Lesson 3 Population Distribution

Aynalem Adugna, March 2017

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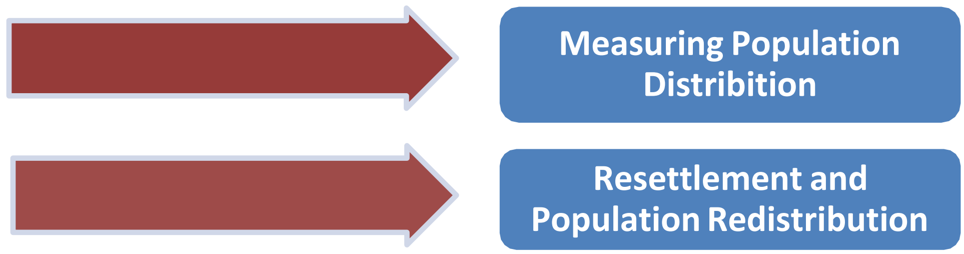
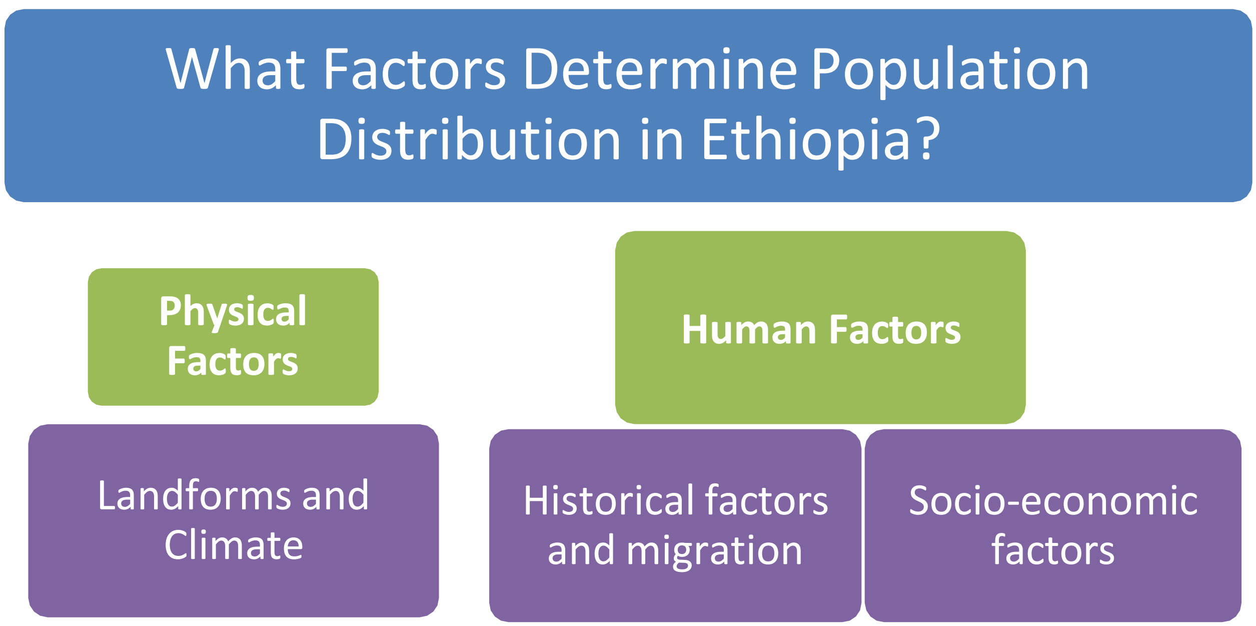
Learning Objectives





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Population distribution

Introduction: Population Size

A live, minute-by-minute update for all countries of the world puts Ethiopia's March 2017 population size at just over **103,640,549** [1a]. Another website provides the percentage breakdown of regional population sizes as follows [1b]:

Percentage Distribution of Regional Populations, 2015

Oromia	Amhara	SNNPR	Somali	Tigray	Addis Ababa	Afar	Ben-Gum	Dire Dawa	Gambela	Harari
37.5%	22.7%	20.3%	6.1%	5.6%	3.6%	1.9%	1.1%	0.5%	0.5%	0.3%

The total size of a population is the first and most important information kept by governments. In all countries of the world population data are needed:

- for fiscal and military purposes,
- in apportionment of representatives in a legislative body,
- to study population movements,
- to determine the existing population-resource balance/imbalance, and
- to make sensible projections for the future.

Information on the **total** population of a country is not sufficient, however. Data are often needed for geographic subdivisions by province, county, and district, zone, etc.

Populations are rarely evenly distributed across geographic subdivisions. Data on sub-national geographies allow analyses of distributional variations across sections of a given country or geographical sub-unit. Moreover, urban centers have a much higher concentration of population than the same area of land in rural villages. This makes the rural urban dichotomy very important for distributional analysis of populations in addition to geographical or political subdivisions of countries. However, the term "urban" does not mean the same thing everywhere even though it is defined almost always on the basis of the size of the resident population.

It is difficult to generalize the population distribution patterns for a country the size of Ethiopia with diverse topography, climate, and settlement history. Moreover, since population distribution patterns are partly a reflection of government policies and programs, similar socio-economic environments could produce very dissimilar population patterns. An excellent example is the government policy actions towards nomadic populations, which included extreme measures ranging from no intervention of any kind to forcing nomads to become settled agriculturalists.

Another example is the socialist collectivization and resettlement conducted by the defunct Derg government. In just three years (1985 to 1988) 12 million people had been moved to a different location, some just a few hundred meters away, to form socialist agricultural communes [2].

