Displaced Persons' Camp Siting and Conflict Prediction in The Sahel

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(1.0) Introduction

(1.1) Capstone statement

Within the biogeographic region of the Sahel, approximately **4.9 million** people are forcibly **displaced** as a result of environmental degradation, poverty and insecurity associated with terrorism and criminal organizations (World Bank 2013, UN 2016). As these forces of displacement proliferate, there are subsequent emerging vulnerable areas throughout this **biogeographic zone**. Our mission is to better prepare settlements for the arrival of displaced persons by identifying likely areas of displacement, and determine preferred site locations for the settlement of displaced populations.

(1.2) Background

In the Sahel, 4.9 million persons are displaced and a greater proportion of the region's population are close to displacement as many residents maintain life in extreme vulnerability. It is estimated 30 million people who will not have enough to eat in 2017, 12 million will require emergency food assistance, an estimated 4.7 million children suffer from malnutrition in 2017, 30 million people are affected by violence, 11 million need urgent assistance and protection in the Lake Chad Basin. (UNOCHA 2017). Our primary goal is to identify areas that are prone to displacement using existing, comprehensive indexes that consider various factors contributing to vulnerability. Applied concurrently with calculations of strategic centrality→ a statistical predictor of violence based on spatial network connectivity→ the indexes will assist in the identification of areas at highest risk of future displacement

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As the number of displaced persons rises, the question of where they will go is increasingly important. From 1993 to 2003, the average duration of major refugee situations has increased from 9 years to 17 years. The world's largest refugee settlement in Dadaab, Kenya, exemplifies how the trending protraction of refugee situations effects the settlement of displaced persons. Planned for 90,000 refugees in 1991, the complex is now home to 235,269 registered refugees and asylum seekers (UNHCR).With settlements frequently outgrowing their planned capacities and available resources, while simultaneously shifting from temporary to permanent destinations, the need for improved preparation, planning and implementation in both the placement of displaced persons and the development of new settlements is of increasing importance. To this end, we will associate identified areas of probable displacement with existing, best-fit settlement destinations, as well as conduct a site suitability analysis to identify preferred locations for future settlements.

(1.3) Key Terms

The term '**forcibly displaced person**' refers to any individual who falls into one of the numerous technical classifications of persons forced from their homes, whether they are refugees, internally displaced persons (IDPs), asylum seekers or stateless persons. As of 2016, the global tally of forcibly displaced persons reached 65.6 million (UNHCR).

'**Refugee**' refers to a person who has been forced to flee his or her country because of persecution, war, or violence. These people have a fear of persecution for reasons of race, religion, nationality, political opinion or membership in a particular social group. Most likely, they cannot return home or are afraid to do so. War and ethnic, tribal and religious violence are leading causes of refugees fleeing their countries. More than half of all refugees originate from three such conflict stricken countries: South Sudan, Syria, and Afghanistan (UNHCR).

Internally displaced people (IDPs) are people who are forced to flee their homes but never cross an international border. These individuals seek safety anywhere they can whether it be nearby towns, schools, settlements, internal camps, even forests and fields. IDPs, which include people displaced by internal strife and natural disasters, are the largest group that the UNHCR assists. Unlike refugees, IDPs are not protected by international law or eligible to receive many types of aid because they are legally under the protection of their own government. The countries with largest IDP populations include Sudan with 2.2 million, South Sudan with 1.6 million, Nigeria with 1.2 million and Somalia with 1.1 million (UNHCR). Many African countries have historically dealt with large numbers of IDPs.. Out of an estimated 26.4 million IDPs in the world at the end of 2011, there were some 9.7 million IDPs in sub-Saharan Africa, down 13% from 2010 when there were just over 11 million. This refers only to those displaced by conflict and human rights violations. Patterns of internal displacement resulting from conflict are similar to the number of refugees (UNDP). In Appendix C (figure 5) there is an explanation of all the phases and stages of displaced people that are considered Internally displaced.

A **stateless person** is one who is not a citizen of any country. Citizenship is the legal bond between a government and an individual and it allows certain political, economic, social and other rights of the person, as well as the responsibilities of both government and citizen. A person can become stateless due to a variety of reasons, including sovereign, legal, technical or administrative decisions or oversights. The Universal Declaration of Human Rights underlines that “Everyone has the right to a nationality” (UNHCR).

An **asylum seeker** is an individual seeking sanctuary in another country. They apply for asylum and the right to be recognized as a refugee and receive legal protection and material

assistance. An asylum seeker must demonstrate that his or her fear of persecution in his or her home country is well founded (UNHCR).

(1.4) Site Setting

The Sahel is the semiarid, biogeographic and Eco climatic region of western and north-central Africa extending from Senegal east to the Sudan. It forms a transitional zone between the arid Sahara Desert to the north and the belt of humid savannas to the south. The Sahel stretches from the Atlantic Ocean eastward through northern Senegal, southern Mauritania, the great bend of the Niger River in Mali, Burkina Faso , southern Niger, northeastern Nigeria, south-central Chad, and into The Sudan. It has historically been prone to long and severe droughts.

Environmental degradation refers to changes in both quantity and quality of the environment including the decrease in vegetation cover and loss of biodiversity (Abusin, 1991). The Sahel region historically has the fragile environment in terms of agriculture. In the early 1970s, there was a long period of drought. It spanned over 7 million square kilometers and had close to 135 million inhabitants. Some of the larger countries that contain extensive expanses of desert include Mali and Niger within the Sahel Region. They have low population densities of fewer than 20 people per square kilometer. Starting in 1968 this led to the virtual extinction of crops and the loss of 50 to 70 percent of cattle. In 1972 there was nearly no rain and by 1973 sections of the Sahara had advanced southward up to 60 miles. The loss of human life by starvation and disease were estimated in 1973 at 100,000. Severe drought and famine again afflicted the Sahel between 1983–1985, and desertification progressed despite government reforestation programs. The Sahel continued to expand southward into neighboring savannas, with the Sahara following in its wake (Britannica). Consequently, UNEP's 2007 report estimated that the northern desert boundary in Sudan has shifted southward 50 km, since the 1930s, which

indicated a considerable risk of degradation in the study area (UNEP, 2007). The ecosystem in this area is characterized by high rainfall variability and high water deficiency (Elfaig et al., 2013), low sustainability, low resilience, low carrying capacity and restoration as it resembles the general features of the Sahelian ecosystems. Given these characteristics, we identify Sahel region as vulnerable site and therefore chose to analyze it for site suitability.

(3) Methodology:

Vulnerability has many indicators, and accordingly, a handful of vulnerability indexes have been prepared by various state and non-state organizations. Some robust indexes that we used are the Human Development Index (HDI) calculated by the United Nations Development Program (UNDP), the Corruption Perception Index (CPI) calculated and published by Transparency International (TI), and GPI (Global Peace Index) calculated and created by the Institute of Economics and Peace. These indexes incorporate different variables to focus on each organization's area of expertise. We are using these three indexes to provide a backdrop of vulnerable areas for our site suitability analysis.

Human Development Index (HDI)

The HDI is an average measure of basic human development achievements in a country. Like all averages, the HDI masks inequality in the distribution of human development across the population at the country level. The 2010 HDR introduced the IHDI, which takes into account inequality in all three dimensions of the HDI by 'discounting' each dimension's average value according to its level of inequality (2015 HDR Report).

