the year were all caused by natural disaster, not conflict. Since rainfall is particularly heavy in this season, overflowing rivers caused the destruction of homes in areas with a high flood risk. This also caused a reduction in humanitarian food distribution as can be seen in Figure 31, as reason 10 (Reduction / Irregularity Humanitarian Food Distribution) was also mentioned quite often.

5.4.4 Season 4: October, November and December

The last season of the year includes October, November and December. While October is still a very wet month, rainfall quickly decreases in November and December. Temperatures slightly increase but are not very high compared to the first season of the year. Even more than in season 3, reason for departure 3 (destroyed homes) is the most popular trigger for movement. According to the Flow Monitoring Registries (2020), destroyed homes are solely caused by natural disaster. Because October is characterised by quite a lot of rainfall and because rivers have to transport all the water collected in the third season, extreme flooding is an ongoing problem during the fourth season.

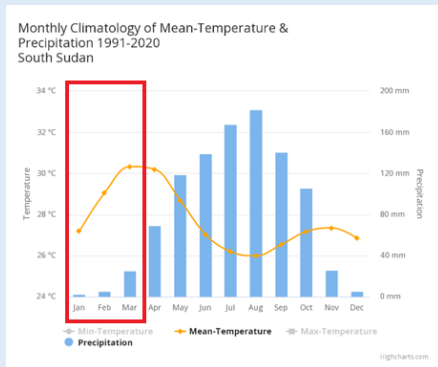


Figure 29 – Reasons for departure in season 1

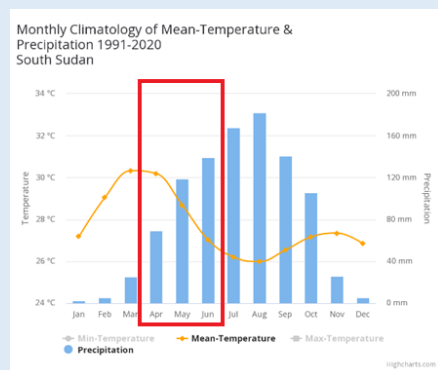
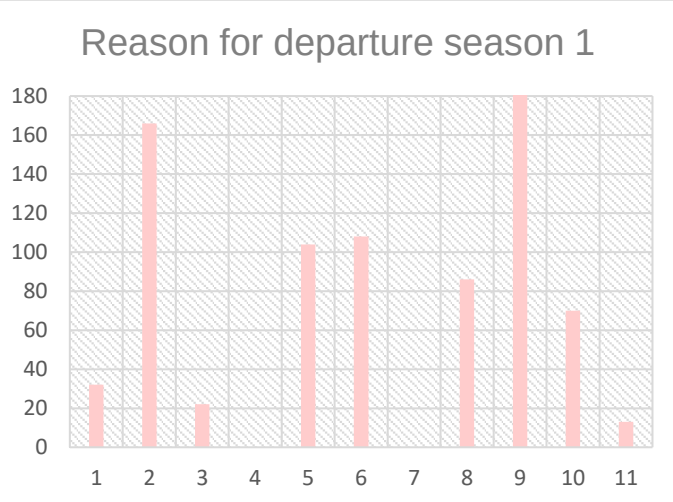


Figure 30 – Reasons for departure in season 2



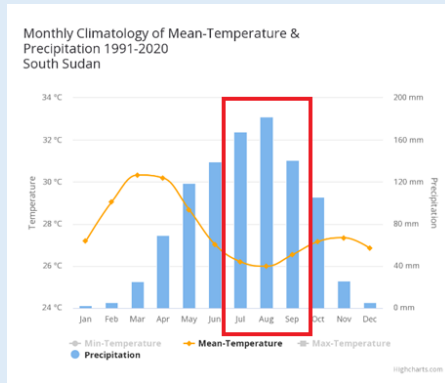


Figure 31 – Reasons for departure in season 3

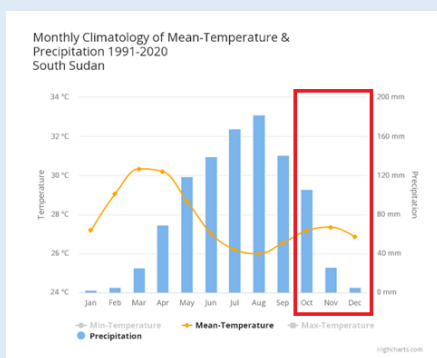
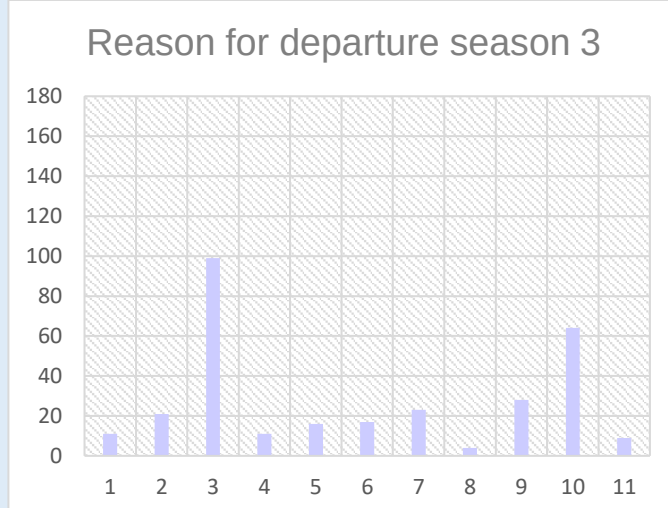
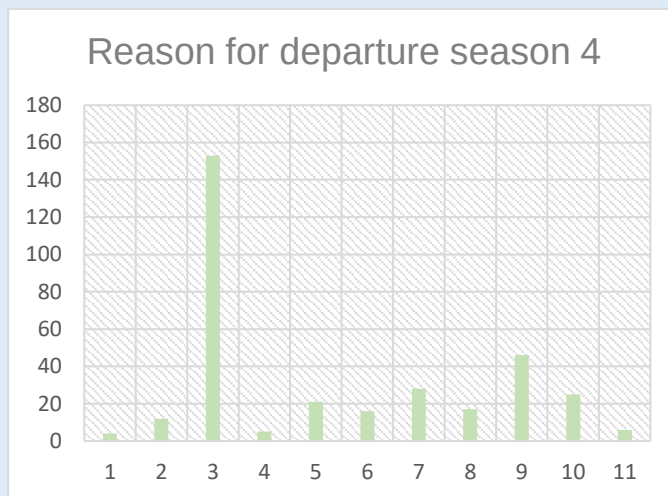