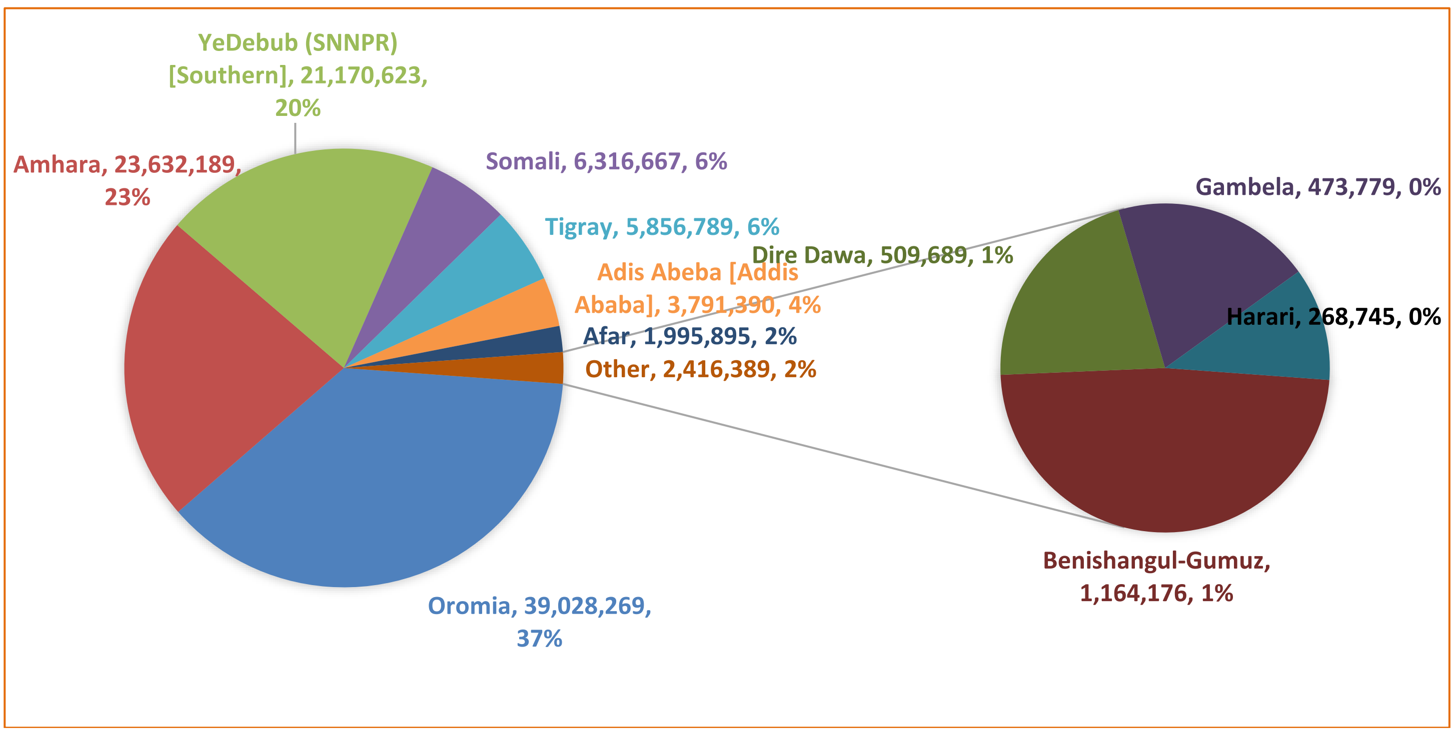
The best way to understand the population distribution patterns in Ethiopia is to first look at the regional-level distributional patterns. The forum chosen here – the Internet – allows easy access

to the regional–level information we have managed to assemble, with just a click of the computer mouse. Pick any region on the home page, or click the region's name on the map to access the regional population, health, and demographic data. Every region has a population density map except Harari, Diredawa and Addis Ababa. The density scale is made uniform to allow comparison across regions. A major drawback of the maps, however, is that it is based on administrative Wereda boundary lines. Such maps do not show ***natural*** density gradations from high to low, or present a picture of true density gradations from high to medium to low.

Regional Distribution at a Glance

Over a third of Ethiopia' population (35%) lives in Oromiya, with Amhara in second place at 25%. The SNNPR with 20% of the country's total ranks third. An identical percentage of Ethiopians lives in Tigray and Somali (6% each).

Ethiopia: Regional Population Distribution, 2017



Source: Based on [1b]

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Population distribution: Determining factors

Altitude

In 1994, 1.88 billion people around the world (35% of the global total then) lived below 100 meters above sea level which comprised only 15 % to total land area [3]. Globally, the number of people "…decreased more than exponentially" with increasing altitude and population density below 100 meters was larger than in any other range of elevations [4]. This effect takes place, primarily, through the coastal distribution of cities including all of the mega cities – those with populations of over 10 million inhabitants - and high-density costal settlements. "Altitude also affects biological hazards for humans, including infectious diseases such as Malaria, Filariasis, Lyme disease, and toxoplasmosis". Altitude can also affect "human reproductive physiology and birth weight, exposure to cosmic radiation, other physiological functions, and agricultural production" [3]. Three quarters of China's billion-plus population lives below 500 meters and an estimated 228 million Chinese - comparable to the combined population of Germany, France, Italy, and Spain - live below 25 meters [4].

Ethiopia presents an opposing picture. Here, altitude and the attendant climatic differences determine the distributional pattern of the Ethiopian population in reverse order of the global pattern with population numbers rising (rather than declining) with an increase in altitude. In the process, altitude becomes a very important variable, more than any other single factor, in shaping the distributional pattern of the country's population. This is clearly evident in the following quote:

> "The Ethiopian population has traditionally been highly concentrated in the highlands. About 10% of the population lives at the extreme cold zone, at an altitude of over 2,600 meters above sea level, 39.2% lives between 2,200 meters and 2,600 meters above sea level, 28% between 1,800 meters and 22,200 meters above sea level…The lowlands are very sparsely populated mainly because of malaria and other vector borne diseases" [5].

As a result, 80% of the country's population inhabits only 37% of the total land area, mostly in the highlands [2].

Population Density

A simple but powerful measure of population distribution is known as population density. It is a ratio of two numbers: population size as the numerator, and area size of the land they inhabit as the denominator. This ratio is often referred to as ***crude density***. Regional population densities reveal that even in the highlands of Ethiopia the distribution pattern is uneven (see Table below). The highest population densities in Ethiopia are "…. in the Enset Belt which covers Gurage, Hadiya, Kambata and Wolayta Zones of SNNPR" [2]. All thirteen of the Weredas in Ethiopia with densities of over 500 persons/km^2 are also located in SNNPR. The table below lists all of the Weredas with a density of 300 persons/km^2 or higher. A total of 38 Wereda's are listed. All but nine of these Weredas are in SNNPR.