The Human Development Index is a measure of performance in three key variables of human development, which are a long and healthy life, access to knowledge and a decent standard of living. The HDI is the geometric mean of normalized indices for these three

dimensions. Data regarding life expectancy at birth, expected and mean years of schooling, GNI per capita, demographic health data from the World Bank, UNICEF and UNESCO respectively.

Dimension	Indicator	Minimum	Maximum
Health	Life expectancy (years)	20	85
Education	Expected years of schooling (years)	0	18
	Mean years of schooling (years)	0	15
Standard of Living	Gross national income per capita	100	75,000

Figure B: HDI Scoring Scheme

Source: HDI Website

The reason researchers opted for an natural zero for life expectancy at 20 years is since it is based on historical evidence that no country in the 20th century had a life expectancy of less than 20 years (Maddison 2010, Oeppen and Vaupel 2002, Riley 2005). Secondly, they opted for 0 years for minimum formal education since societies can survive without formal education education based on evidence. Furthermore, they opted for 18 for maximum expected years of schooling, as it considered is equivalent to achieving a graduate or master's degree in most

countries. The maximum for mean years of schooling, 15, which is the projected maximum of this indicator for 2025. The low minimum value for gross national income (GNI) per capita, $100, is explained by the considerable amount of unmeasured subsistence and nonmarket production in economies close to the minimum. The maximum is set at $75,000 per capita. Research and study by Kahneman and Deaton (2010) have shown that there is virtually no gain in human development and well-being from income per capita above $75,000. After the minimum and maximum values, the dimension indices are calculated as:

$$\text{Dimension index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}} \quad \text{(equation 1)}$$

For the education dimension, equation 1 is first applied to each of the two indicators, and then the arithmetic mean of the two resulting indices is taken. Since each dimension index is a substitute for capabilities in the corresponding dimension, thus the transformation function from income to capabilities is likely to be concave (Anand and Sen 2000) thus, each extra dollar of income has a smaller effect on expanding capabilities. Therefore, for income the natural logarithm of the actual, minimum and maximum values is used. The World Bank's 2016 World Development Indicators database contains estimates of GNI per capita in constant 2011 purchasing power parity (PPP) terms for many countries. To measure the GNI per capita they use the data from the 2016 Report was used. In step 2, the dimensional indices are aggregated to produce the Human Development Index. Sahelian countries have historically ranked in the lowest in human development ranking. In Appendix B (Figure 2) the table shows the the 2017 ranking of the lowest 5 HDI global countries which includes Sahelian countries.

Equation: $HDI=(I\ Health+I\ Education+I\ Income)\ ^{\wedge}⅓$

Scoring Scheme

Very high human development	**0.800 and above**
High human development	**0.700-0.799**
Medium human development	**0.550-0.699**
Low human development	**Below 0.550**

Figure C: HDI Cut off points for grouping countries

Source: HDI Website

Consumer Perception Index (CPI)

Transparency International (Ti) created Consumer Perception Index (CPI). Transparency International (TI) has published the Corruption Perceptions Index (CPI) since 1995. Therefore, CPI annually ranking countries "by their perceived levels of corruption, as determined by expert assessments and opinion surveys." The CPI defines corruption as "the misuse of public power for private benefits. The main objective of the index is to bring corruption matter to global agenda. The Composite Index obtained by combining research which scores and classifies countries based on the perception of public sector corruption. The scoring scheme is such 0 (zero) reflects highly corrupted countries and 100 (hundred) indicates highly clean countries. Sahelian countries rank among some of the highly corrupt and corrupted countries as per the ranking. Therefore, corruption is clearly a key problem across the Sahel region. Out of 182 countries profiled in Transparency International's Corruption Perceptions Index, Sahelian countries occupied some of the worst spots. On a list where the number one country, New Zealand was the least corrupt, Sahelian countries ranked 100 (Burkina Faso), 112 (Senegal), 118 (Mali), 134 (Eritrea and Niger, tied), 143 (Mauritania and Nigeria, tied), 168 (Chad), and 177 (Sudan).With South Sudan

ranks (180) and Somalia ranks (179) out of 180 countries.

As per the index, there is improved anti-corruption efforts in some countries of Sahel Region. An example of which is Senegal. However the situation continues to worsen in others. The lowest-scoring countries on the index like South Sudan and Sudan are in conflict or war. Reducing corruption in these contexts is particularly challenging. The fragile nature of governments in these situations presents a real challenge to making meaningful changes. Additionally, countries that perform poorly on the index are led by African leaders that run for office on an anti-corruption ticket. However, they never live up to their pledges to deliver corruption free services to their citizens (Transparency International website).

Global Peace Index (GPI)

Global Peace Index (GPI) is created by the Institute of Economics and Peace. It is the Main measure of global peace and thereby ranks peacefulness GPI consists of a total of 23 qualitative and quantitative indicators, that are taken from highly respected sources, covering 163 countries (99.7% of the world population) and reports them about the results of Pacific actions, reasons for violence and ways to combat it. These indicators are subdivided into three subgroups: the level of security of a society, the number of external and internal conflicts, and degree of militarization.The scale adopted by GPI considers 0 (zero) for countries without any violence and 5 (five) for extremely violent countries (Institute for Economics and Peace, 2016). Sahelian countries ranks very low in this index as well. South Sudan ranks 159 out of 162 countries, Somalia ranks 157 out of 162 countries and Nigeria ranks.

Correlation Between Indexes

To assess the compatibility of the these indexes we conducted statistical analysis of these three indexes between countries of different development levels. The correlation result is

presented through scatter plot and regression in Appendix C (Figure 3 and 4). Based on the data there is forecasted to be correlation between these three indexes for the countries of the Sahel Region. There is a negative correlation between HDI and CPI for "low development countries" like Sudan, Niger, Chad, Burkina Faso and South Sudan. There is negative correlation between HDI and GPI for "low development countries" However correlation for developed countries more significant compared to countries for other level of developments.

Strategic centrality and original data layer:

Conflict has strong spatial components and we calculated our original data layer based on the spatial relationships of cities. Although areas experiencing conflict share many socio-economic and geopolitical challenges, violence manifests itself with different degrees of severity across space. Dr. Weisi Guo in "The Spatial Ecology of War and Peace" makes the case that "global patterns in war and peace are closely related to the relative position of cities in a global interaction network" (Guo et al.2016). To quantify this phenomenon Guo calculated the betweenness centrality and degree of a global city networks and he informs us "Betweenness measures the number of shortest paths through a node (i.e., city). The shortest path of travelling between a city *m* to any other city *n* is defined as the path with the least number of hops." (Guo et al.2016). The betweenness centrality of a node *v* is given by the expression: $g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$ where σ_{st} the total number of shortest paths from node *s* to node *t* and σ_{st} (v) is the number of those paths that pass through *v*. The degree (D_v) of a node is calculated by summing the number of connected nodes for *v*. By dividing betweenness centrality by degree we arrive at strategic centrality which normalizes a nodes centrality regarding the number of connections it has.

