The Use of Geospatial Techniques in Predicting and Monitoring Population Movements in Mogadishu, Somalia

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1. Background

Mogadishu, locally known as *Hamar*, is the capital city of Banadir and is the capital of Somalia. Mogadishu is the most populous city of Somalia, and currently consists of 17 districts. The Banadir population stood at 1.65 million as per the Population Estimation Survey (PESS); its urban population was estimated at 77.6%, while the Internally Displaced Persons (IDP) in camps population was 22.4% (UNFPA, 2014). Mogadishu's population has been on the rise for years. This continuous increase in population can be attributed to 1) changes in administrative divisions leading to expansion of the city, 2) continuous movement of people mainly due to displacement by natural and man-made disasters from the neighboring regions and 3) internal migration from other parts of the country in search of employment. The sharp increase in displacement in Mogadishu is due to lack of security and opportunities (IDMC, 2018). A total of 153,682 individuals were forcefully evicted in Banadir region alone in 2017, it is shown from records that more than 11,000 IDPS are evicted on monthly basis in Banadir (Lüscher, 2019). See Annex 1 for a breakdown of the forced evictions in 2017.

Mogadishu hosts the largest internally displaced population in Somalia, estimated at 33.4%; living mainly in informal IDP sites across the city. This is mainly due to the Somalis from the South and Central part of Somalia flocking to Mogadishu for security and other services (UNFPA, 2014). Existing information on exact locations and site level vulnerabilities is sparse and existing assessments have been ad-hoc and un-harmonized, resulting in low comparability and verification. To date, the IDPs are yet to be categorized into those who have been IDPs for nearly two decades and those displaced more recently. This is important as the needs of the two categories of IDPs vary.

2. Study Area

The study covers Banadir region in Somalia with a focus on two districts, namely; Dayniile and Kaxda. Dayniile is located in the north-western part of Banadir region; neighboring Lower Shabelle region. Kaxda is situated in the western part of Banadir region; also neighboring Lower Shabelle region. Kaxda district was officially formed in 2012. The two districts were found to host the largest number of IDPs in Banadir region, estimated at 220,000 persons (55% of 400,000 IDPs in Banadir region) during the IDP Profiling exercise in 2016 (Lüscher, 2019).