Weredas With Densities Over 300 Persons per km^2 (July 2007)					
Wereda	**Region**	**Density**	**Wereda**	**Region**	**Density**
Cheha	SNNPR	308	Haromaya	Oromia	442
Selti	SNNPR	322	Hula	SNNPR	446
Bensa	SNNPR	337	Limo	SNNPR	450
Soro	SNNPR	340	Shashemene	Oromia	462
Konteb	SNNPR	342	Kochere	SNNPR	470
Dale	SNNPR	342	Deder	Oromia	476
Mana	Oromia	343	Badawach	SNNPR	500
Kersa	Oromia	349	Awasa	SNNPR	565
Tehuldere	Amhara	350	Boloso	SNNPR	583
Ganta Afeshum	Tigray	351	Shebedino	SNNPR	592
Chencha	SNNPR	359	Kedida Gamela	SNNPR	594
Kersa	Oromia	375	Dara	SNNPR	633
Mata	Oromia	375	Angach	SNNPR	624
Meskanena Mareko	SNNPR	392	Kacha Bira	SNNPR	637
Omo Sheleko	SNNPR	394	Zuria	SNNPR	638
Tulo	Oromia	402	Yirgachefe	SNNPR	677
Arbegona	SNNPR	416	Aleta Wendo	SNNPR	705
Adama	Oromia	436	Damot Gale	SNNPR	746
Bule	SNNPR	441	Wenago	SNNPR	1121
Kem	SNNPR	442			

Source: Based on [1]

With more than a thousand persons per square kilometer Wenago in SNNPR has the highest density of any Wereda in the country. This is a high number for a rural population. For obvious reasons urban densities can be in the thousands, but the very high rural densities in SNNPR are unique to this part of the country. The happy corollary here is that this is not a region often mentioned in connection with drought, famine, and environmental degradation even though it has a modest share of all of these predicaments. The impressive traditional land-management system in SNNPR, especially in the "enset-belt" which is handed down from generation to generation has ensured a sensible stewardship of the land (go to the SNNPR page to see the population density map).

The Amhara and Tigray regions have only one Wereda each in the 300+ density category. Oromiya has seven. Weredas with low densities are mostly in Afar and Somali as well as the low lands of Tigray, SNNPR, and Oromiya.

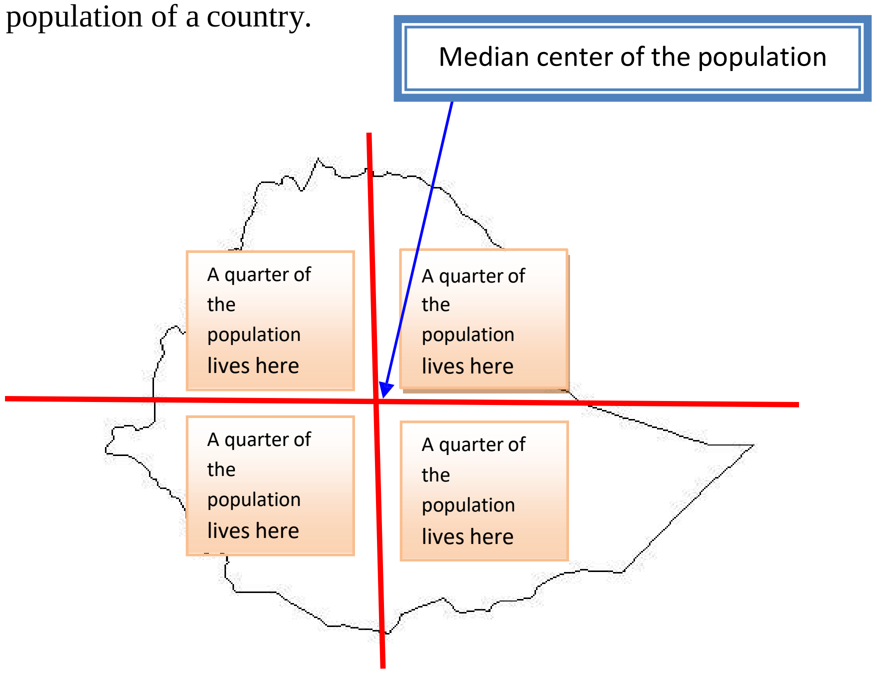
In sum, population density as a crude measure offers a glimpse (though potentially misleading), into how the population of a country is distributed, and whether or not there are 'too many", or "too few" persons in a certain area. However, it would be useful to stress that the phrase "too many" or "too few" can be quite deceptive since threshold population sizes cannot be accurately defined for a given geographical area. For example, the crude density of 4.2 for Guradamole and Arero (Oromiya) could realistically be described as a case of too many people per unit area compared to the figure of 1121 in Wenago (SNNPR) if conditions in the two Weredas are such that the land cannot provide enough sustenance for any more persons per unit area. It all depends on the population-resource balance i.e. whether or not equilibrium has been reached. Overall, crude densities do not accurately depict how the population of a country is distributed. It is always the case, for example, that urban areas of Ethiopia, or any other country for that matter, have much larger densities than rural settlements, with the capital Addis Ababa representing an area of most intense population concentration in the country.

The Ethiopian population being mostly agrarian (over four-fifths of the population is engaged in traditional farming), a different measure known as ***agricultural density*** would be more appropriate. This measure (also referred to as ***physiological density*** [6]), relates the numbers of rural inhabitants to the size of arable land. It is difficult to compute agricultural densities here, however, due to the unavailability of data on exact sizes of arable land for all Weredas or sub-divisions of Weredas. This might be a topic to be picked up by a student taking this course as a senior essay topic in post-graduate research. One of the likely outcomes of such research would be a change in the ordering of Weredas away from the rakings shown in the above Table. It can also be presumed that, for the country at large, the density range between the highest and lowest densities would be smaller than that represented by the crude density values.

Measuring Population Distribution

Spatial Central Tendency Measures

In statistics the mean, mode, and median represent the measures of central tendency for a given observation. The concept has been adopted by geographers to calculate the mean, median, and modal centers for the population of a country.



The vertical and horizontal lines are the median lines. The two orthogonal lines (at right angle to each other) each of which divides the geographical area of a country or its sub-divisions into two parts with equal numbers of inhabitants are superimposed on a population distribution map, preferably a dot map [7]. The median point of the population of a country, whether it is evenly distributed or not, would be the point of intersection of the two lines. The modal point is much easier to locate because it is the point of maximum population concentration often represented by the capital city. Hence, for almost all countries in Africa, the capital cities also represent the modal centers of that country's population space.