To produce these graph metrics city data for the countries of the Sahel from the National Geospatial Intelligence Agency's Geographic Names Database. With a data sheet of the cities in

our network to analyze we can implement the statistical program R to calculate the betweenness and the degree of those cities. We can use igraph package 1.0.0. in order to measure betweenness and obtain a value for each city. This value will then be attached to our attribute table for Sahelian cities allowing us to create proportional symbols for each location. If it proves to be a useful visualization, network analyst will provide a network visualization of city connections. We can then perform a logistic regression for determining 'high' and 'low' betweenness cities. Following that categorization we can then measure how many attacks have occurred within various distances of the cities and perform a linear regression to test how accurate of a predictor strategic centrality is for the number of terrorist attacks a city experiences.

We intend to reproduce the results of Guo et al., 2016, "The Spatial Ecology of War and Peace." Although a methodological framework is provided for calculating these values in the aforementioned article, there is no raw data that links the centrality and degree measurements quantitatively to actual city locations. For this reason the above process will be done to create an original data layer and to be used in our analytics. With this value accurately calculated we will create a multi-distance buffer in order to exclude cities with high strategic centrality from our site suitability analysis.

Implementation of Graph Analysis

Calculating betweenness centrality and degree of a regional Sahelian city network requires the creation of a graph on which to analyze. The R igraph package requires an edge list and a vertex list with attributes of edges and vertices. The edge list comprises attributes relating to the origin vertex and all destination vertices and weight attributes. Origin and destination attributes were generated in a distance matrix with the "Generate Near Table" function via the vertex list in ArcMap. From the vertex list this function connects all nodes within a specified

radius, in this instance, 500 km. The weight of the edges is equal to the inverse distance (1/d) between nodes. More distant nodes having less weight than near nodes.

With the edge list and its attributes compiled we make a graph from these data frames with igraph in R. This graph contains all 565 nodes of our network and 20,667 edges. The graph is then simplified to remove multiple edges and loops which would overcalculate our graph metrics. This graph does not however contain any spatial components and only "understands" distance in terms of hops between nodes. In order to perform analysis on our 350 zones, the zones must be extracted from main graph. Because our distance matrix limited connections to a 500 km radius of any given node, our graph inherited that limitation from the dataframe.

We create subgraphs for each of 350 Sahelian nodes on which to calculate betweenness and degree for. Each subgraph maintains the integrity of the network and the edges between all nodes within the subgraph. This is paramount. Creating a graph based on the origin node alone will result in a hub and spoke style graph without the edges between nodes maintained. Betweenness and degree for a graph such as this is a function of the number of nodes rather than an expression of the connections among nodes.

The creation of subgraphs finally allows for the summation of degree and betweenness for our Sahelian city network and the calculation of our normalized variable proposed by Dr. Guo, strategic centrality, Sz = (Bz/Dz). This variable is shown to be the greatest predictor of the number of attacks within a given distance from a city. Betweenness centrality and degree are also reliable predictors, however, the normalized predictor allows comparison of heterogeneous spatial networks from around the globe.

Site Suitability for Displaced Persons Camps

Derived from recommendations and requirements for settlement sites as per the UNHCR Emergency Handbook, our site suitability analysis is comprised of five variables accounting for elevation, land-use, waterways, existing camps, and cities & roads. (UNHCR 2017) Each variable will be operationalized to strictly defined thresholds and limits, followed by their reclassification to boolean values. Once reclassified, the operationalized variables will be input to a weighted sum overlay. The subsequent output will then exclude overlapping areas of strategic centrality buffers, identifying suitable future settlement locations.

Elevation data is extracted from regional DEMs, from which we calculated area slope. Slope is operationalized to values greater than 25%. After reclassification, slope was attributed a weighted multiplier of .3 in the weighted sum overlay.

Land-use data is operationalized to include forests, savannah, grasslands and shrublands, and applied a weighted multiplier of .2 in the weighted sum overlay.

Locational data of surface water features (**waterways**) are used to calculate the Euclidean distance of water sources to outlying land. The Euclidean distance are then be operationalized to values within the range of 1-2 km and applied a weighted multiplier of .2 in the weighted sum overlay

Locational data of **existing camps, cities** and **roads were** used to calculate the Euclidean distance of each of the respective phenomena to outlying land. The respective calculations of Euclidean distance are then operationalized to values within 1-5 km and applied a weighted multiplier of .15 in the weighted sum overlay.

As alluded to before, the variable definitions applied in the operationalization and their weighted multipliers are based on essential criteria identified within the UNHCR Emergency

Handbook. The exclusion of suitable sites within overlapping strategic centrality buffers aims to eliminate areas of close proximity to high risk of violence

(3.0) Results & Analysis, Discussion and Conclusion

Based on the cumulative analyses of the Indexes it can be concluded that South Sudan, Sudan, Nigeria, Chad and Somalia are most vulnerable of the Sahelian countries. They have consistently ranked the lowest for 5 years or more worst in terms of Human Development (HDI), as well as very high in terms of corruption as per CPI as well and very low in terms of peace (GPI).

The Sahel's problems with corruption are not entirely unique. But in a region of fragile governments and powerful, violent non-state actors, corruption can fuel conflict and illegal activity (Transparency International 2015). In Chad, oil wealth meant for development instead went to arms purchases so that the government could hold rebels at bay. Only after Chad's rapprochement with its neighbor and sometime rival Sudan in 2010 did attention turn seriously to infrastructure, and much of the spending has been concentrated in the capital. Government corruption has also contributed to the problem of drug trafficking in the Sahel (Transparency International 2012). In recent years, West Africa has increasingly become a transit point for illegal drugs. Mali, in particular, has seen a rise in drug trafficking. From stolen flood relief funds in Niger to the complicity of local government officials in Mali's drug trade, corruption is a major problem in the Sahel (Thurston, 2012). The CPI, HDI and GPI highlights this in their analyses of 2017.

Strategic Centrality

The global graph created by Guo et al. in "The Spatial Ecology of War and Peace" proved to be incredibly robust in predicting the outbreak of conflict across the globe. It was our

intention to repeat these methods at the regional scale for the Sahelian countries. It turns out that this global model decays below tis scale. Due the spatial homogeneity of the Sahelian network, our graph analysis results did not vary enough to provide useful in predicting the number of attacks in the Sahel. Furthermore, our area of interest in one in which perpetual conflict has been the norm for decades. Therefore, there is not enough range in value for both the graph metrics and the conflict metrics for any linear correlation to be found between betweenness centrality, degree, strategic centrality, and the number of attacks within a 50km radius of each city.

Strategic centrality was not incorporated into our site suitability analysis as intended. If a global model were created and values calculated therein we would be able to Identify the thresholds determined by a logistic regression at which graph metrics could be categorized into descriptive terms such as ‘high’ or ‘low.’ We wanted to include cities with a ‘high’ strategic centrality in our site suitability analysis and exclude any area within a 50 km buffer from these cities. The justification for using this fixed distance buffer is that 76% of violent conflict occurs within a 50 km radius of such cities. (Guo et al., 2016). Although there is no statistical significance between degree and the number of attacks per our analysis, degree still proves useful in understanding the connectivity of zones. Map 2 illustrates the number of attacks by way of choropleth symbolization and degree with proportional symbols. It is easy to see that many of the most violent areas are also poorly connected.