Figure 32 - Reasons for departure in season 4



The statistic results of seasons three and four show that physical geography plays an important role as a trigger for movement. As can be concluded from this section, the various seasons show different reasons for departure. In other words, seasons do matter. Taking into account the influence of weather and climate is important to understand flows of internally displaced people and refugees in South Sudan. As the first season is quite dry, a high level of food insecurity arises. During seasons 3 and 4 the complete opposite takes place. Because the seasons are so wet, extreme flooding causes the destruction of homes. Physical geography is an important element in the case of internal displacement and refugee flows. To see how place, season and reason all connect, the next section will present a matrix that includes an overview of all of the given reasons for departure for every region in every season.

5.5 The importance of space and time

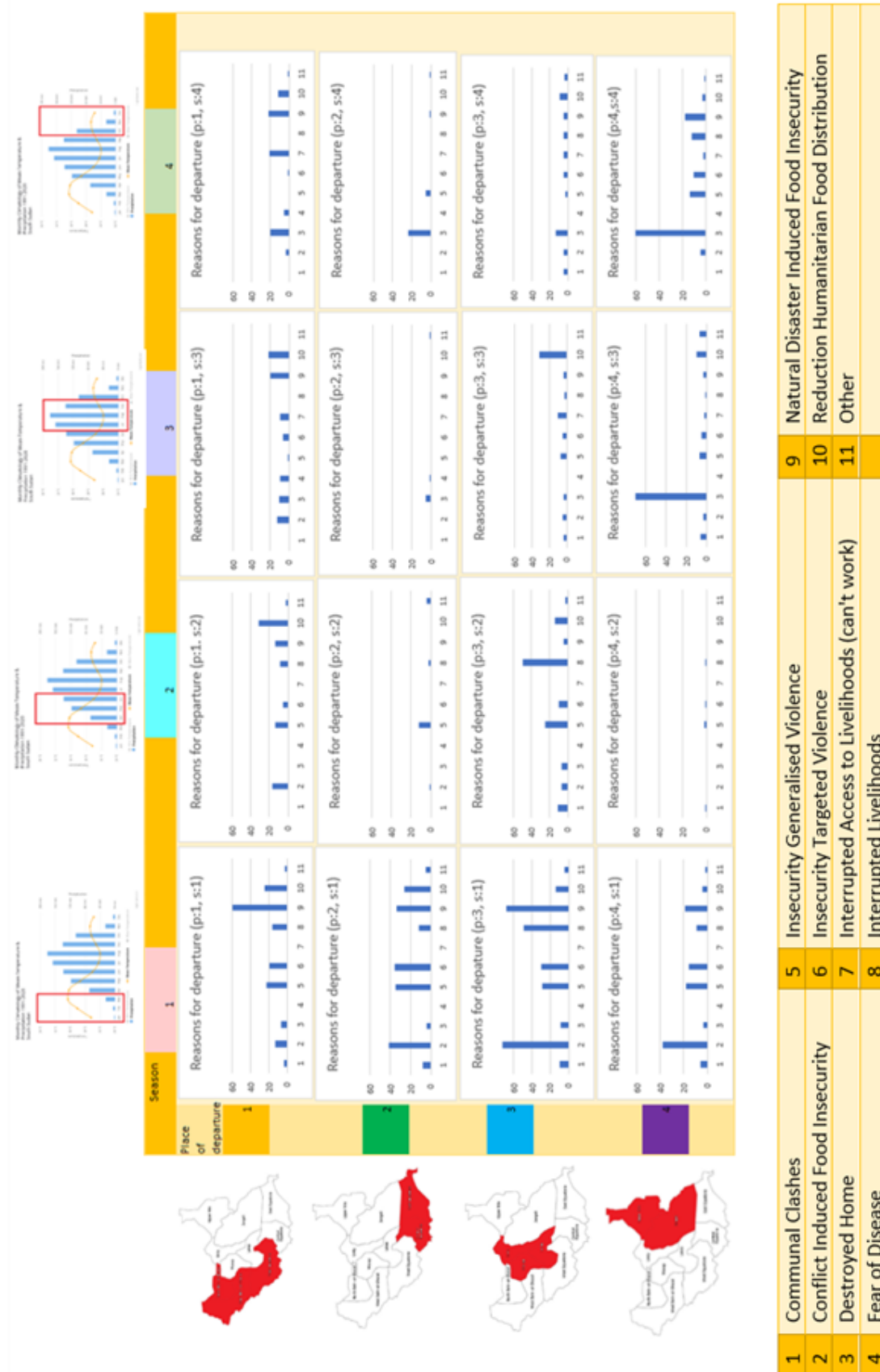
As shown, both place of departure and season of departure matter when it comes to the type of reason chosen for departure. In other words, surroundings matter. This is not necessarily new information on refugee flows, since this information was already gathered from the reports analysis in chapter 5.1 and 5.2. However, the qualitative analysis does not say anything about how physical geography influences

refugee flows in different places and at different times. Through examining the numerical differences between reason for departure and place and season of departure, this research aims to show the degree of influence of physical geography rather than just naming it. Figure 33 includes the statistic results of both place of departure and season of departure, combined in a matrix.