Calculation of the spatial equivalent of the mean of a statistical distribution requires a little more work. The geographical mean center of the population represents "the center of population gravity for the area", or "the point upon which the [area under consideration] would balance, if it were a rigid plane without weight and the population distributed there on, each individual being assumed to have equal weight and to exert an influence on the central point proportional to his distance from the point. The pivotal point, therefore, would be its center of gravity" [7]. The calculation of the mean center or the center of gravity of the population uses the following formula:

,

where:

p_i is the population of the geographic subdivision i
x_i and y_i are the vertical and horizontal coordinates of point i.
k equals the total number of geographic subdivisions

For ease of calculation, all of the people in a given area (in a Wereda, for instance) are assumed to be concentrated at the geographic center of that area. Once this assumption has been made, the calculation of the numerators - the products of populations and the ***x*** coordinates *(p**i*** times *x**i**)* and *y* coordinates *(p**i*** times *y**i**)* - is fairly straight forward. The denominator is the total population of a country, a state, a province, etc. whose geographic population center is being calculated.

A study in the mid 1980's put both the geographical mean and median of the Ethiopian population very near the modal point (Addis Ababa) [8]. However, the breakaway and independence of Eritrea has since removed over 3 million people from the northern half (or the then northern limit of the country). This would lead to a southward shift in the horizontal median line, and a similar southward shift in the locations of the geographical mean and median. Eritrean impendence did not affect the location of the modal center. Another factor in the possible shift in median and mean population centers is the north-to-south population movement both due to voluntary north-south migrations by individuals and government-sponsored resettlement. Given the numbers involved in both, it would be reasonable to assume that this has had at least as much impact on the location of the mean and median centers as the separation of Eritrea from Ethiopia. The impact is a further shift southward in both the mean and median centers.

Standard Distance Deviation: The Spatial Equivalent of Standard Deviation

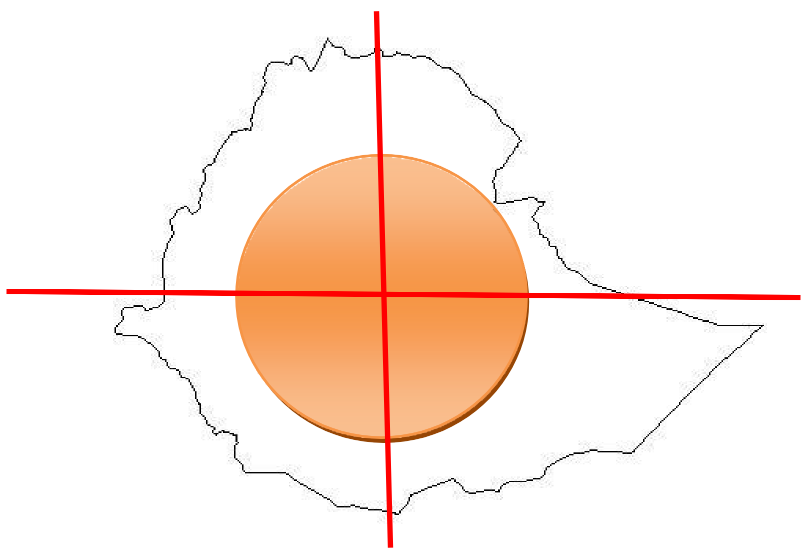
The measures of dispersion – standard deviation, variance, etc. - also have their spatial equivalents. The spatial equivalent of standard deviation is known ***as spatial distance deviation***, and is represented by upper case letter ***D*** in the formula below. "The standard distance deviation bears the same kind of relationship to the center of the population that the standard deviation of any frequency distribution bears to the arithmetic mean. In other words, it is a measure of the dispersion of the distance of all inhabitants from the center of the population" [7]

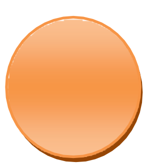
$$D = \sqrt{\frac{fi\,(xi - x)^2}{n} + \frac{fi\,(yi - y)^2}{n}}$$

where:

fi = the population in a given unit area and

n equals the total number of areas (usually subdivisions of a country) considered in the calculation of ***D***.





Area within one Standard Distance Deviation contains 68 percent of the population of the geographic area under consideration.

As is the case with numerical data (represented by an area under normal curve), the spatial distance deviation is presumed to contain roughly 68 percent of the total population.

The Lorenz Curve and Gini Concentration Ratio

The Lorenz curve has long been used to measure income inequalities, but "it has also been used to depict the state (as opposed to the process) of concentration of population and of other demographic aggregates" [6]. To draw the Lorenz Curve, the spatial subunits of a country or a portion of it (for example the Amhara region), are arranged individually or grouped into class intervals according to the population density ranking of the spatial subunits (Weredas, for instance), from places with the lowest densities, to those with the highest densities or vice versa.

