Area-based sampling for an epidemiological study on injury patterns and risk factors in a low-income urban setting in sub Saharan Africa

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Abstract

The following paper is intended to document an area-based sampling method designed to facilitate a an epidemiological study to examine injury patterns among children and adolescents in Dar es Salaam, Tanzania. We used official census data and geographic information system software to create a series of area maps for Dar es Salaam city. Then, based on these maps, we identified population clusters for sampling based on area population density.

Background

Unintentional injuries represent an important health threat to the lives of children and adolescents world-wide. The epidemic of injury and resulting harm such as disability or death, are likely to be the most severe in the low- and middle-income countries of the African continent. In 2001, approximately 20% of all recorded deaths on the African continent were among children under the age of 5, and over 40% of these deaths occurred in Sub Sarahan Africa (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Among all age groups in Sub Saharan Africa, injuries are the third leading cause of death (C Moshiro, Mswia, Alberti, Whiting, & Unwin, 2001).

In Tanzania prevalence patterns has been a subject of investigation in recent years. The overall incidence of injuries in Tanzania is estimated at 32.7 per 1000 per year of which 96% are unintentional (WHO, 2005). A recent study compared injury patterns for all age groups in Dar es Salaam (DES) city (urban), Hai (rural), and Morogoro (rural) districts of Tanzania between 1992 to 1998. In urban DES, transport injuries n=68 (206 total injury cases) were the leading cause of nonfatal injury with males and females being roughly equally represented in the numbers of those injured. The balance of these injuries (n=138) were categorized as falls n=56; cuts/stabs n=38; struck by object n=12; animal bites n=4; assault n=7; and other n=9 (Candida Moshiro et al., 2005). The Moshiro (2005) study analyzed injury records of 8,188 surveyed individuals in DES the study had a response rate of 89%,. The findings from this study indicated that burns were the most common injuries among younger children in urban settings ages 0-5 (35%). Falls were reported for the age groups 0-4 (30%) and 5-14 (40%) respectively, as being more likely to occur in and around homes in urban areas.

Children between the ages of 5 and 14 were less likely to sustain traffic related injuries when compared to those between the ages of 15 and 44. Other studies document the high injury risks experienced by children in Tanzania generally. Dental trauma (Kahabuka & Mugonzibwa, 2009) and eye injuries

(Mselle, 1998) are known to be contributors to the overall injury burden in children ages 0-15. Children aged 0-15 represented 44% (n=114) of all eye injury patients (n=257) admitted for treatment at the Muhimbili Medical Centre between January 1993 and January 1994. The literature shows that most injuries occurring among Tanzania's children are unintentional and preventable. The evidence from these studies indicate a need for investigations centered around children's environments, to better understand injury risks to Tanzanians from infancy through age 18 years.

In 2009 a cross-sectional epidemiological study designed to investigate injury patterns among children and adolescents in DES was carried out. As DES did not have a well-developed system for systematically demarcating populations, such as a postal code system, we devised an alternative system using census data and geographic information tools. The aim of the present paper was to describe the method and procedures employed in reaching a representative population sample using an area-based sampling method.

Method

Setting

The procedures carried out in this paper were based on information obtained from official sources in the United Republic of Tanzania. The country has a population of approximately 34.4 million people with approximately 77% resiging in rural areas. DES is a major commercial city the former capitol of the East African nation. It is a coastal city having a total area of 1,393 km2 which is divided into three districts (Ilala, Temeke and Kinondoni). These districts are further subdivided into 72 wards.

As of the latest census report, the city had a population of approximately 3.5 million people with roughly 33% being under the age of 14 years (Kamala, Wilson, & Hasselberg, 2011).

Sample size calculation

Using Stata 10, a power of 80% was selected to detect as significantly different from the null hypothesis (1.0), an adjusted odds ratio of 2.5 for the association between injury risk and the demographic and socio-economic exposures. Assuming a 5% incidence of all cause childhood injury (ages 0-18) (Candida Moshiro et al., 2005), the unit sample size with 80% power of the two-tailed test at 0.05 level of significance was calculated to be 1,968 households. Thus approximately 2,000 households were needed to fulfill the sample size requirements for the overall study.

Ward selection and sampling procedure

We utilized a stratified random cluster sampling method to identify seven contiguous zones within the greater DES region. The sample units used for all calculations were households having at least one child aged 0-18 years. Demographic data on ward population densities and sizes were obtained from the 2002 Tanzanian Census (CENSUS, 2006). This information was used to facilitate the development of maps characterizing each ward within the Dar es Salaam region. The general procedures are described elsewhere (Kamala et al., 2011). Briefly, one map with all wards was created using the geographic information system package ArcGIS 9.2. From this map, DES was divided into six contiguous zones based on incremental distances from the city's central business district.

A computer-assisted random sampling of 17 wards was obtained to be used in the study. A proportional sample of households were chosen from each ward. This was equal to 1.1% of the total number of households in each of the selected wards. This yielded a total of 2, 131 households. Two wards were removed due to demographic and structural similarities with other wards, this resulted in a final sample of 2,007 households selected for visitation.

Results

Table 1 provides information on all of the wards which were included in the original selection. The
wards which were removed have been identified with NS. The results of the sampling process are
illustrated in Figures 1-12.

Table 1: Selected wards during the initial ward selection procedure

Ward name	Ward type	Number of households per ward	Number of households selected*
Kigamboni	Urban	8 858	97
Ukonga	Urban	16 752	184
Vijibweni[NS]	Rural	1 287	14
Ndugumbi	Urban	9 351	103
Somangira	Rural	2 725	30
Charambe	Urban	19 849	218
Manzese	Urban	17 685	195
Kawe	Urban	21 478	236
Kunduchi	Mixed	16 885	186
Kurasini	Urban	8 331	92
Azimio	Urban	15 692	172
Sandali[NS]	Urban	9 885	109
Segerea	Urban	16 130	177
Chanika	Mixed	6 004	66
Pemba Mnazi	Rural	1 199	13
Kimara	Urban	14 328	158
Mbezi	Mixed	7 290	80

*=1.1% of the total number of households per ward.
NS=Wards which were not included in the final sample

Discussion

The sampling method described may prove useful in the design and implementation of future
population-based studies where the identification of households by addresses or other criteria is
difficult.

