Towards Equal Standards of Welfare Among Populations of Different Subdivision Areas of a Country: A Case Study of Sudan

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Preface

The objective of this paper is to find/develop simple indicators for measuring the equality of welfare among population of different subdivision areas of a country; to find/develop simple indicators for measuring the rate of improvement of welfare levels towards a required level of equality; and to study the poverty variation and trends through populations of Sudan states using these indicators.

The administrative divisions of Sudan have been changed through time. The major subdivision of the country is the State; the 15 states included here are the states of the Northern part of Sudan before the separation of the Southern part. Most of the recent censuses and surveys in Sudan were conducted on the basis of these states. However, after the separation of the South some states in Kordofan and Darfur Regions have been split into different states.

The first published survey on poverty in Sudan was conducted in 2009; but, the population censuses and surveys conducted in the country included information on different demographic, health and socioeconomic fields which can be used to measure poverty indices from information on Unmet Needs. Some researchers used these information and calculated different poverty indices in their research papers based on longevity, knowledge and economic data. The main sources of data they used are the two 1993 & 2008 population censuses and the two 2006 & 2010 Sudan Household Health Surveys (SHHS). In this paper we are going to use the poverty indices from the 2009 Poverty Survey and indices calculated by different researchers from other sources of data, in addition to indices and indicators we calculate from these sources to fill the gaps in the required information.

The paper is going to touch three areas: the variation of values of poverty indices among states, the pace of change of this variation through time and the

relationships between different indices and indicators, specifically the relationships between poverty indices from the 2009 Poverty Survey and poverty indices and indicators based on unmet needs data from other surveys.

1. Data sources

In this paper we are going to use the poverty indices from the 2009 Poverty Survey and indices calculated by different researchers from other sources of data, in addition to indices and indicators we calculate from these sources to fill the gaps as required. The documents and sources of data we used in this respect are as follows:

1.1 The first document is a paper written by [1]Dr. Eltahir Mohammed Nur (Nur, 2003). In his paper Mr. Nur presented poverty indices classified by urban/rural residences for 16 states; but we excluded the 16th state (West Kordofan) to have our analysis based on the same number of states. AS the total estimates of poverty indicators are not included in Dr. Nur's paper we calculated that from his urban/rural estimates.

Mr. Nur used different sources of data referred to different reference years for estimating his poverty indices; these include the 1992 Household Budget Survey, the 1993 Population Census, the 1999 Safe Motherhood Survey, the 2000 Multiple indicators Survey and other backdated surveys. So it is not clear, to what reference time his estimates would be referred. In any case our analysis would be on the variations of these levels of indicators in a time considered to us as the first historical time of poverty levels among Sudan states.

Mr. Nur's poverty indices based on three areas of human deprivation: deprivation in survival (P1), deprivation in knowledge (P2) and deprivation in economic provisioning (P3). He identified 12 human poverty indicators for these three areas (See Appendix 1).

1.2 The second document is written by [2]Mr. Jamal Eldeen Abd Elrazig Sulieman (Sulieman, 2011). In his paper Mr. Sulieman calculated the Human Poverty Indices for the total Sudan from the 2008 Population Census. He used the indices of the same three areas of human deprivation as came in Mr. Nur's paper but with somewhat different sets of indicators (See Appendix 1).

[1] Nur, Eltahir Mohamed Nur, Income and Human Poverty in Sudan, an Empirical Assessment, 2003.
[2] Sulieman, Jamaleldeen Abd Elrazig Sulieman, Human Poverty in Sudan, An Empirical Analysis, 2008.

1.3 The 2008 Population and Housing Census; the recent population census conducted in Sudan. We used the data from this census to calculate longevity indices (P1), and knowledge indices (P2) as calculated by Mr. Nur to study the trend of equality among states in these areas through time.

1.4 The 2006 and 2010 Sudan Health Household Surveys (SHHS). These surveys provide data on key health indicators which used as proxy indicators for calculating poverty indices. We used underweight prevalence, water and sanitation quality indicators from the two surveys to study the level and trend of equality in the respective areas in this interval of time.

1.5 Finally the 2009 Baseline Household Survey, which referred to also as poverty Survey. This is the first approved poverty survey that emerged poverty indices according to the standard definitions and concepts of poverty measurements. We used in this paper the poverty incident, severe poverty and poverty gap indices calculated from the survey data for the 15 states of Sudan.