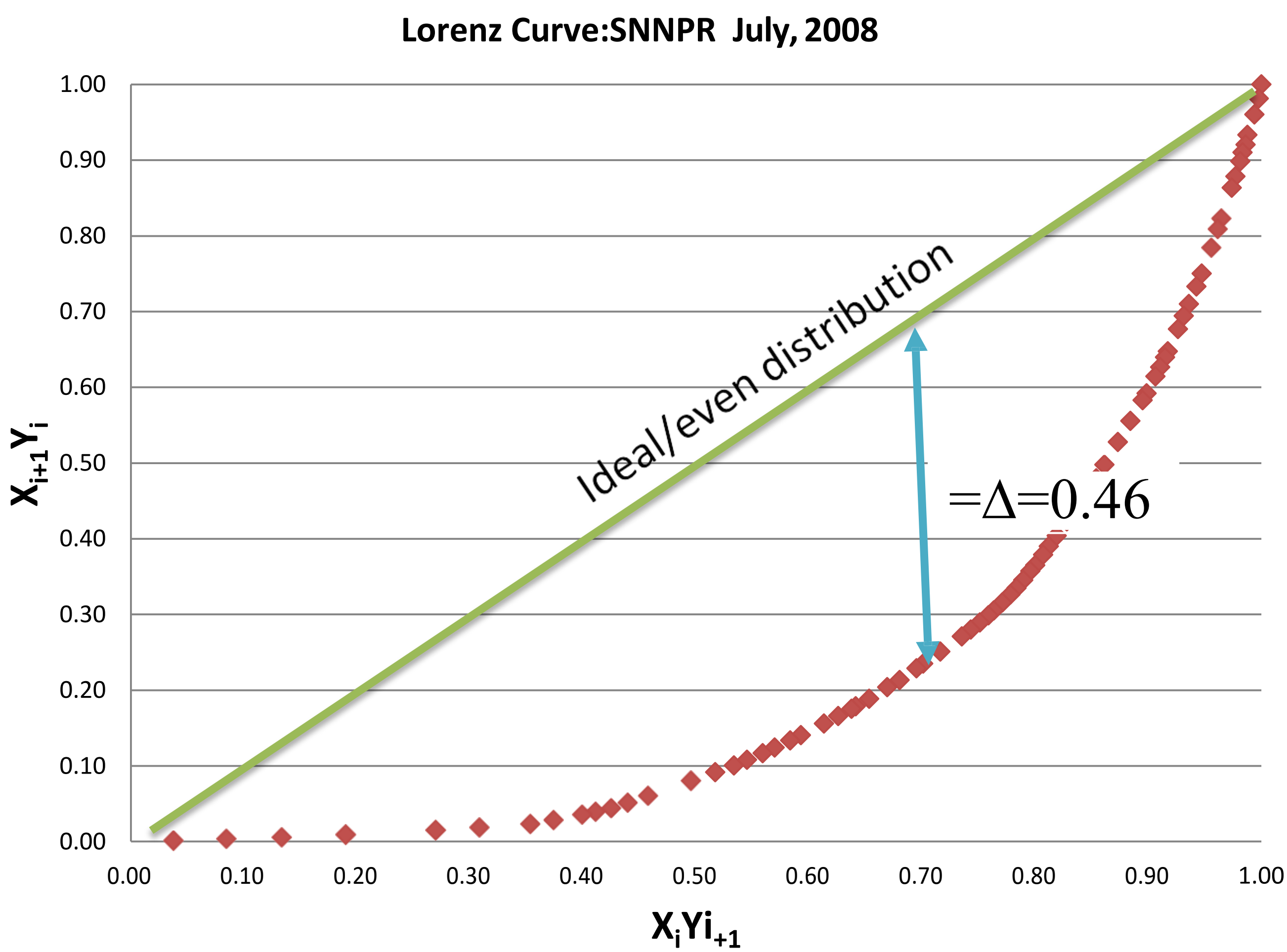
The tables below show the application to the Lorenz Curve and Gini Concetration Ratio to measure the degree of unevenness of SNNPR's population. (zoom to 150% for best viewing, or visit the "calculate demographic rates" page of this website). The third and sixth columns show the population and area share of each Wereda. For example, Aleta Wendo's share of the population (X_3) is 0.0264 and the Y_3 (its share of Wereda area size) is 0.005. The two columns add up to 1.0 each.

Index of Concentration (Δ)

In column 7 the corresponding rows of columns 6 are subtracted from those in column 3 and the absolute values entered. The total for this column is shown at the bottom as 0.9330. We divide this number by two to get the index of concentration (Δ). Algebraically, the index of concentration (see formula below) is simply "the maximum of the set of k values of (Xi – Yi). Geometrically, it is the maximum vertical distance from the diagonal to the [Lorenz] curve. Δ is also algebraically equivalent to the Index of Dissimilarity, which is the sum of the positive differences between the two percentage distributions" [7]

The formula gives a value of 0.4665 for SNNPR showing a 46.65 percent departure from evenness (see the Lorenz Curve also). If the population of SNNPR was perfectly evenly distributed, a graph made on the basis of ***xi*** and ***yi*** values would be a perfect diagonal, with no distance between the Lorenze Curve and the diagonal, i.e. the Lorenze curve and the diagonal would overlap. However, since the population of SNNPR is not evenly distributed the Lorenz Curve and the diagonal do not overlap. Thus, the Index of Concentration (Δ) tells us algebraically what we see pictorially.

$$\Delta = - \qquad | x_i - y_i |$$



Source: Based on [1] (see Appendix for detailed steps and calculations)

The graph above shows the Lorenz Curve for SNNPR based on the July 2008 Wereda population estimates. A diagonal line has been added to show the amount of deviation of SNNPRs population form an ideal condition of perfect evenness.

A related concept, and a very useful measure of population distribution in space, is the Gini Concentration Ratio (Gi). The ratio measures the proportion of the area under the diagonal line (above) relative to the area that lies between the Lorenz Curve and the diagonal line. Columns 5 and 6 are, simply, the xi and yi columns cumulated from top down. In column 7 the xi values in column 5 are multiplied with y_{i+1} (or a yi value in the next row) of column 6. In column 8 the y_i values of column 6 are multiplied with the X_{i+1} (or an X_i value in the next row). The totals for these two columns are calculated easily, and represent the values needed to calculate the Gini Concentration Ratio (Gi). The detailed nature of the table above points to the immense computational need and time required to arrive at these two numbers, and the need for spreadsheet programs like Microsoft Excel.

$$Gi = \left(\sum_{i=1}^{n} X_i Y_{i+1}\right) - \left(\sum_{i=1}^{n} X_{i+1} Y_i\right)$$

To learn more about the calculation of the Gini Concentration Ratio (Gi), Click on the "calculate demographic rates" button on the main page at www.EthioDemographyAndHealth.Org and follow the instructions.

As has been defined above, the Gini Concentration Ratio measures the proportion of the total area under the diagonal that lies between the diagonal and the Lorenz Curve. We have also noted that if the population of SNNPR was perfectly evenly distributed the diagonal line and the curve would over lap; there would be no area under the curve. In other words, the area under the curve would be 0. The calculated Gi of 0.611 represents an uneven population distribution in this southern region of Ethiopia, as elsewhere in the country. One might be confused by the lack of similarity in the values of Δ and Gi for SNNPR. The difference results from the fact that they measure two different things. The index of concentration (Δ) measures the ***distance*** between the curve and the diagonal whereas are the Gini Concentration Ratio (Gi) measures the ***area*** between the curve and the diagonal

Population Redistribution in Ethiopia

Government sponsored large-scale resettlement involving millions started under the Derg regime headed by Colonel Mengistu Hailemarian. "By 1988, despite the resettlement program's obvious failure, President Mengistu repeatedly asserted that the program would continue". He estimated the number that will eventually be resettled at 7 million (out of Ethiopia's estimated 48 million) [9]. As the country celebrated the new millennium resettlement was "in full swing again" [10]. "Under pressure from international donors tired of giving millions of dollars in food aid to help Ethiopians at risk of starvation, the Ethiopian government came up with a quick fix -- move them; two million of them" [10].