In studying the matrix, a few striking phenomena can be found:

- It is clear that during the first season more data was collected in comparison to the other seasons. This can be caused by a larger flow of internally displaced people, but it is most likely caused by irregular data collection of the researchers. Therefore, the extent to which the data can be represented in (exact) numbers (both for the different places as the different seasons of departure) is highly questionable. The statistical analysis is highly subjective, but more important is the method with which the statistical analysis was executed. With the right amount of data collection, the method can be used again in the future.
- During season 1, many internally displaced persons mentioned reason 2 and 9, which both entail food insecurity. The food insecurity in this season was caused by both conflict and natural disaster. As this season is very hot and dry, it is sensitive to food insecurity. Therefore, the results seem to correspond with the characteristics of the season. This shows that weather and climate, in other words: physical geography, plays an important role in predicting refugee flows. Because the data is subjective it is hard to give exact numbers because they might not fully represent the real-life situation. However, physical geography seems to be more important for refugee prediction modelling than was previously mentioned in the literature.
- Regarding the place of departure 4, the number of times opted for reason 3 (destroyed home) during season 3 and 4 is considerably higher than in other places of departure and in other seasons (figure 34 & figure 35). According to the Flow Monitoring Registries (2020), the cases of destroyed homes in season 3 and 4 were all caused by natural disaster. Since season 3 and 4 are both wet and sensitive to flooding, the research found significant proof of the importance of weather and climate. Therefore – once more –, it is very important to take physical geographical components into refugee flow prediction models.

Figure 33: Matrix: place, season and reason



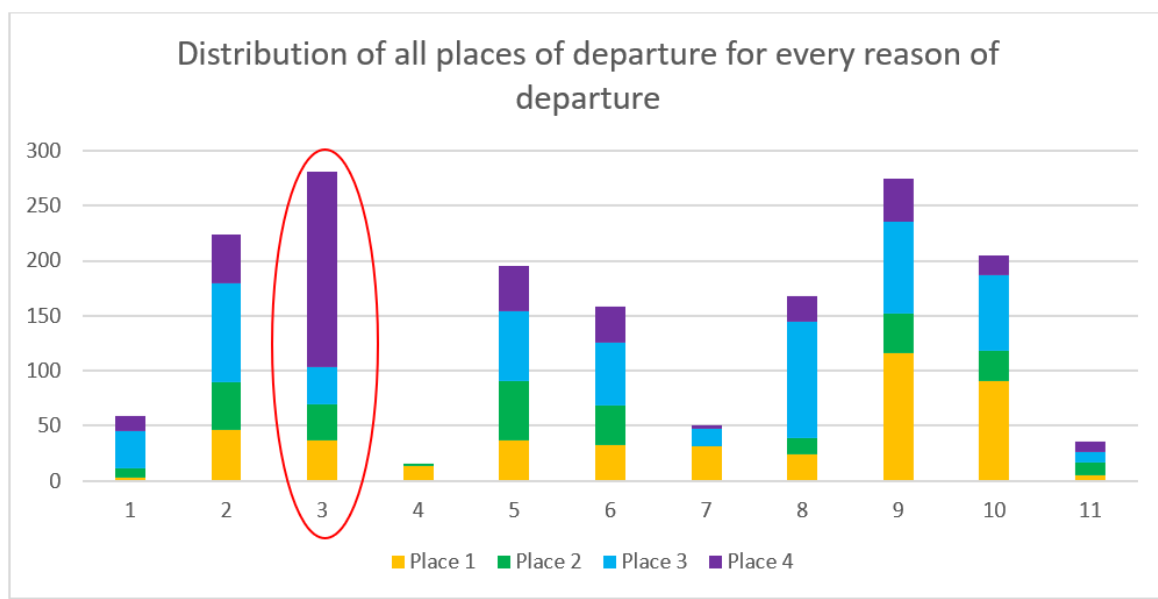


Figure 34: In place of departure 4 a lot of people flee because of reason 3: destroyed home.