2. Methodologies

The measurements used in this respect are illustrated below:

- The Standardized Standard Deviation: The standard deviation is one of the measurements of dispersion in statistics; it indicates how far is the value of an element from the mean value of a set of elements. The value of the standard deviation depends on the relative levels of the values of the elements. For this reason and to have standard measure of equality we use the standard deviation of the percentages of the values of poverty indicators to measure equality; we denote this standard deviation here as Standardized Standard Deviation (SSD).
- The Standardized Mean: We found that the mean of the percentages of elements is always the same for the different sets of the same number of elements; we call this mean here as standardized mean (SM).
- The Equality Index: The characteristics of the standardized mean encourages us to make use of it to develop a positive measure of lower and upper limits of equality equals SM – SSD with minimum value = 0 and maximum value = SM; we call it here as the Equality Index (EIX).
- The Correlation Coefficient: The Correlation Coefficient of the relationship between (the values of a variable referred to a base year

time) and (the differences between these values and values of the same variable referred to subsequent point of time) is used to estimate the trend of improvement in equality. When we fix the values of the variable at the subsequent point of time on specific target the value of the Correlation Coefficient of this relationship would be a unity by definition. This is considered to be the ideal trend of improvement.

- The Poverty Equality Gaps: Defined as the gap in the specific poverty component during specific period in order to reach the required targeted level of equality. They are calculated as the difference between the percent decrease of poverty component index per year per state during a specific period according to an actual trend and the required decrease of the poverty component index per year per state according to the required trend to reach the equality target.
- The Regression statistics: We used the linear regression method to find the degree of relationships between different poverty indices/indicators.

3. Equality levels

As noted in the Methodology Section we are going to use the standard deviation statistic to estimate equality among states.

To start with the historical situation Appendix 2 show the deprivation indices by state from data on previous censuses and surveys in Sudan calculated by Mr. Nur; and Table 1 shows the results of SSD and EIX of the percentages of values of these indices by urban and rural. Had these indices been in the same level of the respected area the SSD would be zero and the EIX would be 6.67; this is the ideal situation that would hardly be achieved in the real world. However endeavors should be made to reduce the variations towards zero. Table-1 shows that the variation in all three areas of well fare among Sudan states in the long past measured by SSD reached more than one for all three areas of deprivation. Longevity and knowledge areas registered the same level of equality among Sudan states at that time, of SSD equals 1.63 (EIX = 5.04 out of 6.67). This level of equality was lower than that for economic area (SSD=1.01, EIX = 5.66 out of 6.67). In fact longevity and knowledge areas of welfare depend highly on health and education services whereas economic area depend mostly on individuals economic activities. Table-1 indicates that variation in deprivation levels in rural areas of Sudan states were lower than that for urban areas of the states for all the three fields of deprivation at that time. This means that welfare instruments

worked selectively among urban areas more than rural areas of the country especially in the longevity field where the SSD in urban areas of the states reached more than 2 with relatively big difference from that in rural areas.

Table 1
Levels of variation of welfare among Sudan states
By area of deprivation and place of residence
From historical data (Nur's estimates)

Deprivation	Standardized Standard deviations (SSD) and Equality Index (EIX)					
	Total		Urban		Rural	
	SSD	EIX	SSD	EIX	SSD	EIX
Longevity (P1)	1.63	5.04	2.03	4.64	1.65	5.02
Knowledge (P2)	1.63	5.04	1.90	4.77	1.72	4.95
Economic (P3)	1.01	5.66	1.34	5.33	1.20	5.47

15 states with standardized mean (SM = 6.67)
* Calculated from Appendix 2

To come compare between equality situation in the past and the more recent time Table 2 shows the SSD and EIX values of P1 and P2 poverty indices for the total states of Sudan as obtained from Mr. Nur's estimates and that calculated from the 2008 Population Census for the same indicators used by Mr. Nur. The table also presents the P3 poverty index as obtained by Mr. Nur and that calculated by Mr, Sulieman from the 2008 Population Census and the 2006 Health Household survey data. The SSD and EIX values in the table show that equality in longevity and knowledge improved in 2008 by almost the same level; the SSD in both areas dropped from 1.63 in the reference time of Nurs' estimates to 1.40 in the year 2008 (The EIX increased from 5.04 to 5.27). For economic deprivation the indicators used by Mr. Nur are different from that used by Mr. Jamal so there is some lack of validity in comparability in this respect.

Table 2
Levels of variation of welfare among Sudan states
By area of deprivation as obtained from the 2008
Population Census data and Nur's estimates

Index	SSD	EIX
P1 (Nur's estimates)	1.63	5.04
P1 ((from 2008 population census)	1.40	5.27
P2 (Nur's estimates)	1.63	5.04
P2 ((from 2008 population census)	1.40	5.27
P3 (Nur's estimate)	1.01	5.66
P3 (Sulieman's estimate)	2.08	4.59

15 states with standardized mean (SM = 6.67)
* Calculated from Appendices 2 and 3

To throw more lights on equality in the economic component P3 we calculated from the 2006 and 2010 Health Household Surveys some indicators usually used by scholars to calculate poverty indices in this area. These indicators are: Proportion of underweight children, proportion of households with unsafe drinking water and proportion of households with bad sanitation facilities for the different states. Table 3 shows the SSD and EIX values of these indicators. A cross-sectional view of the SSD and EIX values of states for these indicators from both sources shows that unsafe water condition registered the highest level of variability among states with very high level of SSD in 2006 equals 6.55 (EIX= 0.12); followed by sanitation facilities levels (SSD= 4.02 EIX= 2.65). Children underweight registered the lowest level in this respect where underweight – 2 types was lower than that of – 3 types. It is important to remark here that safe water and sanitation facilities likely to be service oriented indicators whereas children-underweight likely to be household income oriented indicator. We conclude from this proposition that variability in services among Sudan states was higher than the variability in household income among these states.