At its core, the plan envisaged resettling over 2 million people in just 3 years (2004 – 07). "And it is not hard to see why. The country faces enormous challenges: its central highlands have been over-worked for generations; its population has doubled since the great famine of 1974. Something has to be done" [11]. The process was advertised as entirely voluntary and "the destination areas were characterized as safe-havens with abundant land, fertile soil, regular rainfall, and irrigation potentials. Each settler household was promised access to two hectares of land, a house, a pair of oxen, three years of relief aid, infrastructural facilities, social services, agricultural inputs, and complete household utensils" [12]. Critics viewed these as empty promises which never materialized and posed a number of questions:

- Is the current resettlement based on scientific studies of its short- and long-term merits?
- Is it based on sound planning?
- Is it truly voluntary both on the part of settlers, and the host communities?
- Have exhaustive cost-benefit analysis of its impacts on human lives and the environment been carried out?
- Brushing aside the seemingly endless justifications in daily offerings of political speeches, is there a measurable difference in the outcomes of the ongoing resettlement when compared to those conducted by the defunct Derg regime?

The answer, according to the Ethiopian Forum for Social Studies, seems to be a no. The head of the Organization Desalegn Rhmato recommended relocation to urban centers instead [11].

A study of settler response to the new environment reveals adoptive strategies that varied significantly not just on the basis of macro groupings, but also at the individual level based on gender, age, education, "wealth", health status, etc. Alula Pankurst's yardstick for measuring success or failure at the individual (micro) and community levels was very apt [13]:

> "Some resettlers, particularly from the Harerge area of Oromia, have been able to become very successful in a short period of time. They were able to do so by bringing cash with them or obtaining income from production in their home areas, which they were able to invest to increase production in the resettlement areas, by obtaining more land through share-cropping, hiring labour, producing cash crops and involvement in trade. Some have been able to construct houses with iron roofs and purchase more and better household and consumer goods, build shops and tea rooms in local towns, and even have hired tractor services and bought grinding mills. Many of the more successful are characterised by better social capital, taking on leadership positions, with involvement in informal community institutions such as funeral associations and churches, and good relations with the administration, local people and investors. Avenues to success include not just agriculture with a focus on cash crops and irrigation, but also livestock rearing and trade.
>
> Cases of failure often exhibited the opposite attributes of the more successful. They produced much less, were food insecure, had few or no livestock, and poor social capital. They included or involved female-headed households, the elderly, weak, disabled, those suffering from malaria and other lowland diseases, those who had problems of drink, those who were characterised as "lazy" by other resettlers or "not cooperative" by the leadership, and also included those who were not motivated to stay in resettlement areas, and were unable to get access to education or jobs."

Resettlement often negatively impacted the host communities. It has been reported that "with the exception of a few sites (e.g., Quara and Shanaka), in almost all sites covered in the studies, dispossession of land and other natural resources was reported by the host communities" [12].

Stories of positive outcomes among individual settlers and communities abound, and notable benefits have accrued to some. This has been overshadowed, however, by the preponderance of reports of failures of some, or all, of the goals of resettlement depending primarily on the match or mismatch between planned actions, and resources available for implementation.

Appendix 1. Steps followed in the Making of the Lorenz Curve.

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
	Population	Population	Density	**Area**	Area
Wereda		Proportion	Rank	**sq. miles)**	proportion
		(xi)			***(yi)***
WENAGO	243,987	0.0186	1	255.16	0.0023
DAMOT GALE	278,092	0.0212	2	429.07	0.0039
ALETA WENDO	347,123	0.0264	3	567.03	0.0051
YIRGACHEFE	176,500	0.0134	4	301.1	0.0027
DARA	134,284	0.0102	5	243.75	0.0022
KACHA BIRA	152,727	0.0116	6	277.5	0.0025
SODO ZURIA	262,614	0.0200	7	481.25	0.0043
ANGACHA	197,569	0.0150	8	364.07	0.0033
SHEBEDINO	535,057	0.0407	9	1,035.47	0.0093
KEDIDA GAMELA	180,825	0.0138	10	351.25	0.0032
BOLOSO SORE	319,898	0.0243	11	632.66	0.0057
AWASA	454,078	0.0345	12	942.35	0.0085
BADAWACHO	224,540	0.0171	13	516.57	0.0046
GUMER	304,867	0.0232	14	740.78	0.0066
KOCHERE	205,364	0.0156	15	504.22	0.0045
HULA	227,094	0.0173	16	583.76	0.0052
LIMO	388,127	0.0295	17	1,002.03	0.0090
BULE	103,067	0.0078	18	268.91	0.0024
ARBEGONA	172,069	0.0131	19	474.07	0.0043
OMO SHELEKO	160,440	0.0122	20	467.35	0.0042
MESKANENA MAREKO	294,252	0.0224	21	872.5	0.0078
CHENCHA	113,232	0.0086	22	365	0.0033
KONTEB	365,672	0.0278	23	1,225.00	0.0110
SORO	366,065	0.0279	24	1,234.54	0.0111
DALE	393,194	0.0299	25	1,326.41	0.0119
BENSA	237,117	0.0180	26	806.88	0.0072
SELTI	150,119	0.0114	27	535	0.0048
CHEHA	147,444	0.0112	28	549.85	0.0049
EZHANA WOLENE	208,229	0.0158	29	815.63	0.0073
ALABA	240,532	0.0183	30	973.76	0.0087
ENEMORINA EANER	248,938	0.0189	31	1,018.75	0.0091
DAMOT WEYDE	190,209	0.0145	32	783.44	0.0070
OFFA	141,595	0.0108	33	588.13	0.0053
KINDO KOYSHA	178,824	0.0136	34	776.41	0.0070
LANFRO	102,491	0.0078	35	451.88	0.0041
DALOCHA	157,280	0.0120	36	718.75	0.0065
DITA DERMALO	138,668	0.0106	37	654.85	0.0059