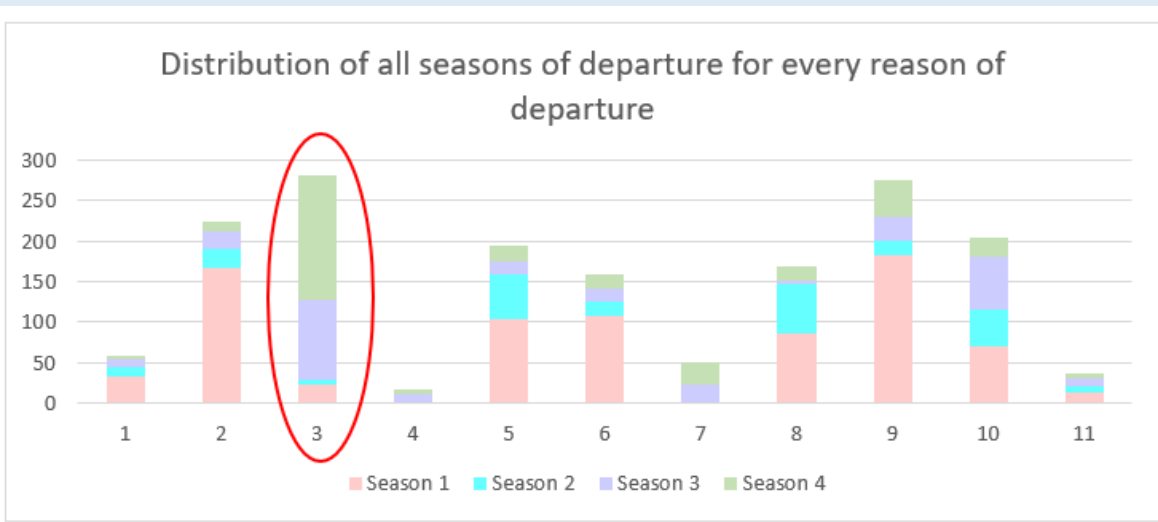


Figure 35 In season of departure 3 and 4 a lot of people flee because of reason 3: destroyed home.

6. Conclusion

6.1 Conclusion

In order to find an answer to the main research question – To what extent do physical geographical factors play a role in predicting South Sudanese refugee flows? – first the push and pull factors of South Sudanese migration flows were examined through a qualitative reports analysis. The most important push factors that cause people to move away from South Sudan are violent conflict, extreme economic underdevelopment and natural disaster. Direct triggers for movement are ongoing violence and insecurity, occupation of homes by armed groups, livelihoods and assets being destroyed (both by armed groups or severe flooding) and direct lack of water and food. The most important pull factors both within South Sudan or in neighbouring countries are the presence of peacekeeping forces, the presence of humanitarian aid, the ability to build a livelihood and dry areas. This part of the research provided enough evidence of the importance of environmental migration drivers which enabled the research to continue to the second part.

To be able to know to what extent these social and physical geographical factors were of importance to refugee flow prediction models, a quantitative analysis of the Flow Monitoring Registries was done. The goal of the statistical analysis was to find the most influential geographical factors for every place of departure and every season of departure. After finding proof that the differences between every place of departure and every season were significant, the research continued to analyse what the differences were. The most important social geographical factor influencing refugee flows is obviously conflict, since it was also already included in the FLEE model (Suleimenova, Bell, & Groen, 2017).

However, it appeared that two physical geographical factors were also of major impact: food insecurity and flooding. Out of the two reasons for departure that included food insecurity 60% was induced by natural disaster (figure 34 and 35, reason 9) That is why it is in this research categorized as a physical geographical or environmental driver of migration. It was caused by lack of water in the dry seasons and flooding in the wet seasons. Food insecurity can also be caused by conflict, in this case around 40% of the reasons of departure including food insecurity in was induced by conflict. But since more than half of the food insecurity was caused by natural disaster, it again shows the impact of physical geography.

Climate change threatens to worsen the weather conditions, food insecurity is very likely to become an increasing problem in the future. This also counts for flooding since the wet seasons will likely become wetter in the future. Destroyed homes are a frequent reason for departure in areas that the White Nile flows through and can also have a major impact on the direction of refugee flows as water can form an intervening obstacle (Lee, 1966). Not including these two physical geographical factors in a refugee flow prediction model for the case of South Sudan, will present a distorted image of the real-life situation.

So, to what extent do physical geographical factors play a role in predicting South Sudanese refugee flows? At least enough to really matter. In the case of this research ‘to what extent’ cannot be translated into numbers because of the subjective data. However, there are some clear observations that serve as evidence for the significant role of physical geography. In the first season many people were internally

displaced because of food insecurity. Because this season is very hot and dry, it is more sensitive to food insecurity. During the third and fourth season the opposite takes place. Rivers have to transport too much water because of heavy rainfall which leads to extreme flooding. This causes people to flee from the water, often after their homes are destroyed. If food insecurity and flooding do not get incorporated into a flow prediction model, the model will only tell half of the story. If the function of the prediction model is to help humanitarian organisations with providing aid in places and times where it's necessary, it is crucial to incorporate physical geographical factors.

6.2 Discussion

Neumann & Hermans (2015) and Castelli (2018) created migration models that include different dimensions and different factors that influence migration flows. Shellman & Steward (2007) explain that conflict and cultural networks are often the biggest predictors of forced migration. This research shows that physical geographical factors, together with social geographical factors, have a significant influence on refugee flows in South Sudan. However, the FLEE-model (Suleimenova, Bell, & Groen, 2017), tested on the case of South Sudan in 2020, only includes the social geographical dimension. In this case only the political dimension: conflict. This can lead to flow predictions that show a distorted image of the real-life situation. According to Schutte (2021), citizens are forced to leave when the physical environment can no longer sustain their mode of living. In order to optimize the refugee flow predictions, this research stresses the importance of including physical geographical factors like food insecurity and flooding in refugee flow prediction models. This aligns with the idea of researchers like Neumann & Hermans (2015) and Castelli (2018) as they both include environmental drivers as factors of influence in their migration models.