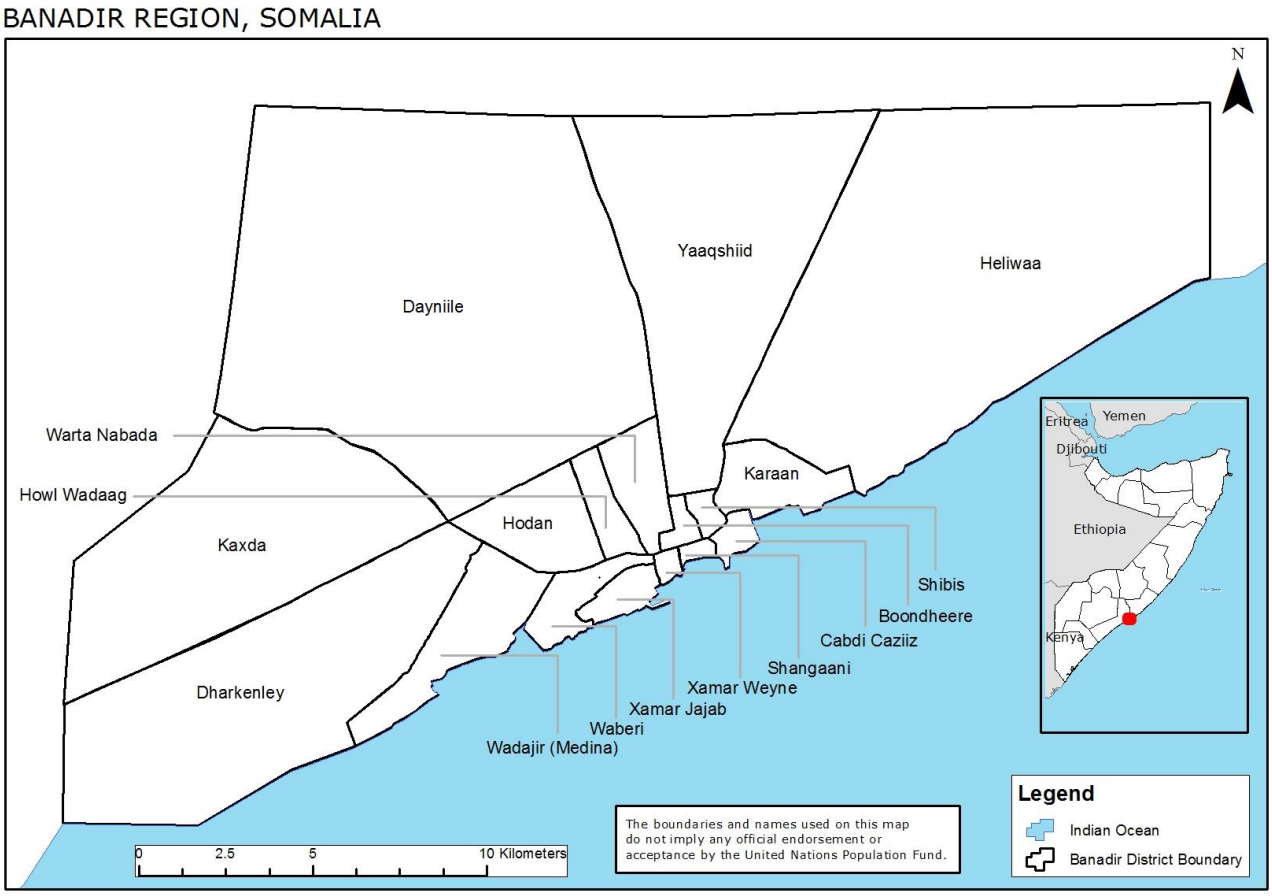

Figure 1: Basemap of Banadir region, Somalia

3. Theoretical Focus

Comparison of population data of different periods/years is of paramount importance in understanding the population change of an area over time. These comparisons facilitate planning for

the implementation of the Sustainable Development Goals and responding to the various humanitarian needs in Somalia. Geospatial technology provides the tools that make the comparisons and analysis of population change faster, easier and better to understand as it provides the spatial component in the analysis. Mogadishu is a volatile city due to the security operations that are ongoing, hence the city exhibits frequent and sporadic population movements. The use of remote sensing and geospatial techniques provides the best tools for prediction of the population and monitoring the population dynamics in Somalia even for areas that are inaccessible due to insecurity. Population of an area can be estimated through the use of satellite imageries where the dwelling units can be estimated from. The population can then be estimated by multiplying the number of dwelling units with the average number of persons living in the dwelling unit. The dwelling unit size (persons-per-dwelling unit) can vary for different categories (Wu, Qiu, & Wang, 2005). Geospatial techniques will thus facilitate faster and continuous updating of the population data which will assist in humanitarian response and implementation of Sustainable Development Goals. Displacement figures fragmented by location and cause help to understand patterns and trends, which helps with providing humanitarian assistance (IDMC, 2018). The objective of this study is to apply geospatial methods in identifying changes in population in Mogadishu, Somalia.

4. Methodology

Enumeration Areas (EAs) were used in analyzing the population change of Mogadishu from 2013 through 2018. An enumeration area is the smallest geographical unit usually allocated to a single enumerator during enumeration. The EAs used in the study contained a minimum of 50 and a maximum of 149 households. A sample of an enumeration area (EA) and dwelling structures (DS) is shown below:

Figure 2: Enumeration Area and Dwelling Structures digitized

The data used in the analysis was obtained from:

1. The Population Estimation Survey of Somalia (PESS) in 2013

   A sampling frame from the survey was used where the initial delineation of EAs in Mogadishu town took place. The enumeration areas were created through delineation on hard copy maps.