When considering degree relative to values from INFORM’s Risk Index, we similarly observed these two measures to be mostly incongruent to one another as predictors of regional patterns of vulnerability. Generally speaking, when referencing figure Map 1, we can see that cities of higher degree in the Chad River Basin are located in areas of relatively low risk as measured by INFORM. As mentioned previously discussing the relationship between degree and

areas of violence, we observe a similar pattern of poor connectivity and high risk throughout Sudan. Being that the cities included in the calculation of centrality are from a list of cities that collectively account for 80% of the world population, we can therefore imagine that these represent the areas of highest population within the Sahel. Being able to understand the connectivity of these centers of population, although not our original goal, can be useful in guiding further investigation into the potential subsequent associations and implications of connectivity–for example access to resources and other markets–and what that means for the large populations at these sites.

Part of our decision to include graph metrics among our conflict predictors was the matter of scale. The data provided by indexes is aggregated to the country level, with the exception of INFORM, which is available as a provincial aggregation as well. While this is sufficient in identifying general areas of conflict, it leaves a very limited understanding of the places and people at risk. By including the graph metrics in a map such as Map 1, the argument can be made that within any given enumeration area with any level of risk, locality 'X', 'Y' or 'Z' are at greatest risk to conflict.

With greater resources in time, processing power and appropriate geocomputing automation, recreating the global network for analyses would be very feasible. as it was, creating graphs with 20,000 nodes and more was rather difficult on the computers at hand. The global network contains 7,322 nodes and over 130,000 thousand edges which would prove to be quite a task for personal computers and also the machines available in the Geography labs or any library on campus.

Site Suitability

Originally setting out to conduct a site suitability analysis of the entire Sahel, we chose to narrow down our subject area to the sub-region of the Chad River Basin, comprised of Cameroon, Chad, Niger and Nigeria. As can be seen in Map 2, our final analysis provides a preliminary selection of sites that would be best suited for future camp locations, which in this case is simply the unweighted intersection of our operationalized variables applied to this sub-region.

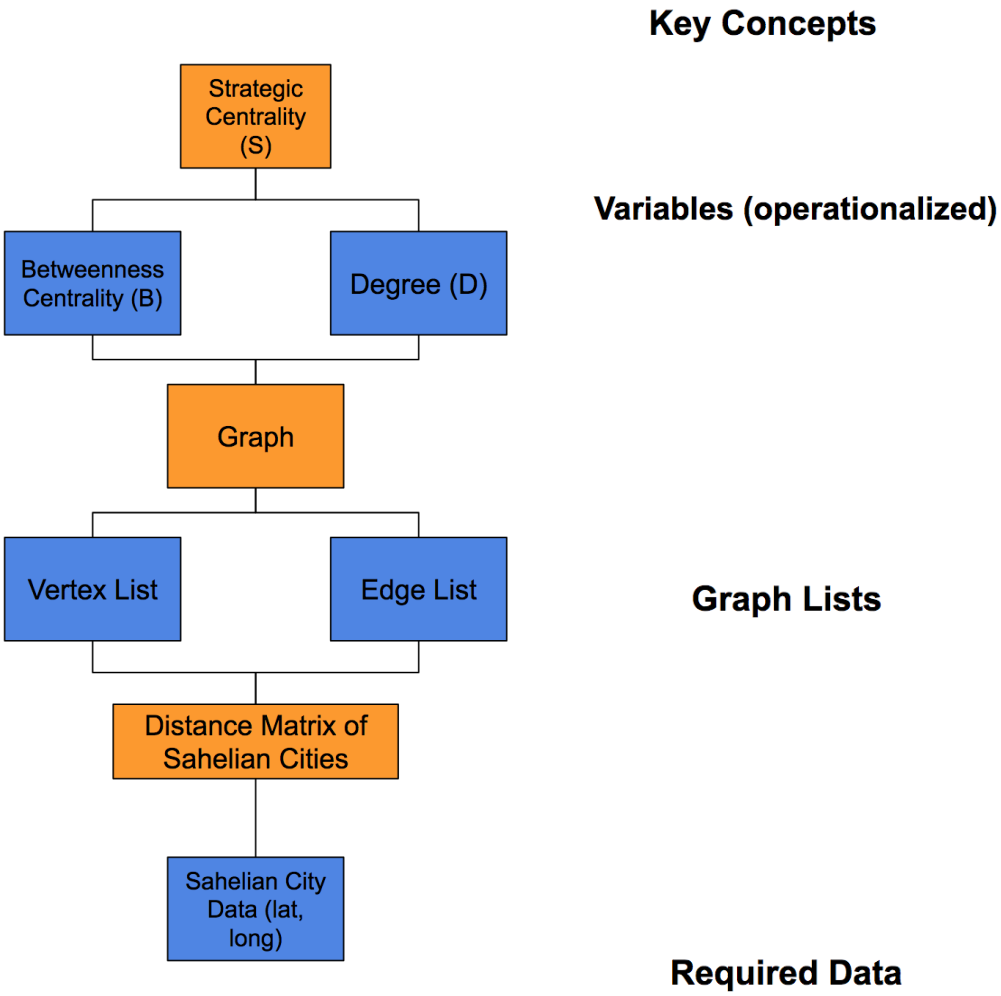
Limitations and Future Research

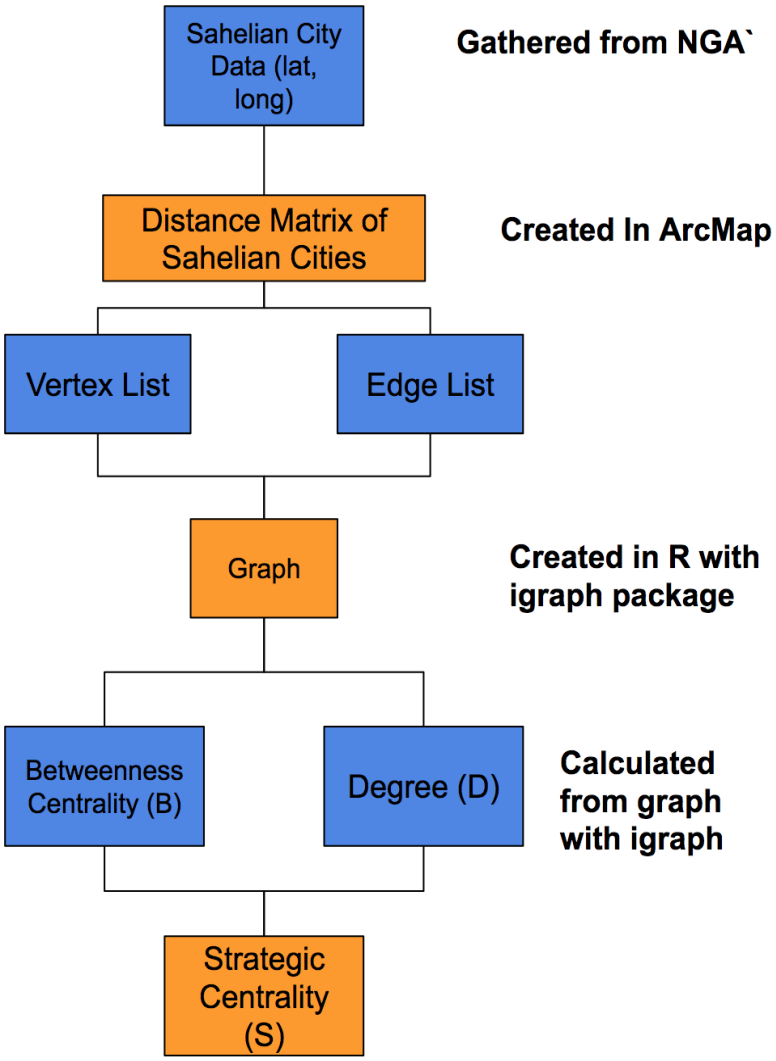
Some of our limitations include time constraints, accessibility to data and data processing power. There were not enough published data on individual provinces of Africa and countries(e.g: Eritrea, Mali) in terms of numbers of Internal displaced people and recent data (e.g 2016 onwards) are owned by various private International agencies and was not open source therefore not readily available . We also had problems with creating degradation of graph model at regional level and also needed to compute graph metrics for global city network which was not viable with the resource and time available. Furthermore, all the research for this study was conducted over the course of one semester. This forced us to only look at selected number of variables. If studied further we would like to analyze economic, environmental and violence/conflict related factors in depth, as well further developing the implementation and interpretation of centrality as a predictor of conflict. Site suitability could also provide additional value by accounting for unique factors pertaining to specific localities