With respect to trend of variability of these indicators among states the SSD and EIX values in the table indicate that equality level dropped down a little bit for both types of children-underweight indicator between 2006 and 2010, and went highly up for unsafe water and a little bit up for sanitation during this period. We have to note here that the type of data collected for quality of water and sanitation might be somewhat different in the two health household surveys.

Table 3
Levels of variation of welfare among Sudan states
By area of deprivation as obtained from the 2006 and 2010
Sudan Households Health Surveys

Index	SSD	EIX
Children underweight type – 2 (2006)	1.12	5.55
Children underweight type – 2 (2010)	1.57	5.10
Children underweight type - 3 (2006)	2.46	4.21
Children underweight type - 3 (2010)	3.10	3.57
Unsafe water (2006)	6.55	0.12
Unsafe water (2010)	4.02	2.65
Sanitation (2006)	3.34	3.33
Sanitation (2010)	3.01	3.66

15 states with standardized mean (SM = 6.67)
* Calculated from Appendix 4

Now we come to the most recent available data on poverty provided from the 2009 Sudan Household Baseline Survey. As indicated earlier this is the first published survey in Sudan providing poverty indices derived from household income and expenditure. The indices used in this paper are: the poverty incident, defined as proportion of population with standard of living below the poverty line; severe poverty, defined as the proportion of population with subsistent level below the food poverty line; poverty gap, defined as how much needed for low level standard of living people to be at poverty line; and lastly poor gap, defined as how much needed for poor people to be at food poverty line. The definition of poverty indicators and indices discussed earlier are based mainly on unmet needs and they are mainly oriented to distribution of socioeconomic services whereas the indices from the 2009 Sudan Base Line Survey based mainly on household income and expenditure; so there is no way to detect equality changes between the respective periods; however, the 2014 Sudan Household Baseline Survey whose data is not yet ready will be a very important source to track equality levels among states in these areas.

Table 4 shows the SSD and EIX values of the four poverty indicators of the 2009 SHBLS Survey. As indicated by the table equality in standard of living among states was better than that in standard of subsistent among states (EIX =4.94 versus EIX = 3.58). That is to say the variations in levels of satisfaction in different

needs including education, health… etc among states were lower than that in food (SSD = 1.73 versus SSD = 3.09). One justification of this result is that education, health… etc depends on distribution of health and education services in addition to household income whereas adequate food requirements depend mainly on household economic activities. Other justification is that more supports in the areas of health and education might come from relatives or medical insurances and other sources to the poor in the different states. With respect to the poverty gap Table 4 shows that the SSD value for poverty gap was higher than that of poor gap among the states (2.52 versus 1.16). This means that the way to equal required level of subsistence for food deprived population is shorter than the way to equal required level of standard of living for generally deprived people in Sudan states. This conclusion may be justified by that the cost of the adequate standard of living items basket is higher than that of the cost of the adequate food items basket.

Table 4
Levels of variation of welfare among Sudan states by poverty index as obtained from the 2010 Sudan Household Baseline Survey