2. A Somalia Births and Deaths Survey in 2016

   During this survey the PESS enumeration areas of 2013 were updated through field mapping.

3. The Somali Health and Demographic Survey (SHDS) in 2017/2018

   An updated frame with new delineation of the EAs was created from on-screen digitization of structures using high resolution satellite imagery.

   In the SHDS, satellite image interpretation was applied to ensure all buildings/structures were digitized in Mogadishu. High resolution satellite imageries; World View 1 (spatial resolution of 0.50m), World View 2 (spatial resolution of 0.50m), World View 3 (spatial resolution of 0.31m), and Geo-eye (spatial resolution of 0.50m) were used in the digitization process.

   The digitized structures were then categorized into three types:

Type 1 –Dwelling structures – these are structures that were interpreted as residential structures.

Type 2 – Non-dwelling structures such commercial buildings, government institutions, communal buildings etc.

Type 3 – Internally Displaced Persons (IDPs) shelters

Type 1 and 3 structures were considered as final dwelling structures (DS) and enumeration areas (EAs) were created with a dwelling structure count range of 50 – 149. A spatial join was then carried

out and necessary adjustments of the enumeration areas were done to ensure the EAs had join count range of 50-149.

Using the field knowledge of the staff from the Directorate of National Statistics, Mogadishu, desk verification was carried out to determine the accuracy of the categorization of the structures.

Thereafter, a ground verification and validation in sampled areas was done and further adjustments were made to the sampling frame.

5. Findings

The study showed how the population of Mogadishu has been changing over time. The population change is shown through the increase in the total number of enumeration areas and households in Mogadishu as shown below.

Figure 3: EAs from PESS frame in 2013
1,545 EAs

Figure 4: EAs from revised PESS frame in 2016
1,582 EAs

Figure 5: EAs from SHDS frame 2018
3,021 EAs

In 2013, during the initial mapping of the city for PESS, there were 1,545 enumeration areas with 115,724 households (HHs). Following the field work in sampled EAs for the births and deaths survey in 2016, the number increased to 1,582 enumeration areas with 144,756 HHs. In the Somali Health and Demographic Survey, a total of 3,021 enumeration areas were digitized which had 227,986 dwelling structures; this was used as a proxy for households in the survey. This constitutes an almost two-fold increase in the enumeration areas from 2013 to 2018. A further look into this increase at EA level brings to light the inter-district differences that caused it.

Furthermore, in mid-2019, 65,231 IDP shelters were digitized using satellite imagery acquired in December 2018. From 65,231 IDP shelters digitized, 62,050 fell in Dayniile and Kaxda which represents 95% of the total number of IDP shelters. 2,071 and 1,110 IDP shelters fell in Hodan and Dharkenley districts respectively which border Kaxda and Dayniile districts.

5.1 Dayniile District

EA 0571 in Dayniile district was created in 2017 for the SHDS. At the time of digitization, the EA had 140 dwelling structures. Following the household listing exercise in mid-2018, the EA had 599 households, resulting in its further delineation into five EAs each in the range of 50-149 households. A comparison of satellite imagery from 2017 (date of imagery acquisition January 2017) and 2018 (date of listing May 2018) showed that this increase was due to the increase of dwelling structures in the enumeration areas as shown below. In 2013, this EA was part of two EAs in the PESS frame and the area had an estimated number of 161 dwelling structures based on satellite imagery from May, 2013. The sudden spike in population is due to the influx of IDPs into the EA.