YEKI	110,900	0.0084	38	603.91	0.0054
NONKE	139,024	0.0106	39	797.82	0.0072
SODO	138,450	0.0105	40	830.63	0.0075
KOKIR GEDEBANO GUTAZER	85,881	0.0065	41	533.44	0.0048
HUMBO	122,908	0.0094	42	846.57	0.0076
ARORESA	120,471	0.0092	43	853.13	0.0077
MAREKA GENA	112,145	0.0085	44	875.78	0.0079
BENCH	266,860	0.0203	45	2,128.91	0.0191
GOFA ZURIA	214,490	0.0163	46	1,720.63	0.0154
YEM SPECIAL WEREDA	82,292	0.0063	47	666.25	0.0060
ARBA MINCH ZURIA	203,636	0.0155	48	1,681.72	0.0151
KEMBA	126,596	0.0096	49	1,160.94	0.0104
CHENA	197,402	0.0150	50	1,871.72	0.0168
GINBO	130,538	0.0099	51	1,269.38	0.0114
BASKETO	43,112	0.0033	52	420.94	0.0038
BOREDA ABAYA	127,130	0.0097	53	1,322.04	0.0119
KUCHA	130,246	0.0099	54	1,384.22	0.0124
KONSO SPECIAL WEREDA	200,644	0.0153	55	2,276.25	0.0204
MENJIWO	90,816	0.0069	56	1,054.22	0.0095
AMARO SPECIAL WEREDA	125,092	0.0095	57	1,534.07	0.0138
TELO	96,906	0.0074	58	1,191.72	0.0107
DIRASHE SPECIAL WEREDA	115,648	0.0088	58	1,526.41	0.0137
ZALA UBAMALE	97,558	0.0074	60	1,301.72	0.0117
ISARA TOCHA	117,822	0.0090	61	1,838.60	0.0165
GESHA	148,774	0.0113	62	2,382.35	0.0214
BAKO GAZER	265,866	0.0202	63	4,284.07	0.0385
LOMA BOSA	117,694	0.0090	64	1,980.63	0.0178
MELOKOZA	95,099	0.0072	65	1,614.85	0.0145
MASHA ANDERACHA	60,115	0.0046	66	1,524.69	0.0137
BURJI SPECIAL WEREDA	50,058	0.0038	67	1,319.85	0.0118
DECHA	95,007	0.0072	68	2,841.26	0.0255
ELA	66,846	0.0051	69	2,253.76	0.0202
KURAZ	61,366	0.0047	70	5,034.53	0.0452
MEINIT	45,629	0.0035	71	4,333.69	0.0389
HAMER BENA	75,406	0.0057	72	8,850.94	0.0794
SHEKO	45,920	0.0035	73	6,321.72	0.0567
SURMA	30,073	0.0023	74	4,883.13	0.0438
DIZI	29,284	0.0022	75	5,775.31	0.0518
SELAMAGO	17,308	0.0013	76	4,191.25	0.0376
Sum	13,143,195	1		111418.18	1.0000

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Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	
	Cumulative					
	Proportion					
	Population	Area				
I(xi) - (yi)I	(Xi)	(Yi)	I Xi - Yi I	$X_{i+1}Y_I$	X_iY_{i+1}	WEREDA
0.0163	1.0000	1.0000	0.0000	0.9814	0.9977	**WENAGO**
0.0173	0.9814	0.9977	-0.0163	0.9581	0.9754	**DAMOT GALE**
0.0213	0.9603	0.9939	-0.0336	0.9281	0.9495	**ALETA WENDO**
0.0107	0.9339	0.9888	-0.0549	0.9101	0.9209	**YIRGACHEFE**
0.0080	0.9204	0.9861	-0.0656	0.8975	0.9056	**DARA**
0.0091	0.9102	0.9839	-0.0737	0.8841	0.8933	**KACHA BIRA**
0.0157	0.8986	0.9814	-0.0828	0.8623	0.8780	**SODO ZURIA**
0.0118	0.8786	0.9771	-0.0985	0.8438	0.8556	**ANGACHA**
0.0314	0.8636	0.9738	-0.1102	0.8013	0.8329	**SHEBEDINO**
0.0106	0.8229	0.9645	-0.1416	0.7804	0.7911	**KEDIDA GAMELA**
0.0187	0.8091	0.9614	-0.1522	0.7545	0.7733	**BOLOSO SORE**
0.0261	0.7848	0.9557	-0.1709	0.7170	0.7434	**AWASA**
0.0124	0.7502	0.9472	-0.1970	0.6945	0.7072	**BADAWACHO**
0.0165	0.7331	0.9426	-0.2094	0.6692	0.6862	**GUMER**
0.0111	0.7100	0.9359	-0.2260	0.6498	0.6613	**KOCHERE**
0.0120	0.6943	0.9314	-0.2371	0.6306	0.6431	**HULA**
0.0205	0.6770	0.9262	-0.2491	0.5997	0.6210	**LIMO**
0.0054	0.6475	0.9172	-0.2697	0.5867	0.5923	**BULE**
0.0088	0.6397	0.9148	-0.2751	0.5732	0.5824	**ARBEGONA**
0.0080	0.6266	0.9105	-0.2839	0.5594	0.5679	**OMO SHELEKO**
0.0146	0.6144	0.9063	-0.2919	0.5365	0.5520	**MESKANENA MAREKO**
0.0053	0.5920	0.8985	-0.3065	0.5242	0.5300	**CHENCHA**
0.0168	0.5834	0.8952	-0.3118	0.4973	0.5158	**KONTEB**
0.0168	0.5556	0.8842	-0.3287	0.4666	0.4851	**SORO**
0.0180	0.5277	0.8731	-0.3454	0.4346	0.4545	**DALE**
0.0108	0.4978	0.8612	-0.3634	0.4132	0.4251	**BENSA**
0.0066	0.4797	0.8540	-0.3742	0.3999	0.4074	**SELTI**
0.0063	0.4683	0.8492	-0.3809	0.3882	0.3954	**CHEHA**
0.0085	0.4571	0.8442	-0.3871	0.3725	0.3826	**EZHANA WOLENE**