Acknowledgements

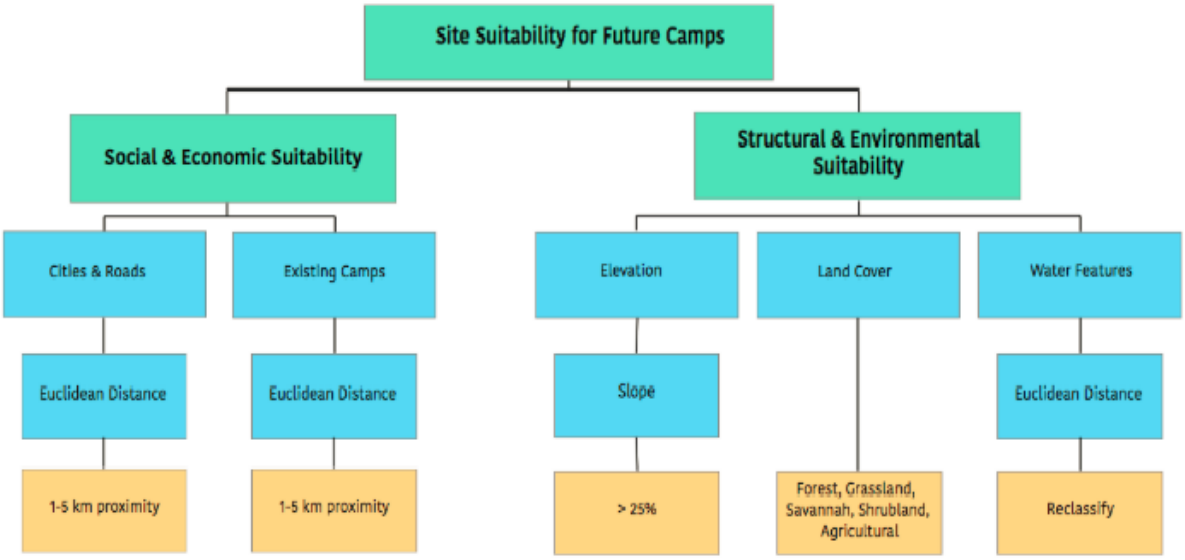
We would like to thank our TA Meilu Wu and Chenxiao Atlas Guo for helping us with advice and helping us conduct our research. We would also like to thank Bill Gartner for helping us through every step of this research project.

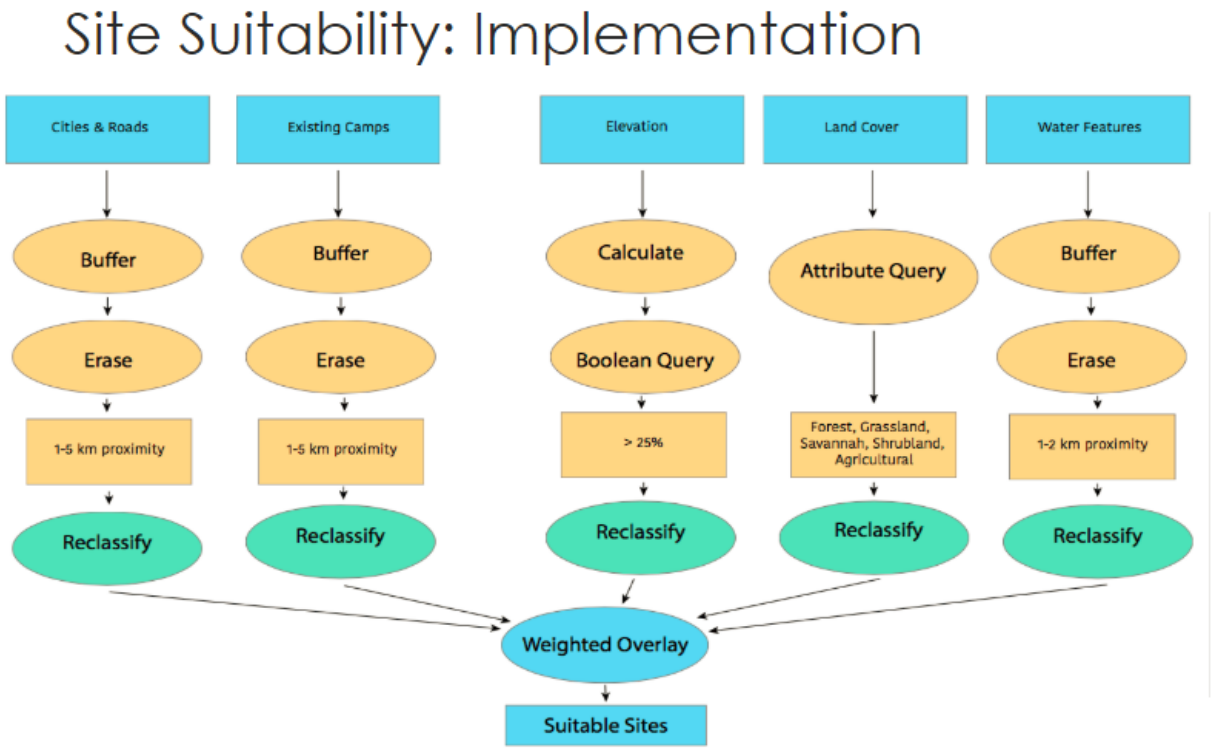
Appendix A: Conceptual and Implementation diagrams




Sahelian City Data (lat, long)
Gathered from NGA`
Distance Matrix of Sahelian Cities
Created In ArcMap
Vertex List
Edge List
Graph
Created in R with igraph package
Betweenness Centrality (B)
Degree (D)
Calculated from graph with igraph
Strategic Centrality (S)