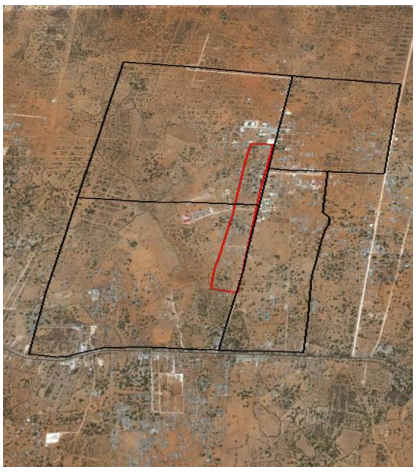

Figure 6: Dayniile EA 0571
161 DS in 2013

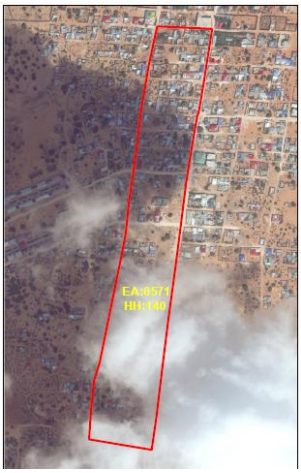

Figure 7: Dayniile EA 0571
140 DS in 2017

Figure 8: Dayniile EA 0571
599 HHs 2018

The movements of IDPs can be seen from satellite imageries dated January 2017 where there were no IDP shelters and in May 2017 IDP shelters can be seen as shown below by the areas within the orange circle.

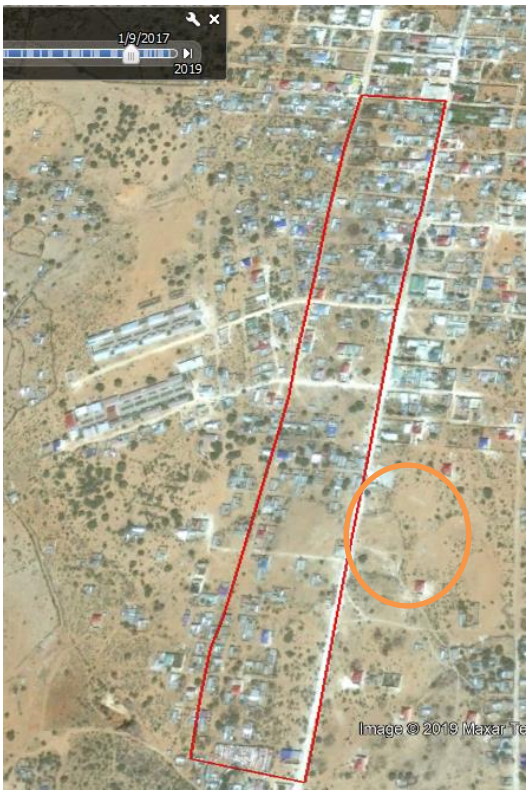

Figure 9: EA 571 in January 2017

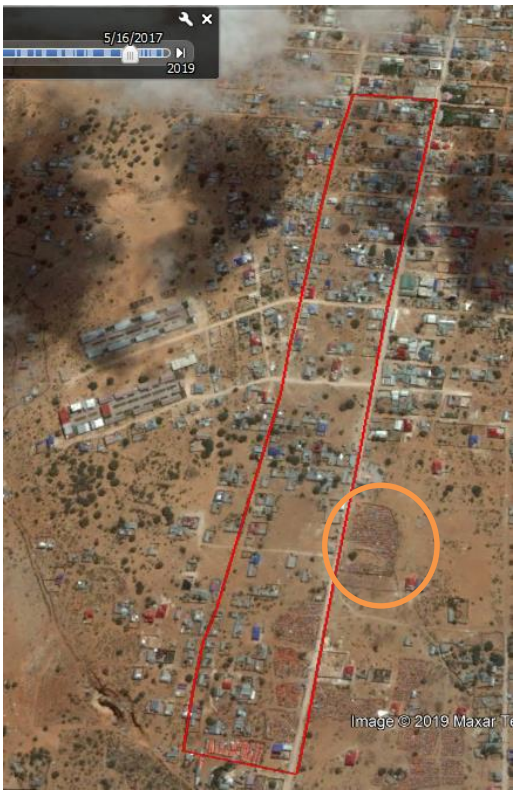

Figure 10: EA 571 in May 2017

5.2 Kaxda District

EA 0252 in Kaxda district also saw a spike in household counts between digitization (end 2017) and listing (2018). A visual comparison of the satellite imagery in the different periods clearly shows an increase in the number of dwelling structures as shown below.