This research serves as a plea to include physical geographical factors into the FLEE-model for the case of South Sudan. However, there are some limitations to this research that need to be addressed. The first limitation of this research is that the research only focusses on the case of South Sudan. This means that only the environmental drivers of migration that are applicable to the case of South Sudan are included in this research. This also stresses the importance of context specificity. Food insecurity and flooding are not the only physical geographical factors that can or should be incorporated into refugee flow prediction models. Other physical geographical factors that could cause refugee flows are storms (for example hurricanes), heatwaves, desertification, earthquakes, volcanoes, tsunamis and the raise of the sea level in deltas, etc. If this research was focussed on another case or country, the geographical factors of influence would have been different. For example, the extreme drought in Ethiopia in 2016 caused ten thousands of people to flee to neighbouring countries due to the lack of food and water. Another example is the back-to-back hurricanes in central America in 2020, that caused thousands of people to move towards the US-Mexico border. Nonetheless, the research serves as proof of the importance of including physical geographical factors into flow prediction models, with the case of South Sudan as an example. And it presents a base and method for further research of the influence of physical geographical factors in other cases.

The second limitation of this research is that the quantitative data that was used, the Flow Monitoring Registries, only focuses on the year of 2020. This means that the results of this research are only

representative for 2020. In order to keep an up-to-date image of what geographical factors are of influence, the research should be repeated annually. The method used for this research is timeless and can therefore be used again in the future. Also, since the data does not represent the actual situation for all times and for all places in South Sudan, more researchers should be deployed to collect data in South Sudan to be able to represent a situation as close as possible to the real-life situation.

The third limitation of this research is that, because of the COVID-19 situation, it was impossible to collect data first-hand. This means that the data used in this research is all secondary data. The method that was used to collect the data could therefore not be altered to fit the exact research question of the researcher. The initial plan was to do face to face interviews with South Sudanese refugees situated in the Netherlands. But many refugee organisations in the Netherlands did not have the capacity or possibility to organise interviews because of the Covid-19 situation.

In this research I have used the refugee flow prediction model created by Derek Groen (2017) as a base for my research. This has proven to render interesting insights and results. Yet, it has also become clear that the model has various shortcomings. There are serious limitations to the model that require necessary discussion and further research. The results presented in this research can therefore not be the end result. The concepts and terminology that are used for this model are based on a certain viewpoint and therefore require critical reflection and evaluation. The scientific debate surrounding these terms and concepts will be addressed in the following paragraphs. It is also important to note that models show a simplistic version of the real-life situation, and that the reality is always more complex. Refugee prediction models can be useful because they provide quantitative data. Humanitarian organisations that provide practical help to refugees can use these numbers to predict when, where and how much shelter, food and medical help is needed. However, the numbers will never be exact since not everyone may have the opportunity and ability to move elsewhere.

This research uses the term refugee 'flow' to provide a connection with previous research on this theme. However, it is important to be aware of the scientific debate surrounding the use of water terms and refugees. Since the Syrian refugee movement in 2015 and 2016 the use of water metaphors for minority groups (including refugees) have been critically revised. Studies have concluded 'minority groups are systematically discriminated in media and deemed as a security, economic and hygiene threat to the majority groups.' (Abid, Manan, & Rahman, 2017, p. 122). Water metaphors represent refugees as an 'unwelcome disaster'. Comparing other people with water dehumanises and normalises and popularises racism (van Houtum, 2022). Water is a natural phenomenon, something that happens to us. With that, we don't think about something that was caused by human action. Talking about floods and tsunamis is associated with natural disaster. People need to arm themselves against natural disaster by for example building dikes and dams. Or in this case: a fence (van der Spek, 2022). The use of the term 'flow' might indicate a negative view on refugee movements in this research. However, in this research 'flow' is only used to represent movement.

This research was mainly built on the concept of push and pull models. A negative aspect of using this concept is that the complexity of real-life migration is overlooked. According to de Haas (2013), 'push and pull models lack explanatory power by failing to provide insight into the social, economic and political

processes that have generated the spatial wage and opportunity gaps to which migration is supposedly a response.’ Looking at people’s capabilities and aspirations to move can help create a better understanding of migration behaviour (de Haas, What drives human migration?, 2013). This research assumes that if natural disaster happens in one place, all people move to another (safer) place. This is not always the case if we take into account personal capabilities and aspirations. For example, when a village is affected by flooding, it does not mean that all people will flee. Some homes might remain intact and some people might simply not have the ability to move. For the case of this research however, there is a need to simplify real life situations in order to work with a prediction model.

As this research represents physical geographical factors as triggers for movement, there is an important debate surrounding climate change and migration that should be discussed. In the last few years, many news sources have claimed that climate change will set in motion mass-migration. However, the environment is but one of the many factors that shape migration. ‘Extreme poverty can actually deprive vulnerable people of the means to travel and migrate over large distances, and they might find themselves therefore trapped where they are, unable to flee.’ (de Haas, 2020, p. 1).

In chapter 3 it was mentioned that in order to calculate the vulnerability to climate change four baskets of vulnerability are combined: physical, demographic, household and governance (Busby, Smith, White, & Strange, 2013). Whether or not individuals experience the worst effects of climate-related events will partially depend on the quality of governance in that country. When a direct causal link is drawn between climate change and migration, the ‘climate refugee’ narrative depoliticizes the migration of vulnerable people. Therefore, governments can shift the blame to environmental or climatic factors ‘beyond their control.’ (de Haas, 2020). ‘If people are displaced or die as a result of natural disaster, this is not just the direct consequence of the disaster, but also reflects the inability of governments to help people to cope with such stresses, such as by building flood defences, timely evacuation efforts and building regulations.’ (de Haas, 2020, p. 1).