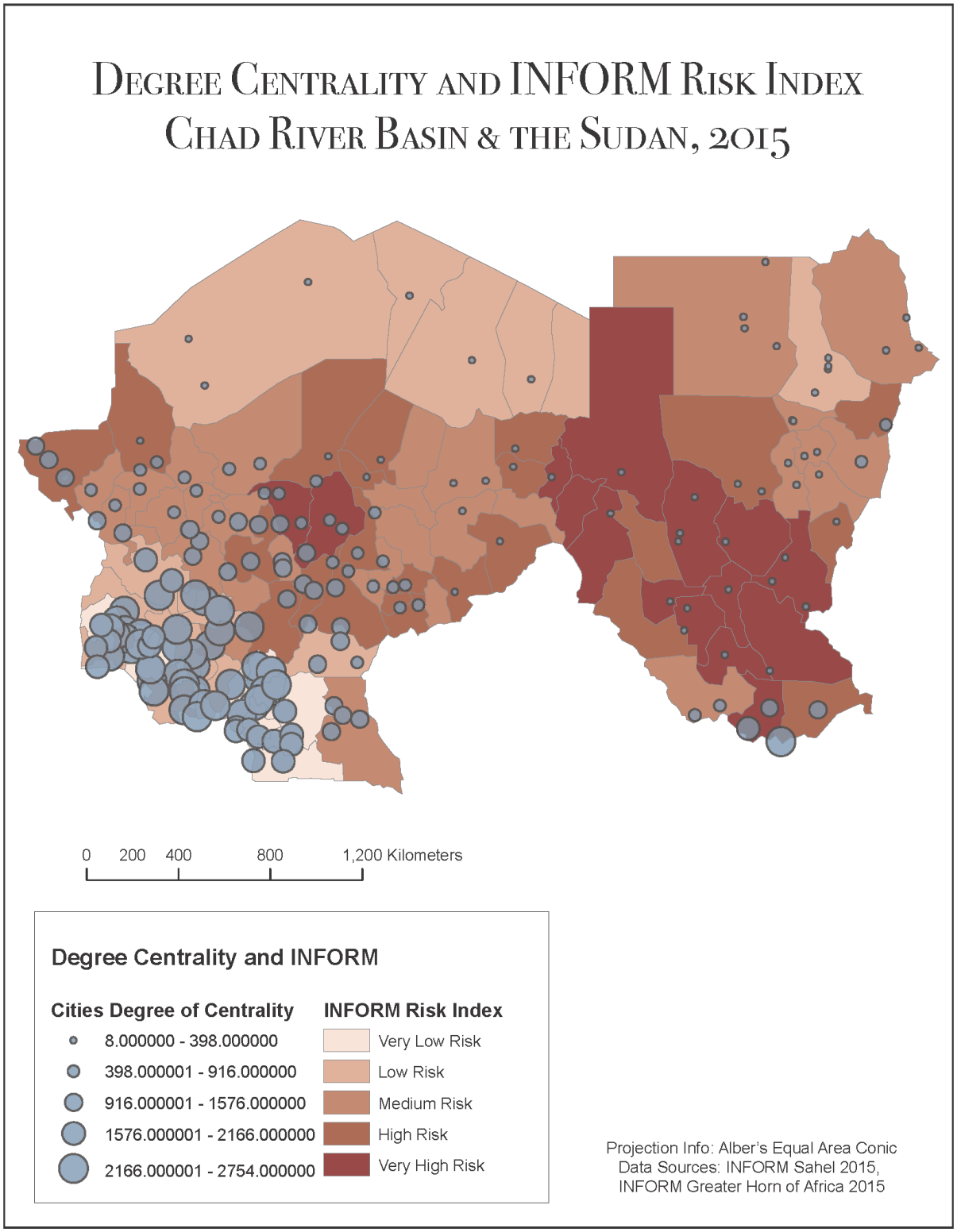
Site Suitability: Conceptualization



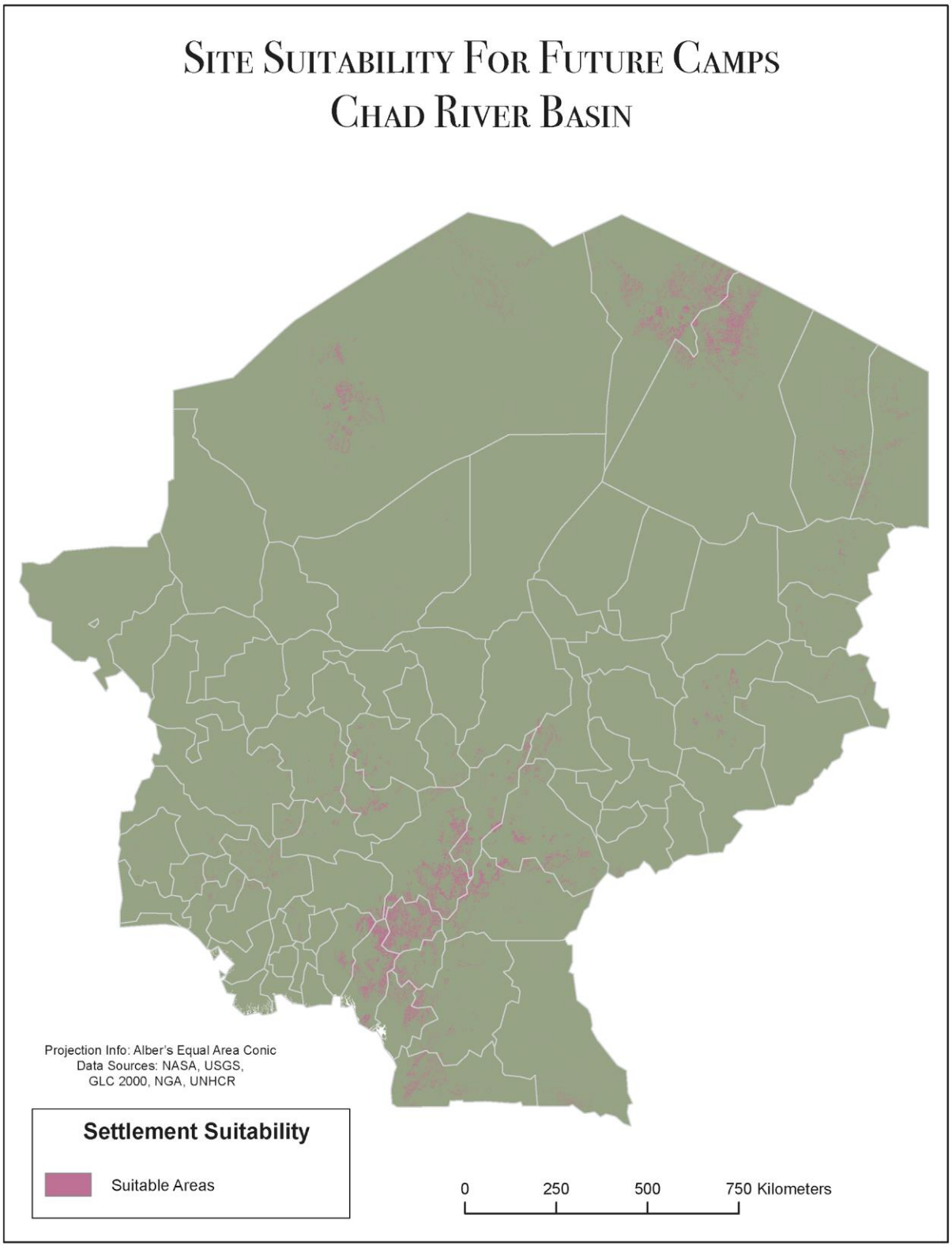


Appendix B: Outputs

Map 1

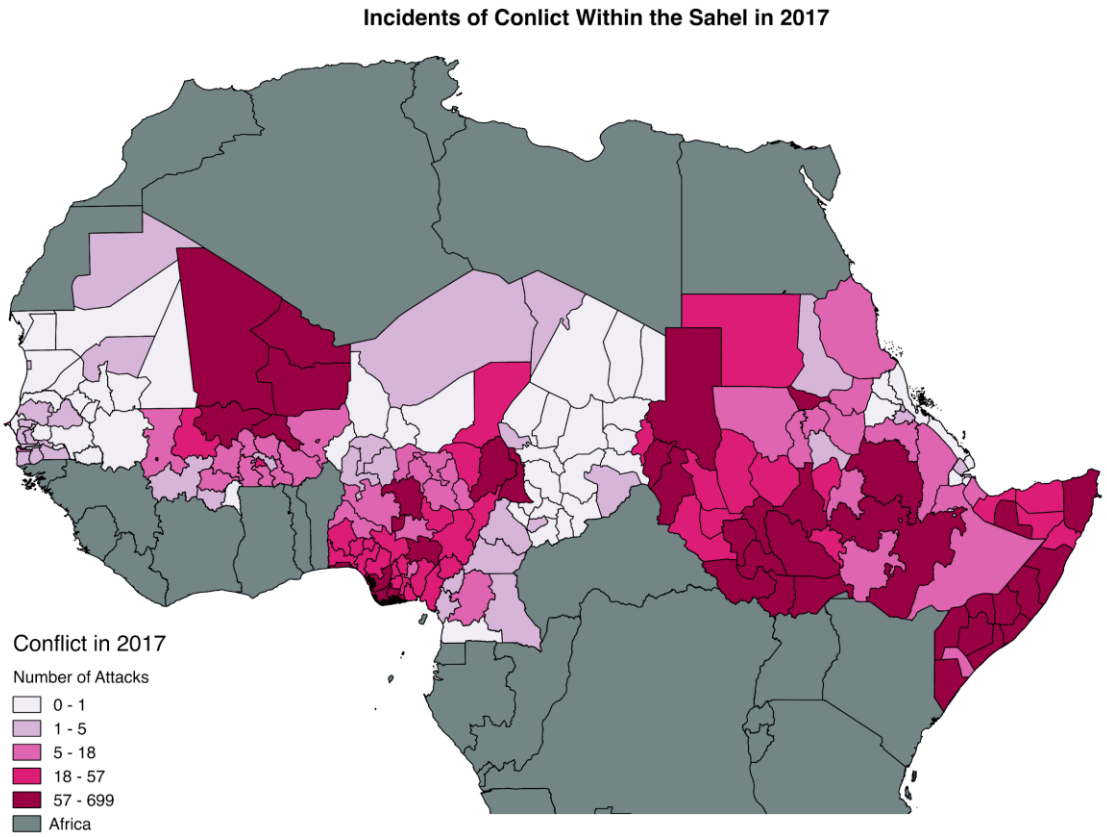

Degree Centrality and INFORM Risk Index
Chad River Basin & the Sudan, 2015
0 200 400 800 1,200 Kilometers
Degree Centrality and INFORM
Cities Degree of Centrality
8.000000 - 398.000000
398.000001 - 916.000000
916.000001 - 1576.000000
1576.000001 - 2166.000000
2166.000001 - 2754.000000
INFORM Risk Index
Very Low Risk
Low Risk
Medium Risk
High Risk
Very High Risk
Projection Info: Alber's Equal Area Conic
Data Sources: INFORM Sahel 2015,