0.0096	0.4413	0.8369	-0.3957	0.3540	0.3654	**ALABA**
0.0098	0.4230	0.8282	-0.4052	0.3346	0.3464	**ENEMORINA EANER**
0.0074	0.4040	0.8190	-0.4150	0.3191	0.3281	**DAMOT WEYDE**
0.0055	0.3895	0.8120	-0.4225	0.3076	0.3143	**OFFA**
0.0066	0.3788	0.8067	-0.4280	0.2946	0.3029	**KINDO KOYSHA**
0.0037	0.3652	0.7998	-0.4346	0.2858	0.2906	**LANFRO**
0.0055	0.3574	0.7957	-0.4383	0.2748	0.2821	**DALOCHA**
0.0047	0.3454	0.7893	-0.4439	0.2643	0.2706	**DITA DERMALO**
0.0030	0.3349	0.7834	-0.4485	0.2557	0.2605	**YEKI**
0.0034	0.3264	0.7780	-0.4515	0.2457	0.2516	**NONKE**
0.0031	0.3158	0.7708	-0.4550	0.2353	0.2411	**SODO**
0.0017	0.3053	0.7633	-0.4580	0.2281	0.2316	**KOKIR GEDEBANO GUTAZER**
0.0018	0.2988	0.7586	-0.4598	0.2195	0.2244	**HUMBO**
0.0015	0.2894	0.7510	-0.4615	0.2105	0.2151	**ARORESA**
0.0007	0.2802	0.7433	-0.4631	0.2020	0.2061	**MAREKA GENA**
0.0012	0.2717	0.7354	-0.4637	0.1849	0.1946	**BENCH**
0.0009	0.2514	0.7163	-0.4649	0.1684	0.1762	**GOFA ZURIA**
0.0003	0.2351	0.7009	-0.4658	0.1604	0.1634	**YEM SPECIAL WEREDA**
0.0004	0.2288	0.6949	-0.4661	0.1483	0.1556	**ARBA MINCH ZURIA**
0.0008	0.2133	0.6798	-0.4665	0.1385	0.1428	**KEMBA**
0.0018	0.2037	0.6694	-0.4657	0.1263	0.1329	**CHENA**
0.0015	0.1887	0.6526	-0.4639	0.1167	0.1210	**GINBO**
0.0005	0.1788	0.6412	-0.4625	0.1125	0.1139	**BASKETO**
0.0022	0.1755	0.6374	-0.4620	0.1057	0.1098	**BOREDA ABAYA**
0.0025	0.1658	0.6256	-0.4598	0.0975	0.1017	**KUCHA**
0.0052	0.1559	0.6131	-0.4572	0.0862	0.0924	**KONSO SPECIAL WEREDA**
0.0026	0.1406	0.5927	-0.4521	0.0793	0.0820	**MENJIWO**
0.0043	0.1337	0.5832	-0.4495	0.0724	0.0761	**AMARO SPECIAL WEREDA**
0.0033	0.1242	0.5695	-0.4453	0.0665	0.0694	**TELO**
0.0049	0.1168	0.5588	-0.4420	0.0604	0.0637	**DIRASHE SPECIAL WEREDA**
0.0043	0.1080	0.5451	-0.4371	0.0548	0.0576	**ZALA UBAMALE**
0.0075	0.1006	0.5334	-0.4328	0.0489	0.0520	**ISARA TOCHA**
0.0101	0.0916	0.5169	-0.4253	0.0415	0.0454	**GESHA**
0.0182	0.0803	0.4955	-0.4152	0.0298	0.0367	**BAKO GAZER**
0.0088	0.0601	0.4571	-0.3970	0.0234	0.0264	**LOMA BOSA**
0.0073	0.0511	0.4393	-0.3882	0.0193	0.0217	**MELOKOZA**
0.0091	0.0439	0.4248	-0.3809	0.0167	0.0180	**MASHA ANDERACHA**
0.0080	0.0393	0.4111	-0.3718	0.0146	0.0157	**BURJI SPECIAL WEREDA**

0.0183	0.0355	0.3993	-0.3637	0.0113	0.0133	**DECHA**
0.0151	0.0283	0.3738	-0.3455	0.0087	0.0100	**ELA**
0.0405	0.0232	0.3535	-0.3303	0.0066	0.0072	**KURAZ**
0.0354	0.0185	0.3084	-0.2898	0.0046	0.0050	**MEINIT**
0.0737	0.0151	0.2695	-0.2544	0.0025	0.0029	**HAMER BENA**
0.0532	0.0093	0.1900	-0.1807	0.0011	0.0012	**SHEKO**
0.0415	0.0058	0.1333	-0.1274	0.0005	0.0005	**SURMA**
0.0496	0.0035	0.0895	-0.0859	0.0001	0.0001	**DIZI**
0.0363	0.0013	0.0376	-0.0363	0.0000	0.0000	**SELAMAGO**
0.9330			-24.7674	25.3545	25.9657	**Sum**

* **Δ = 0.9330 ÷ 2 = 0.4664**

***Gi = 25.9657 – 25.3545 = 0.6112**

Δ : is the maximum vertical distance from the diagonal to the Lorenz curve

Gi: Gini Concentration Ratio measures the proportion of the total area under the diagonal that lies between the diagonal and the Lorenz Curve

***Columns 11 and 12 (respectively) formed the Y an X axes of the Lorenz Curve.**

References:

1a. http://www.worldometers.info/world-population/ethiopia-population/
1b. https://www.citypopulation.de/Ethiopia.html

2 Joel E.C and Christopher S. Hypsographic Demography: The Distribution of Human population by Altitude. *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 95, No. 24 (Nov. 24, 1998), pp. 14009-14014.

3 http://www.iiasa.ac.at/Research/LUC/ChinaFood/data/pop/pop_14.htm

4 Charles H. Teller. The lagging demographic and health transitions in rural Ethiopia: Socio-economic, agro-ecological and health service factors effecting fertility, mortality and nutrition trends. Paper presented at Session 104, Population growth and poverty linkages in Africa, Fifth African Population Conference, Union of African Population Studies (UAPS), Arusha, Tanzania, 10-14 December, 2007

5 Peters and Larking, Population Geography, 2000

6 Shryock and Siegel, Methods and Materials of Demography, 1974

7 Aynalem Adugna, The population Geography of Ethiopia. 1984. University of Durham.

8 http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2004/07/19/MNGFE7NSEV1.DTLse

9 http://news.bbc.co.uk/1/hi/world/africa/3493230.stm

10 http://www.irinnews.org/report.aspx?reportid=48797

11 Gebre Yntiso. Stakeholder Participation in Resettlement Decision-making in Ethiopia.

Department of Sociology and Social Anthropology Addis Ababa University, http://www.sfgate.com/ cgi-in/article.cgi?file=/c/a/2004/07/19/MNGFE7NSEV1.DTLse

12 Alula Pankhurst. Resettlement Planning Lessons from Success and Failure Cases: Experience from eleven sites in four Regions.

http://www.sfgate.com/ cgi-in/article.cgi?file=/c/a/2004/07/19/MNGFE7NSEV1.DTLse