References

CENSUS. (2006). *Tanzania 2002 Census Analytical Report - Dar es Salaam*. National Bureau of Statistics, Ministry of Planning, Economy and Empowerment.

Kahabuka, F. K., & Mugonzibwa, E. A. (2009). Risk factors for injuries to maxillary permanent incisors and upper lip among schoolchildren in Dar es Salaam, Tanzania. *International Journal of Paediatric Dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children*, *19*(2), 148–154. doi:10.1111/j.1365-263X.2008.00930.x

Kamala, B., Wilson, M. L., & Hasselberg, M. (2011). Pattern of childhood falls in a low-income setting: a cross-sectional study in Dar es Salaam. *International Journal of Injury Control and Safety Promotion*, *18*(4), 305–311. doi:10.1080/17457300.2011.581376

Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T., & Murray, C. J. L. (2006). Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *Lancet*, *367*(9524), 1747–1757. doi:10.1016/S0140-6736(06)68770-9

Moshiro, Candida, Heuch, I., Astrøm, A. N., Setel, P., Hemed, Y., & Kvåle, G. (2005). Injury morbidity in an urban and a rural area in Tanzania: an epidemiological survey. *BMC Public Health*, *5*, 11. doi:10.1186/1471-2458-5-11

Moshiro, C, Mswia, R., Alberti, K. G., Whiting, D. R., & Unwin, N. (2001). The importance of injury as a cause of death in sub-Saharan Africa: results of a community-based study in Tanzania. *Public Health*, *115*(2), 96–102. doi:10.1038/sj/ph/1900725

Mselle, J. (1998). Visual impact of using traditional medicine on the injured eye in Africa. *Acta tropica*, *70*(2), 185–192.

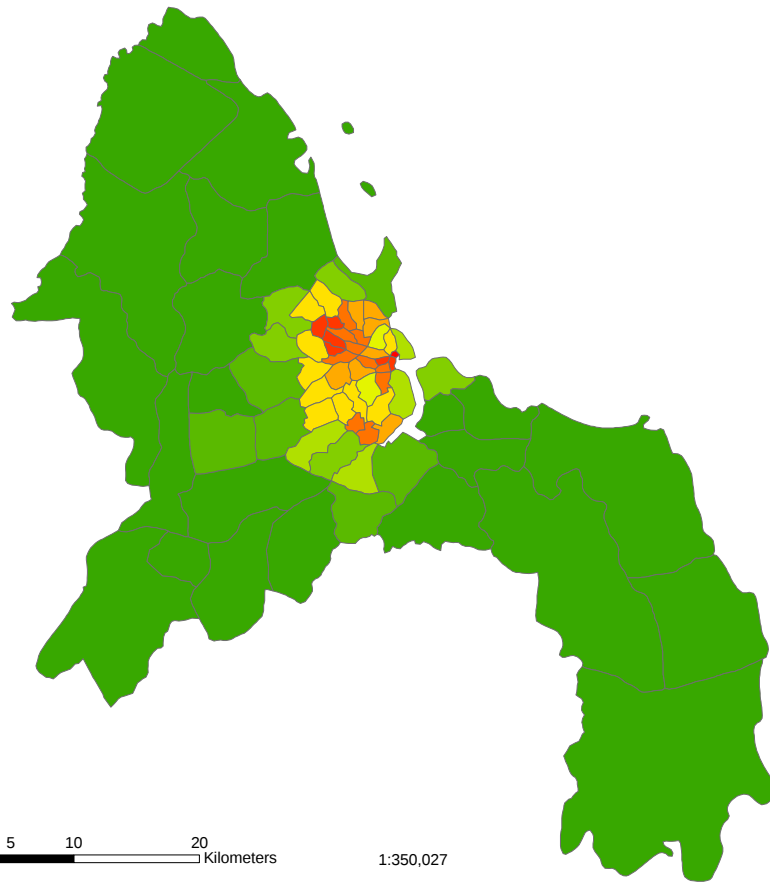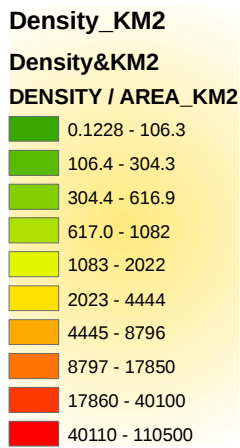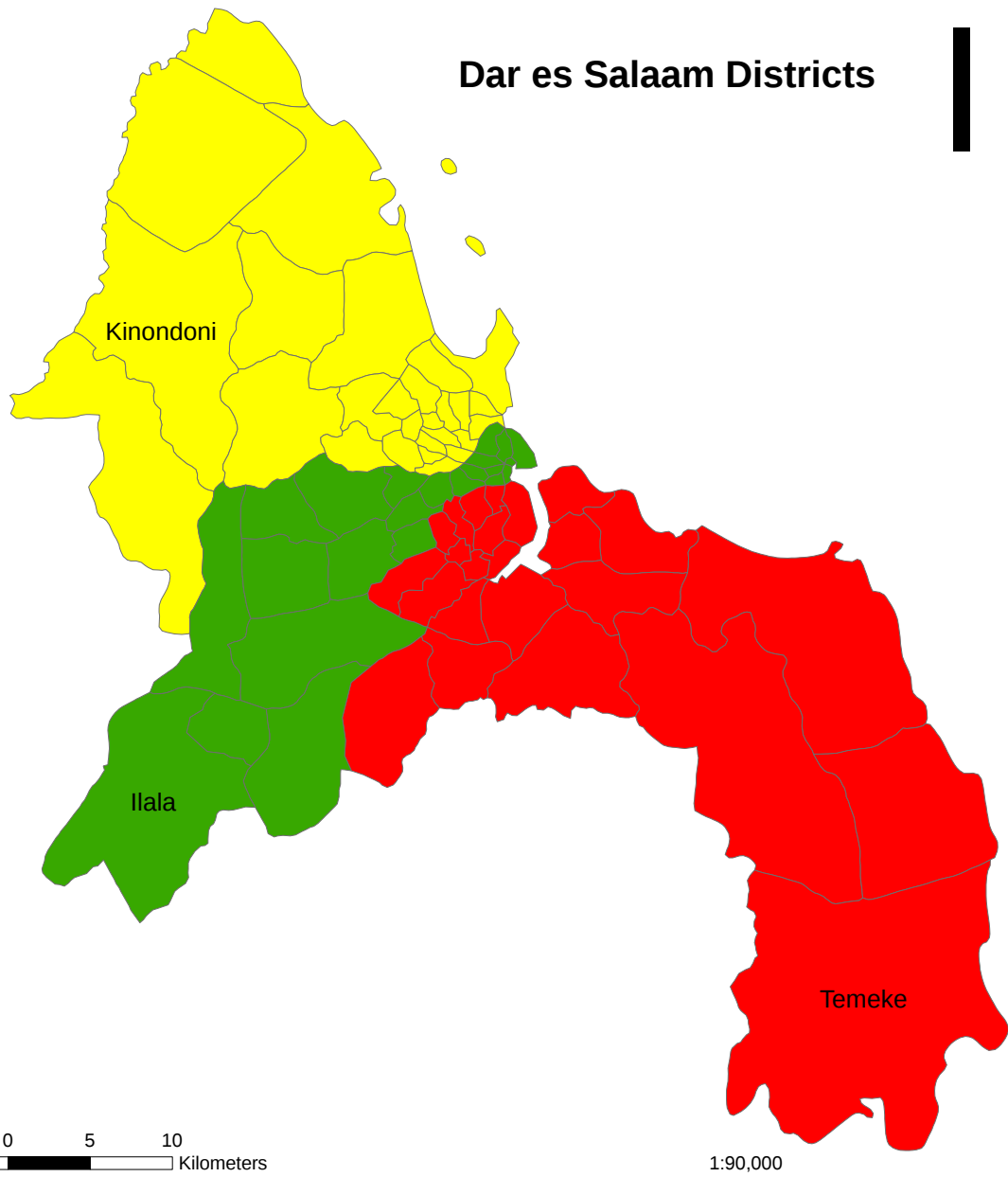**Figure 1 Dar es Salaam population density per square kilometer**