‘Looking at disasters as social productions requires a shift in thinking, away from the notion that the forces of nature – or in the case of financial catastrophes, human nature – produce disasters and toward a fuller understanding of the role that social, political, economic, and cultural factors play in making events disastrous.’ (Tierney, 2014, p. 5). Like was shown in this research, physical geographical factors like flooding can trigger the movement of people. But the root cause of this problem is that the South Sudanese government did not take enough action to make the community resistant to these extreme weather conditions. This again shows how social and physical geographical factors are always intertwined.

6.3 Recommendations for further research

Now that proof is found of the existing influence of physical geographical factors in South Sudan’s refugee crisis, further research could focus on implementing food insecurity and flooding in the FLEE-model. The research can focus on finding the best way to implement these factors into the model. This requires knowledge of geo-ICT and the technical side refugee flow prediction models. The model can then be tested to see if it represents the real-life situation in South Sudan.

Also, now there is a lack of objective numbers and measurable data. The investment in gaining more data could lead to the possibility of using more data driven methods. Refugee flow models are now only designed on the basis of conflict data and exact numbers from refugee camps. By making a mathematical model based on the determined factors in combination with the escape routes, you can calibrate and optimize the factors in such a way that you eventually come close to the actual numbers. If this data would have been there, a statistical solution (regression) or more ML/AI applications could have been applied. By training an ML model it can be developed into a predictive model.

Further research could also focus on examining the extent to which physical geographical factors in South Sudan form intervening obstacles and can therefore influence the route of a refugee. This can provide humanitarian organisations with a more detailed image of the route that will possibly be taken by refugees.

Another focus of further research could be examining the influence of physical geographical factors in other areas with high refugee flows like for example Syria, Venezuela, Afghanistan and Myanmar. Since all these countries know very different geographical environments, it can serve as an interesting base to see what other physical geographical migration drivers can play a role. In these countries conflict is a major driver of refugee flows. However, social and physical geography always link together as can be seen in the case of South Sudan.

The shortcomings of the model, discussed in the last section of chapter 6.2, also require further research. There is a need to look further than push and pull theories to gain an improved image of a more complex reality. Also, the influence of a country's governance should be taken into account when creating predictions as the role of a governance is essential in a refugees decision to move.

The results of this research will provide my internship organisation with more specific data on when and where to expect South Sudanese refugee flows in the near future. This research can also serve as a template for future research on South Sudanese refugee flows but also as a template for different contexts as long as Flow Monitoring Registries are available for the specific country or area. Gaining more knowledge on the migration factors that are important for a specific refugee flow case will give Defence the opportunity to provide help and support in future humanitarian missions.

References

- Abid, R. Z., Manan, S. A., & Rahman, Z. A. (2017). 'A flood of Syrians has slowed to a trickle': The use of metaphors in the representation of Syrian refugees in the online media news reports of host and non-host countries. *Discourse & Communication*, 121-140.
- ACLED. (2021, april 19). *Dashboard*. Retrieved from ACLED:
<https://acleddata.com/dashboard/#/dashboard>
- Akuey, A. A. (2018). South Sudan and the Emerging Security Implications for East Africa. *Universlag Journal of Educational Research*, 218-225.
- Apodaca, C. (1998). Human Rights Abuses: Precursor to Refugee Flight? *Journal of Refugee Studies*, 80-93.
- Berlanga, E. (2021, october 22). *Conflict, climate change and hunger: a triangle of despair in South Sudan*. Retrieved from World Food Programme: wfp.org/stories/conflict-climate-change-and-hunger-triangle-despair-south-sudan
- Busby, J. W., Smith, T. G., White, K. L., & Strange, S. M. (2013). Climate Change and Insecurity: Mapping Vulnerability in Africa. *International Security*, 132-172.
- Castelli, F. (2018). Drivers of migration: why do people move? *Journal of Travel Medicine*, 1-7.
- Climate Change Knowledge Portal. (2022, January 8). *South Sudan*. Retrieved from Climate Change Knowledge Portal: <https://climateknowledgeportal.worldbank.org/country/south-sudan/climate-data-historical>
- Cole, D. (2022, January 8). *Prize-winning photos capture the grit and suffering of flood survivors in South Sudan*. Retrieved from NPR:
<https://www.npr.org/sections/goatsandsoda/2021/11/20/1054865992/prize-winning-photos-capture-the-grit-and-suffering-of-flood-survivors-in-south-sudan>
- Collins, R. O. (2021, october 20). *South Sudan*. Retrieved from Britannica:
<https://www.britannica.com/place/South-Sudan>
- Council of Foreign Relations. (2021, januari 26). *Civil War in South Sudan*. Retrieved from Global Conflict Tracker: <https://www.cfr.org/global-conflict-tracker/conflict/civil-war-south-sudan>
- CPSR. (2021). *Climate, Peace and Security Fact Sheet*. Norway: NUPI & SIPRI.
- de Haas, H. (2013, december 11). *What drives human migration?* Retrieved from Hein de Haas:
<http://heindehaas.blogspot.com/2013/12/what-drives-human-migration.html>
- de Haas, H. (2020, January 31). *Climate refugees: the fabrication of a migration threat*. Retrieved from Hein de Haas: <http://heindehaas.blogspot.com/2020/01/climate-refugees-fabrication-of.html>
- DTM. (2020). *Central Equatoria State Event Tracking Report*. South Sudan: IOM.
- DTM. (2020). *Event Tracking Summary: January - June 2020*. South Sudan: IOM.
- DTM. (2020). *Event Tracking Summary: July-September 2020*. South Sudan: IOM.
- DTM. (2020). *Event Tracking Summary: October-December 2020*. South Sudan: IOM.
- DTM. (2020). *Jonglei State Event Tracking Report*. South Sudan: IOM.