Figure 11: Kaxda EA 0252
March 2013

Figure 12: Kaxda EA 0252
January 2017

Figure 13: Kaxda EA 0252
December 2018

The EA initially merely had 66 dwelling structures during digitization in 2017. However, during the field work, enumerators reported that the EA now had a total of 3,895 households. The influx of IDPs into the EA caused the unprecedented increase in population in the EA as can be seen in figure 12 above.

The eviction of the IDPs in December 2017 can also be seen from satellite imageries acquired in May 2017 and late December 2017. It can be seen that the area left of EA 0252 which had been occupied by IDPs was cleared by end of December 2017 as highlighted in yellow below.

Figure 14: May 2017

Figure 15: December 2017

6. Conclusions and Recommendations

The analysis has shown that the region exhibits frequent and sporadic population movements. From the study it can be concluded that high resolution satellite imageries are indeed cost-effective way of monitoring populations which are volatile as well as provide an estimation for areas that may be not accessible. It was also clear that the development of any dwelling structures' sampling frame needs to be accompanied by field verification.

For a dynamic city such as Mogadishu, regular monitoring of the area using high resolution imagery is required to track population movements. The digitized data from the high resolution satellite imageries can be used to estimate the population of the IDPs by the government as well as facilitate efficient delivery of humanitarian support.

Annex 1

Table 1: IDP forced evictions in Kaxda and Dayniile districts in December 2017 (Lüscher, T. F. (2019)

No	Settlement type	Name of settlement	Location/District	# households evicted	# people evicted	Date of incident	Current location
1	Xaq-Dhowr Center	Maqsuud camp Al-xamdulilaah camp Arbow Eerow Nassib camp Kerow camp Sabiib camp Subagle camp	Km 13 village of Kaxda District	2700	16200	29-30 Dec 2017	Adjacent the destroyed site, Deynille and Various location
2	Umbrella Deeqo	Deeqo Camp Fatxi Camp	Km 13 village of Kaxda District	227	1362	29-30 Dec 2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
3	Umbrella Samafale	Dul-midiid camp Suldaan camp Danyar camp Xayi camp	Km 13 village of Kaxda district	246	1476	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
4	Horumar camp	Horumar camp	Km 13 village of Kaxda district	51	306	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
5	Nurto 2 Camp	Nuurto2	Km 13 village of Kaxda district	500	3000	29 to 30 Dec 2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
6	Ceel-Garas Camp	Ceel-Garas	Km 13 village of Kaxda district	250	1500		Adjacent the destroyed site, Deynille,Kaxda
7	Umbrella Talowadaag	Ciil iyo Calaf Saa'id camp Aliyaale camp Basra camp	Km 13 village of Kaxda district	364	2076	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
8	Umbrella Masha'alaah CentreE	Masha'alaah Dooy-Gaab Awbeele Beerley	Waydow settlement in Garas	450	2700	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
9	Anfac IDP camp	Anfac	Waydow settlement in Garas	120	720	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
10	Bishaar Umbrella	Macaane	Waydow settlement in Garas-Balay of Kaxda district	480	2880	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location

No	Settlement type	Name of settlement	Location/District	# households evicted	# people evicted	Date of incident	Current location
		Rooble Bootis Casharo Bishaar					
11	Galoolshe camp	Galoolshe	Waydow settlement in Garas-Balay of Kaxda district	71	426	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
12	Rowdo	Rowdo	Waydow settlement in Garas-Balay of Kaxda district	180	1080	29-30 Dec,2017	Adjacent the destroyed site, Deynille,Kaxda and Various location
13	Bulsho-Kaab	Bu-lsho-Kaab	Waydow Deynile district	110	660	29-30 Dec,2017	Deynille
14	Host communities closed near Sama-Fale umbrella	Host communities	Waydow Deynile district	58	348	29-30 Dec,2017	Kaxda District
			TOTAL	**5,807**	**34,734**		

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