Density_KM2

Density&KM2

DENSITY / AREA_KM2

- 0.1228 - 106.3
- 106.4 - 304.3
- 304.4 - 616.9
- 617.0 - 1082
- 1083 - 2022
- 2023 - 4444
- 4445 - 8796
- 8797 - 17850
- 17860 - 40100
- 40110 - 110500

0   5   10   20
                        Kilometers   1:350,027

Figure 2 Dar es Salaam Districts

Dar es Salaam Districts

Kinondoni

Ilala

Temeke

5 2.5 0   5   10
                        Kilometers

1:90,000

Figure 3 Dar es Salaam wards
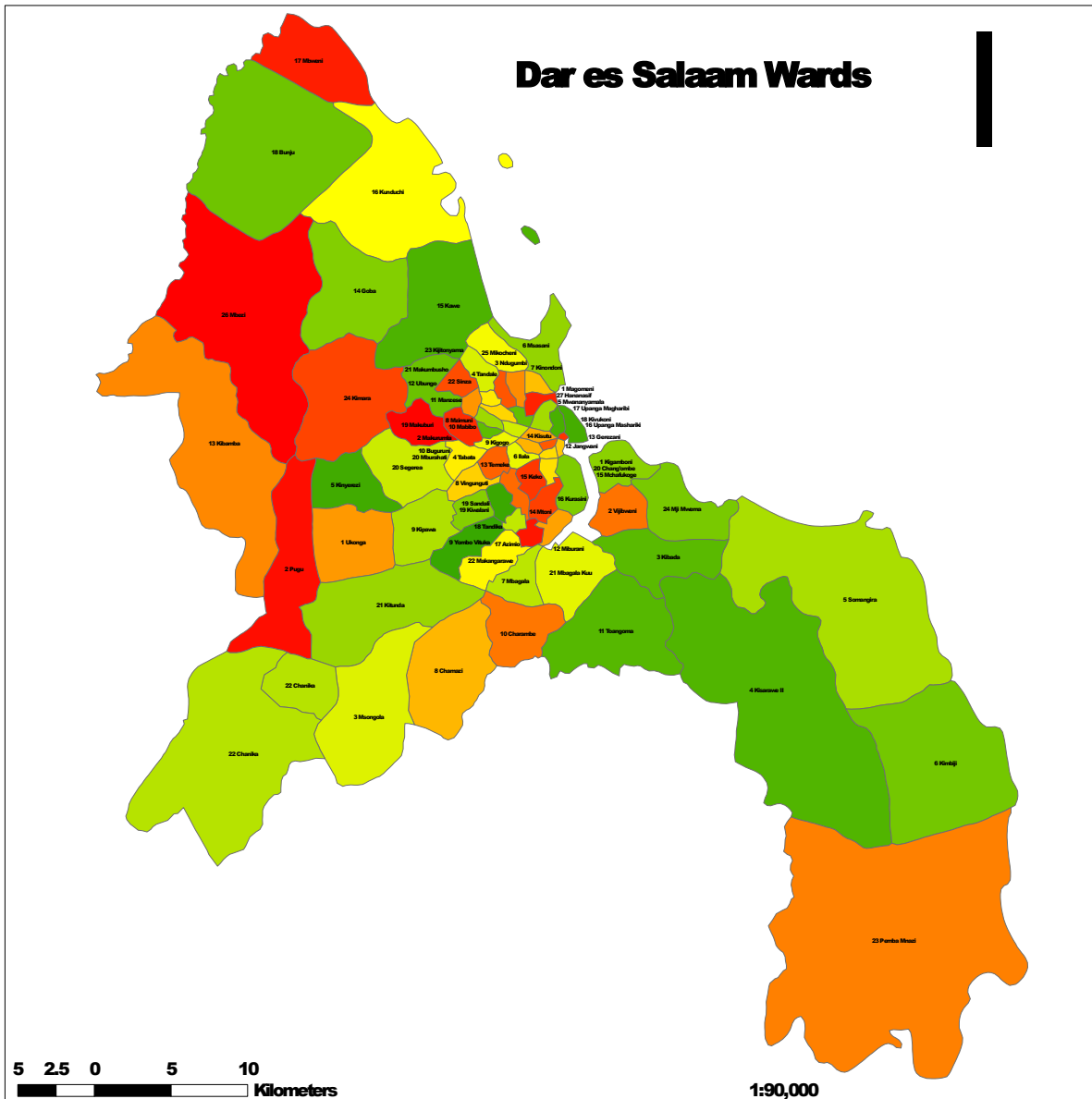
Figure 4 Dar es Salaam wards (inner city)
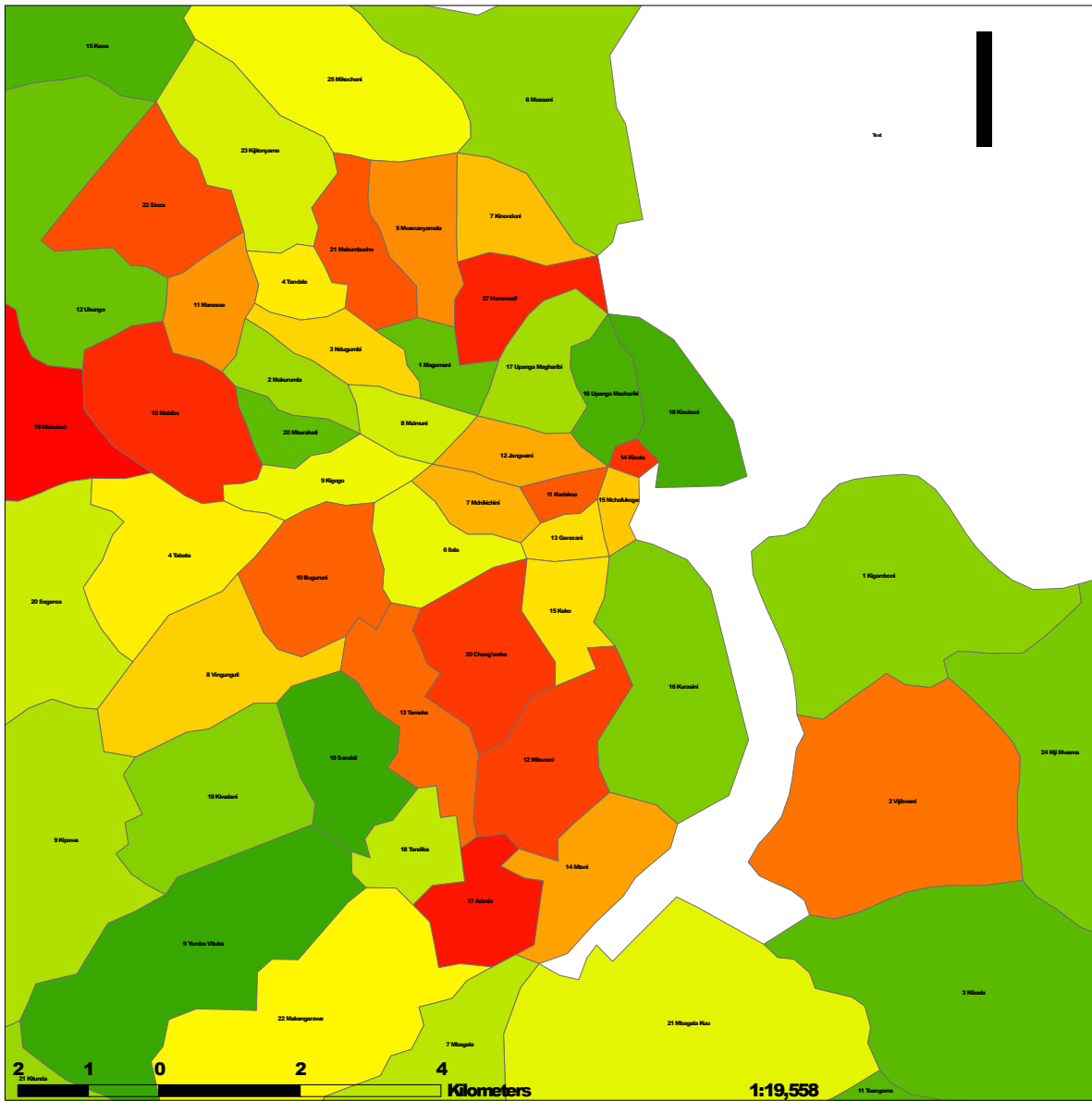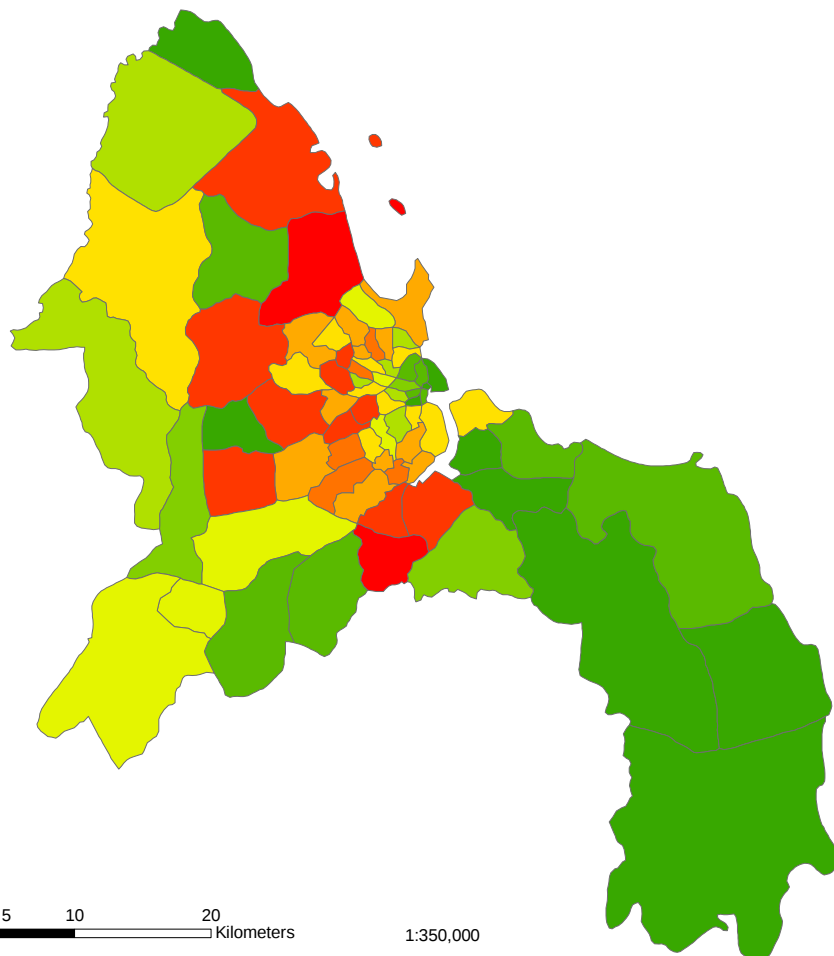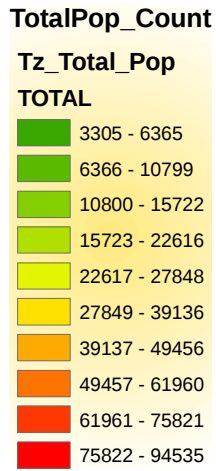
Figure 5 Dar es Salaam total population count by ward