- DTM. (2020). *Seasonal Floods Analysis 2020*. South Sudan: IOM Displacement Tracking Matrix.
- DTM. (2020). *Unity State Event Tracking Report*. South Sudan: IOM.
- DTM. (2020). *Warrap State Event Tracking Report: Tonj East County*. South Sudan: IOM.
- DTM. (2020). *Warrap State Event Tracking Report: Tonj North County*. South Sudan: IOM.
- Dunkley, G. (2004). *Evaluation of UNHCR's contribution to emergency preparedness, contingency planning and disaster management in the Asia Pacific region (2000-2003)*. Geneva: UNHCR.
- Edwards, S. (2008). Computational Tools in Predicting and Assessing Forced Migration. *Journal of Refugee Studies*, 347-359.
- FAO. (2021, april 19). *Crisis in South Sudan*. Retrieved from Food and Agriculture Organization of the United Nations: [http://www.fao.org/emergencies/crisis/south-sudan/intro/en/#:~:text=Follow%20%40FAOemergencies-,Crisis%20in%20South%20Sudan,Phase%20Classification%20\(IPC\)%20analysis](http://www.fao.org/emergencies/crisis/south-sudan/intro/en/#:~:text=Follow%20%40FAOemergencies-,Crisis%20in%20South%20Sudan,Phase%20Classification%20(IPC)%20analysis).
- International Crisis Group. (2022, January 6). *Tracking Conflict Worldwide*. Retrieved from International Crisis Group: <https://www.crisisgroup.org/crisiswatch/database>
- International Rescue Committee. (2022, January 6). *Drought and conflict leave 8.7 million people hungry in Somalia and South Sudan*. Retrieved from International Rescue Committee: <https://www.rescue.org/press-release/drought-and-conflict-leave-87-million-people-hungry-somalia-and-south-sudan>
- IOM. (2020). *Event Tracking Summary January - June 2020*. South Sudan: DTM IOM Displacement Tracking Matrix.
- IOM. (2020). *South Sudan: September External Update*. South Sudan: IOM.
- IOM. (2021, juli 16). *Displacement Tracking Matrix*. Retrieved from Displacement Tracking Matrix : <https://dtm.iom.int/>
- IOM. (2021, juni 30). *Who is a migrant?* Retrieved from IOM: <https://www.iom.int/who-is-a-migrant>
- IOM UN Migration. (2020). *South Sudan Crisis Response Plan 2020-2021*. South Sudan: IOM.
- Knox, P., & Marston, S. (2014). *Human Geography*. Essex: Pearson Education Limited .
- Lee, E. (1966). A Theory of Migration. *Demography* 3, 47-57.
- Martinez, S. (2021, april 19). *Drowned land: hunger stalks South Sudan's flooded villages*. Retrieved from The Guardian: <https://www.theguardian.com/global-development/2021/mar/19/drowned-land-hunger-stalks-south-sudans-flooded-villages>
- Mena, R. (2019). *South Sudan: Prioritizing disaster response in a context of high-intensity conflict*. Rotterdam: International Institute of Social Studies.
- Mercy Corps. (2019, juni 24). *Quick facts: What you need to know about the South Sudan crisis*. Retrieved from Mercy Corps: <https://europe.mercycorps.org/en-gb/blog/south-sudan-crisis>
- Momodu, S. (2021, april 19). *Uganda stands out in refugees hospitality*. Retrieved from Africa Renewal: <https://www.un.org/africarenewal/magazine/december-2018-march-2019/uganda-stands-out-refugees-hospitality>

- Neumann, K., & Hermans, F. (2015). What drives Human Migration in Sahelian Countries? A Meta-analysis. *Population, Space and Place*.
- OCHA. (2015). *South Sudan 2015 Humanitarian Response Plan*. South Sudan: United Nations.
- OCHA. (2020). *South Sudan Flood Risk Map*. South Sudan: OCHA.
- Oxfam International. (2021, april 7). *Hunger crisis in South Sudan*. Retrieved from Oxfam International: <https://www.oxfam.org/en/what-we-do/emergencies/hunger-crisis-south-sudan>
- REACH. (2015). *South Sudan Displacement Trends Analysis*. South Sudan: EU Humanitarian Aid and Civil Protection.
- Republic of South Sudan Ministry of Interior. (2019). *National Comprehensive Migration Policy*. South Sudan: Republic of South Sudan Ministry of Interior.
- Schutte, S., Vestby, J., Carling, J., & Buhaug, H. (2021). Climatic conditions are weak predictors of asylum migration. *Nature Communications*, 1-10.
- Shellman, S. M., & Stewart, B. M. (2007). Predicting Risk Factors Associated with Forced Migration: An Early Warning Model of Haitian Flight. *Civil Wars*, 174-199.
- Suleimenova, D., & Groen, D. (2020). How Policy Decisions Affect Refugee Journeys in South Sudan: A Study using Automated Ensemble Simulations. *Journal of Artificial Societies and Social Simulation*.
- Suleimenova, D., Bell, D., & Groen, D. (2017). *A Generalized Simulation Development Approach for Predicting Refugee Destinations*. Published Online: Scientific Reports.
- Tierney, K. (2014). *The Social Roots of Risk*. Stanford, California: Stanford University Press.
- Tiitmamer, N., Mayai, A. T., & Mai, N. H. (2018). *Climate change and conflicts in South Sudan*. Juba: The Sudd Institute.
- UNDP. (2021, juli 2). *Human Development Data Center*. Retrieved from Human Development Reports: <http://hdr.undp.org/en/data>
- UNHCR. (2020). *Ethiopia Country Refugee Response Plan*. Ethiopia: UNHCR.
- UNHCR. (2020). *Regional Update South Sudan Situation January-February 2020*. South Sudan: UNHCR.
- UNHCR. (2020). *South Sudan Regional Refugee Plan*. South Sudan: UNHCR.
- UNHCR. (2021, november 11). *Climate change and disaster displacement*. Retrieved from UNHCR: The UN Refugee Agency: [unhcr.org/climate-change-and-disasters.html](https://www.unhcr.org/climate-change-and-disasters.html)
- UNHCR. (2021, november 21). *Climate change is an emergency for everyone, everywhere*. Retrieved from UNHCR: The UN Refugee Agency: [unhcr.org/news/stories/2021/11/618a301d5/climate-change-emergency-everywhere.html](https://www.unhcr.org/news/stories/2021/11/618a301d5/climate-change-emergency-everywhere.html)
- UNHCR. (2021, november 11). *Figures at a Glance*. Retrieved from UNHCR: The UN Refugee Agency: <https://www.unhcr.org/figures-at-a-glance.html>