INFORM Greater Horn of Africa 2015

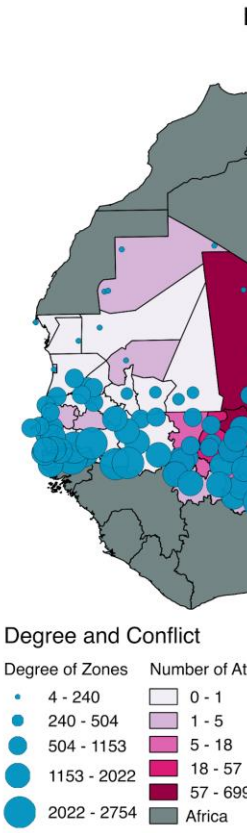
Map 2


Site Suitability For Future Camps
Chad River Basin
Projection Info: Alber's Equal Area Conic
Data Sources: NASA, USGS,
GLC 2000, NGA, UNHCR
Settlement Suitability
Suitable Areas
0
250
500
750 Kilometers

Map 3 &

Map 4


Incidents of Conlict Within the Sahel in 2017
Conflict in 2017
Number of Attacks
0 - 1
1 - 5
5 - 18
18 - 57
57 - 699
Africa


Degree and Conflict
Degree of Zones
4 - 240
240 - 504
504 - 1153
1153 - 2022
2022 - 2754
0 - 1
1 - 5
5 - 18
18 - 57
Africa

Appendix C: Other diagram (figures and maps)