TotalPop_Count

Tz_Total_Pop
TOTAL

- 3305 - 6365
- 6366 - 10799
- 10800 - 15722
- 15723 - 22616
- 22617 - 27848
- 27849 - 39136
- 39137 - 49456
- 49457 - 61960
- 61961 - 75821
- 75822 - 94535

0   5   10   20
                              Kilometers

1:350,000

Figure 6 Dar es Salaam population density by ward

Miles

0   2   4   8   12

Dar es Salaam, Tanzania
Population Density by Ward

Tz_wards_2002

☐	25.24 - 251.18
☐	251.19 - 556.42
☐	556.43 - 2331.89
☐	2331.90 - 4756.40
☐	4756.41 - 6838.65
☐	6838.66 - 10158.50
☐	10158.51 - 14460.38
☐	14460.39 - 22048.98
☐	22048.99 - 27936.99
☐	27937.00 - 42507.55
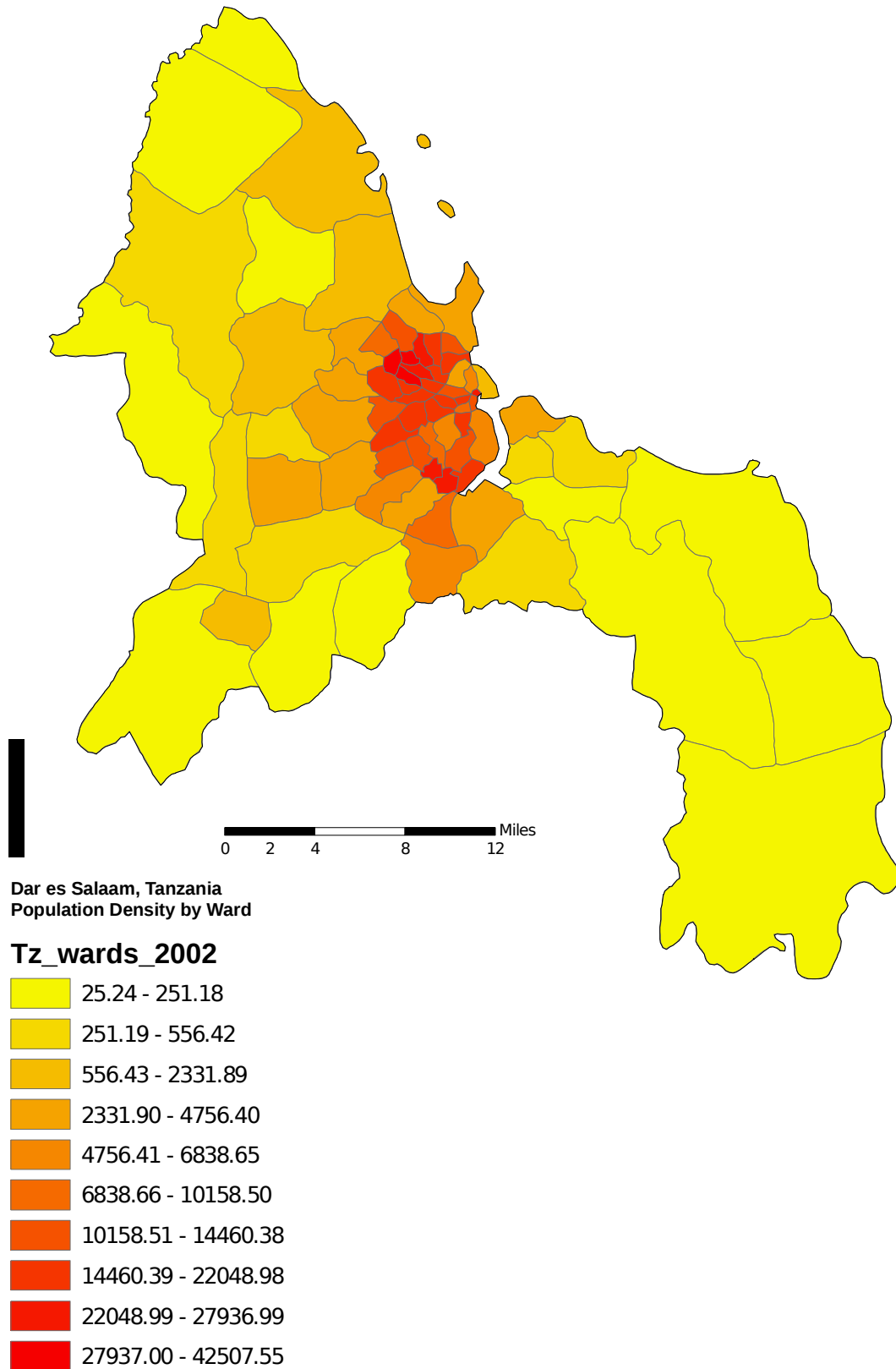
Figure 7 Dar es Salaam average household size by ward
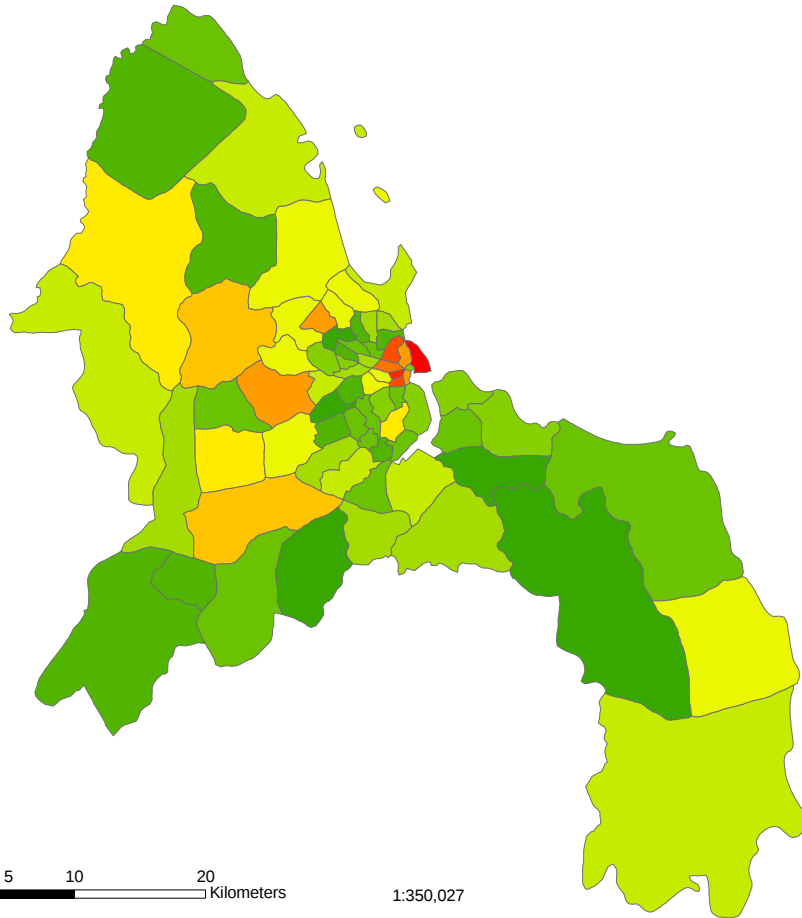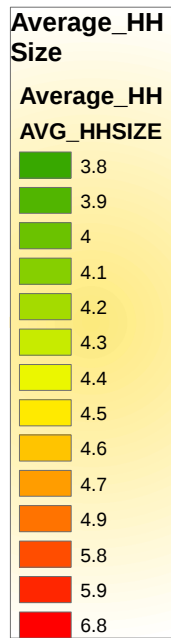
Figure 8 Dar es Salaam actual household counts

House Holds

Tz_wards_HHNO
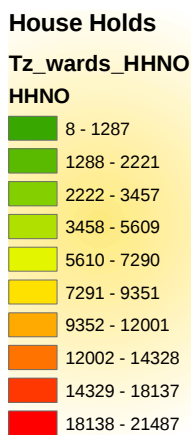
HHNO

- 8 - 1287
- 1288 - 2221
- 2222 - 3457
- 3458 - 5609
- 5610 - 7290
- 7291 - 9351
- 9352 - 12001
- 12002 - 14328
- 14329 - 18137
- 18138 - 21487

0   5   10   20
                              Kilometers   1:350,000
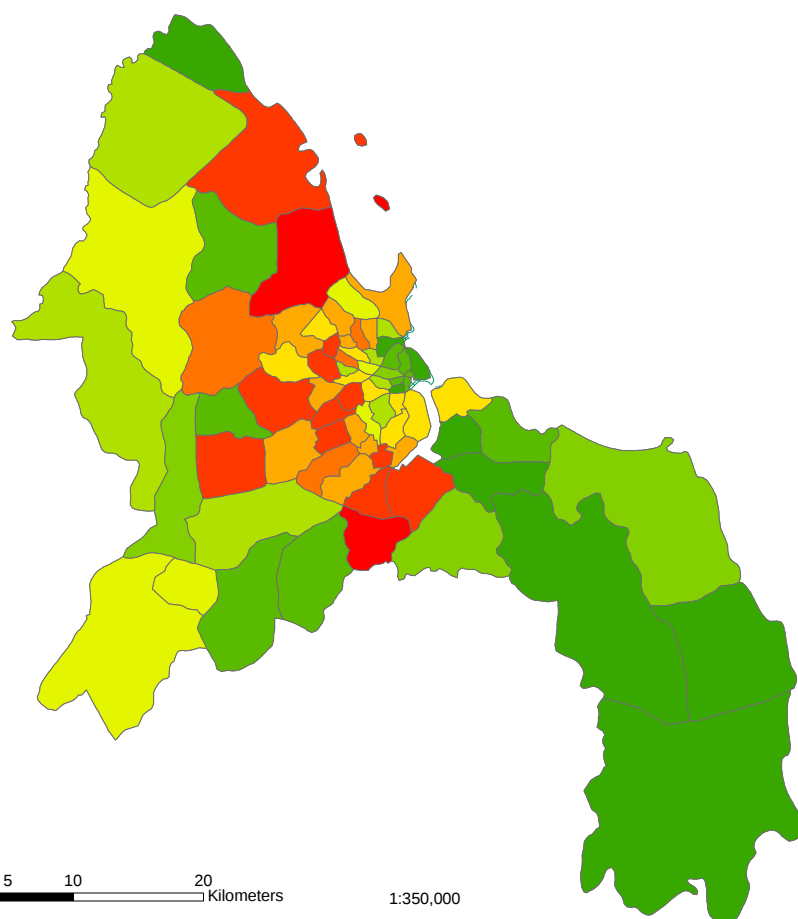
Figure 9 Dar es Salaam female population actual count