- UNHCR. (2021, juni 29). *Internally Displaced People*. Retrieved from UNHCR: <https://www.unhcr.org/internally-displaced-people.html>
- UNHCR. (2021, maart 9). *South Sudan*. Retrieved from Operational Portal Refugee Situations: <https://data2.unhcr.org/en/situations/southsudan>
- UNHCR. (2021, november 11). *The 1951 Refugee Convention*. Retrieved from UNHCR: The UN Refugee Agency: <https://www.unhcr.org/1951-refugee-convention.html>
- USAID. (2022, January 6). *South Sudan Crisis Map #11 January 7, 2014*. Retrieved from USAID: <https://www.usaid.gov/documents/1866/south-sudan-crisis-map-11-january-7-2014>
- van der Spek, E. (2022, june 5). *Watertaal*. Retrieved from Hendrikx van der spek: <https://hvds.nl/nieuws-en-blogs/blog/watertaal/>
- van Houtum, H. (2022, june 5). *Henk van Houtum over Europees migratiebeleid en legale migratieroutes*. Retrieved from Cordaid: <https://www.cordaid.org/nl/share-the-journey/experts-aan-woord-migratie-en-vluchtelingen/henk-van-houtum-over-europees-migratiebeleid-en-legale-migratieroutes/>
- Vox. (2021, october 20). *South Sudan may be heading towards genocide*. Retrieved from Youtube: <https://www.youtube.com/watch?v=LkWldwFdTPo>
- WFP. (2020). *Emergency Dashboard South Sudan*. South Sudan: World Food Programme.
- WFP. (2021). *South Sudan: Country office and regional bureau update #1 October 2021*. South Sudan: World Food Programme.
- World Food Programme. (2021). *WPF South Sudan Situation Report #285*. WFP.

Appendix 1

Place of departure vs. Reason of departure: Observed frequency

Reason for departure	Place of departure				Total
	1	2	3	4	
1	3	8	34	14	37
2	46	44	89	45	135
3	37	33	33	178	70
4	14	2	0	0	14
5	37	54	63	41	100
6	33	36	57	32	90
7	31	1	15	4	46
8	24	15	106	23	130
9	116	36	83	40	199
10	91	27	69	18	160
11	5	12	9	10	14
Total	437	268	558	405	995

Place of departure vs. Reason of departure: Expected frequency

Reason for departure	Place of departure				Total
	1	2	3	4	
1	16,25025126	9,965829	20,74975	15,060302	37
2	59,29145729	36,36181	75,70854	54,949749	135
3	30,74371859	18,85427	39,25628	28,492462	70
4	6,148743719	3,770854	7,851256	5,6984925	14
5	43,91959799	26,93467	56,0804	40,703518	100
6	39,52763819	24,24121	50,47236	36,633166	90
7	20,20301508	12,38995	25,79698	18,723618	46
8	57,09547739	35,01508	72,90452	52,914573	130
9	87,4	53,6	111,6	81	199
10	70,27135678	43,09548	89,72864	65,125628	160
11	6,148743719	3,770854	7,851256	5,6984925	14
Total	437	268	558	405	995

Appendix 2

Place of departure vs. Season of departure: Observed frequency

Reason of dep.	Season				Grand Total
	1	2	3	4	
1	32	12	11	4	59
2	166	25	21	12	224
3	22	7	99	153	281
4	0	0	11	5	16
5	104	54	16	21	195
6	108	17	17	16	158
7	0	0	23	28	51
8	86	61	4	17	168
9	182	19	28	46	275
10	70	46	64	25	205
11	13	8	9	6	36
Grand Total	783	249	303	333	1668

Place of departure vs. Season of departure: Expected frequency

Reasons of dep.	Season				Grand Total
	1	2	3	4	
1	27,69604317	8,807554	10,7176	11,7788	59
2	105,1510791	33,43885	40,6906	44,7194	224
3	131,9082734	41,94784	51,045	56,0989	281
4	7,510791367	2,388489	2,90647	3,19424	16
5	91,53776978	29,10971	35,4227	38,9299	195
6	74,16906475	23,58633	28,7014	31,5432	158
7	23,94064748	7,613309	9,26439	10,1817	51
8	78,86330935	25,07914	30,518	33,5396	168
9	129,0917266	41,05216	49,955	54,9011	275
10	96,23201439	30,60252	37,2392	40,9263	205
11	16,89928058	5,374101	6,53957	7,18705	36
Grand Total	783	249	303	333	1668