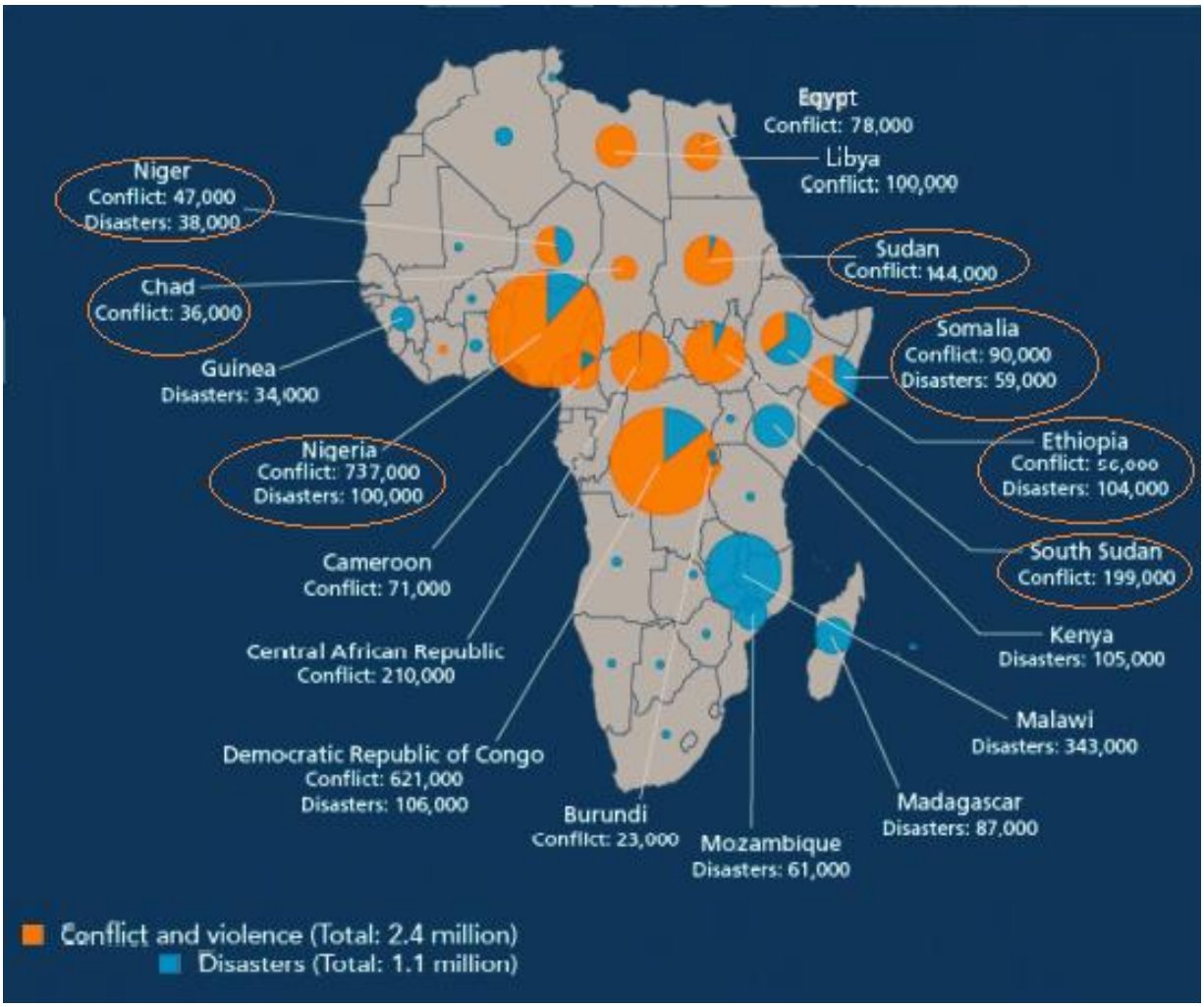


Figure 1: 2017 Map of total number of Internally displaced people due to conflict & violence and disasters in Africa

Data Source: IDP.org

RANKING	COUNTRY	HDI OF 2016
1	**Central Africa Republic**	**0.352**
2	**Niger**	**0.353**
3	**Chad**	**0.396**
4	**Burkina Faso**	**0.402**
5	**Burundi**	**0.420**

Figure 2: Lowest 5 HDI Global HDI Countries

(Source data from HDI Index 2016)

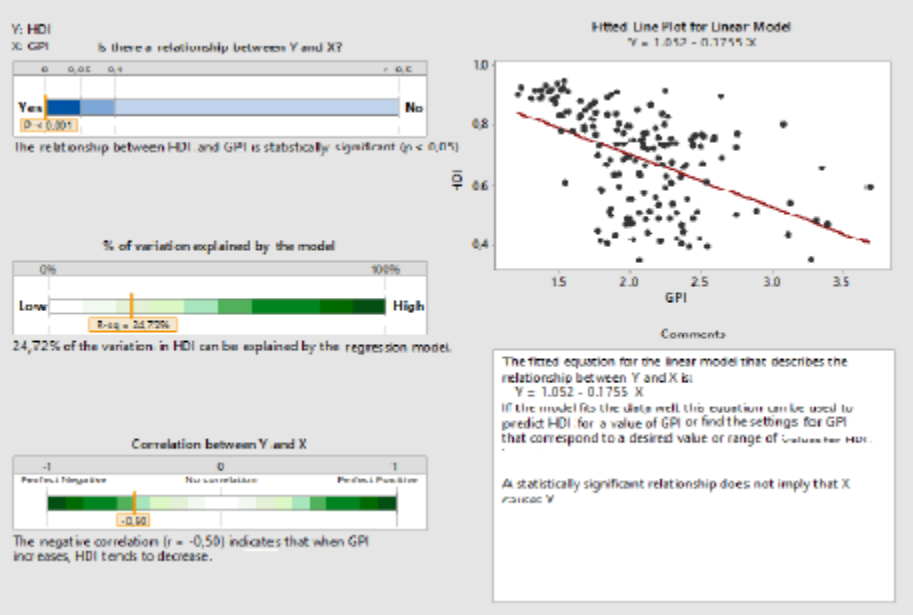


Figure 3: Regression of correlation between HDI and GPI for countries of development levels

Source: Data from ISAE

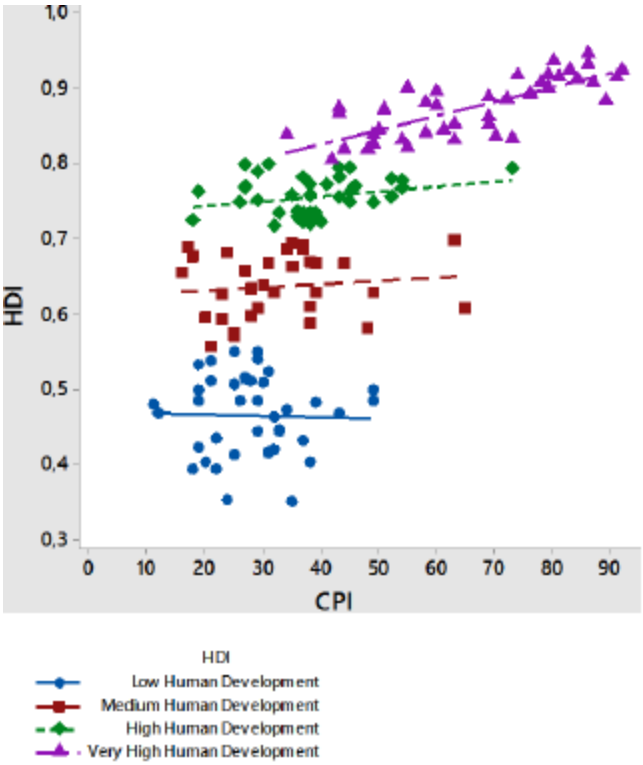


Figure 4: Scatterplot of correlation between HDi and CPI for countries of development levels

Source: Data from ISAE

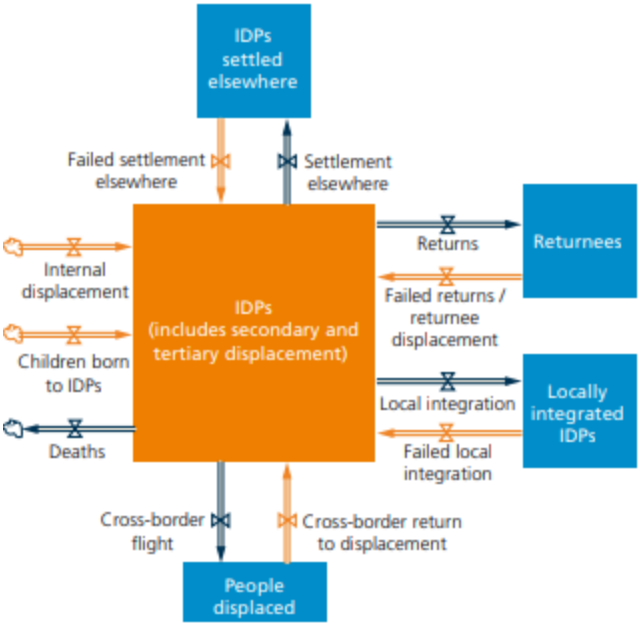


Figure 5: IDP data model depicting different characteristics and sources at different stages

Source: (Internaldisplaced.org)

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