Female_Count

Tz_wards_Female
FEMALE

- 1610 - 2844
- 2845 - 5200
- 5201 - 8834
- 8835 - 11816
- 11817 - 15050
- 15051 - 19143
- 19144 - 22585
- 22586 - 27433
- 27434 - 37988
- 37989 - 46477

0   5   10   20
                  Kilometers

1:350,000
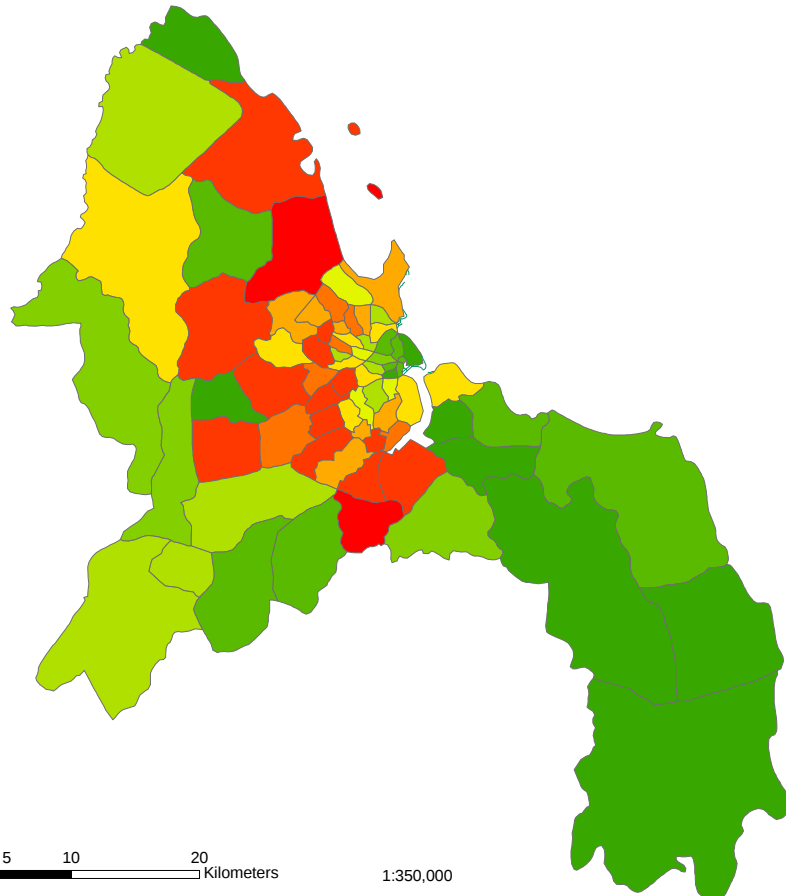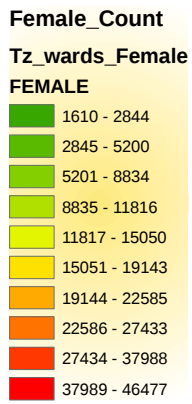
Figure 10 Dar es Salaam male population actual count

Male_Count

Tz_wards_Male
MALE

- 1597 - 3418
- 3419 - 5599
- 5600 - 9164
- 9165 - 11634
- 11635 - 14040
- 14041 - 19282
- 19283 - 23588
- 23589 - 28269
- 28270 - 35455
- 35456 - 48058

0   5   10   20
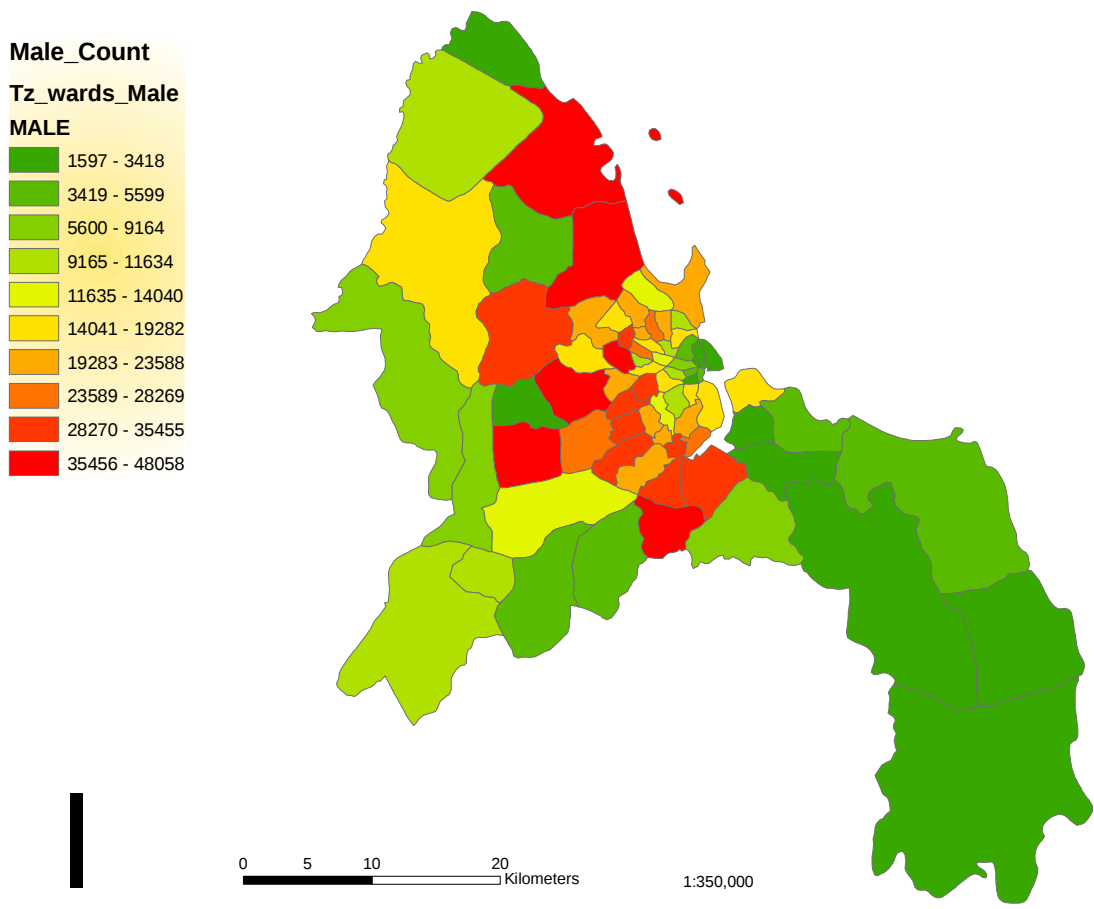Kilometers   1:350,000
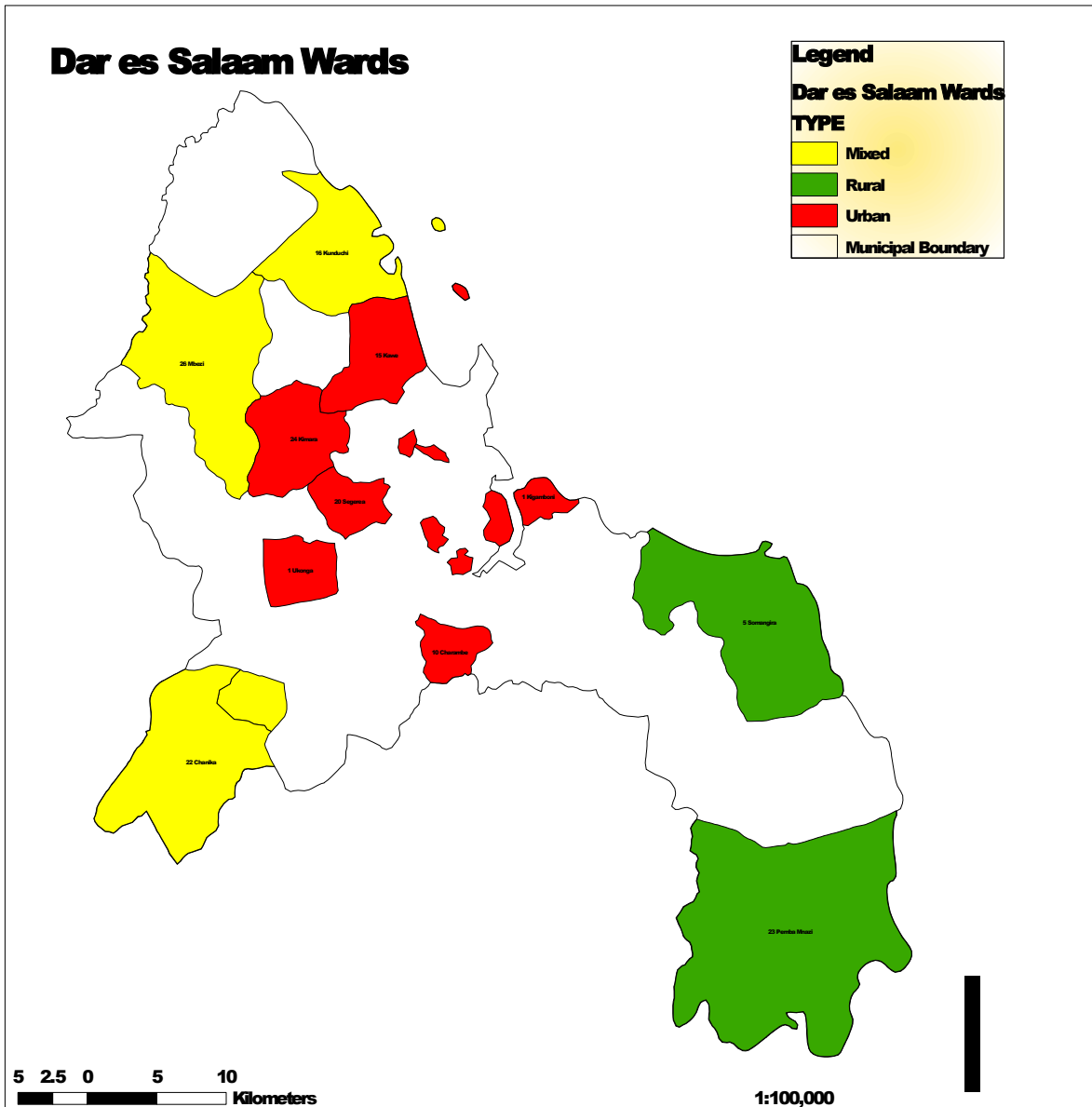
Figure 11 Initial selection of wards in Dar es Salaam

Figure 12 Dar es Salaam zone and ward selection