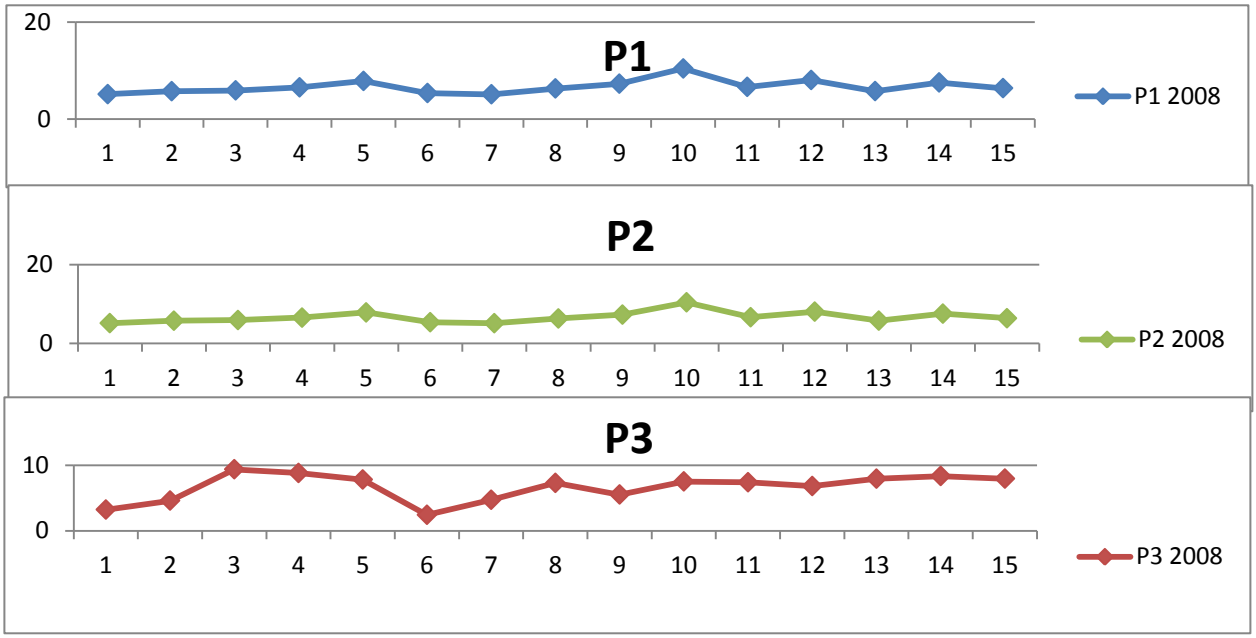
Index	SSD	EIX
Poverty incident	1.73	4.94
Severe poverty	3.09	3.58
Poverty gap	2.52	4.15
Poor gap	1.16	5.51

15 states with standardized mean (SM = 6.67)
* Calculated from Appendix 5

The three Figures below give clear and more information about equality issues discussed above. The upper part of the each Figure is a line graphic representation of the distribution of percentages of indices/indicators of the 15 Sudan states; the lower part is the bar graph of the level of Equality for each line graph measured by the Equality Index (EIX). We notice in the line graphs that most of the compared indices/indicators of deprivation/welfare tend to follow the same trend through states. In Figure 1 we see that in addition to the similarity in Equality Index value of longevity and knowledge the trend of their line graphs is

almost parallel which means that there is positive relation between longevity levels and knowledge levels in the 15 states of Sudan. In Figure 2 although the Equality Indices are not equal between the different indicators from 2006 and 2010 Sudan Health Household Surveys we see that line graphs of indicators represented from the two surveys take almost the same trend through states; the highest difference in this respect is shown by unsafe water line graphs. In figure 3 also the line graph show clear relationship between the four presented poverty indicators from the 2009 SHBLS Survey.

Figure 1: The Graphs of Percentage Distribution of P1, P2 and P3 Indices of deprivation for Sudan State as Obtained from the 2008 Population Census Data and the Equality Index Value (EIX) for each distribution



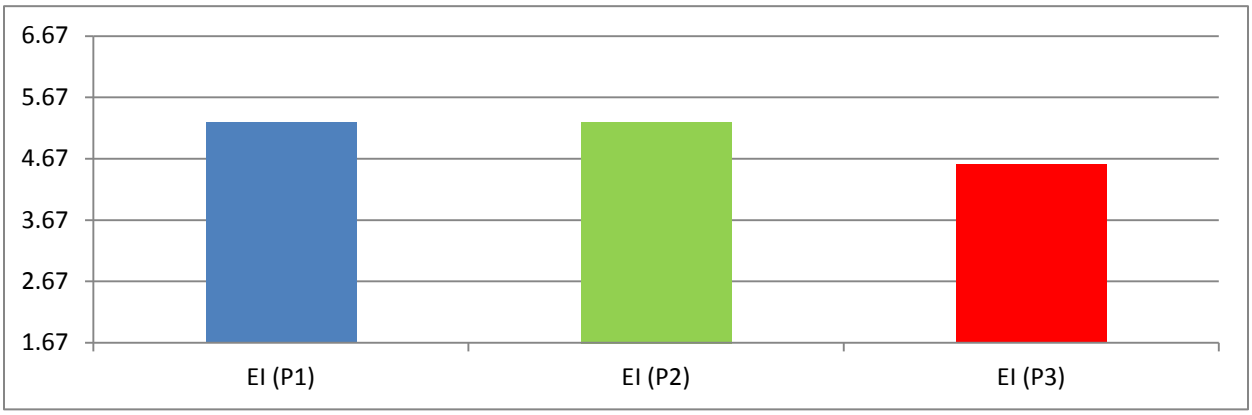


Figure 2: The Percentage Distribution of Children Underweight, Unsafe Water and Poor Sanitation Indicators for Sudan States as Obtained from the 2006 and the 2010 Sudan Household Health Surveys Data, and the Equality Index Value (EIX) for each distribution

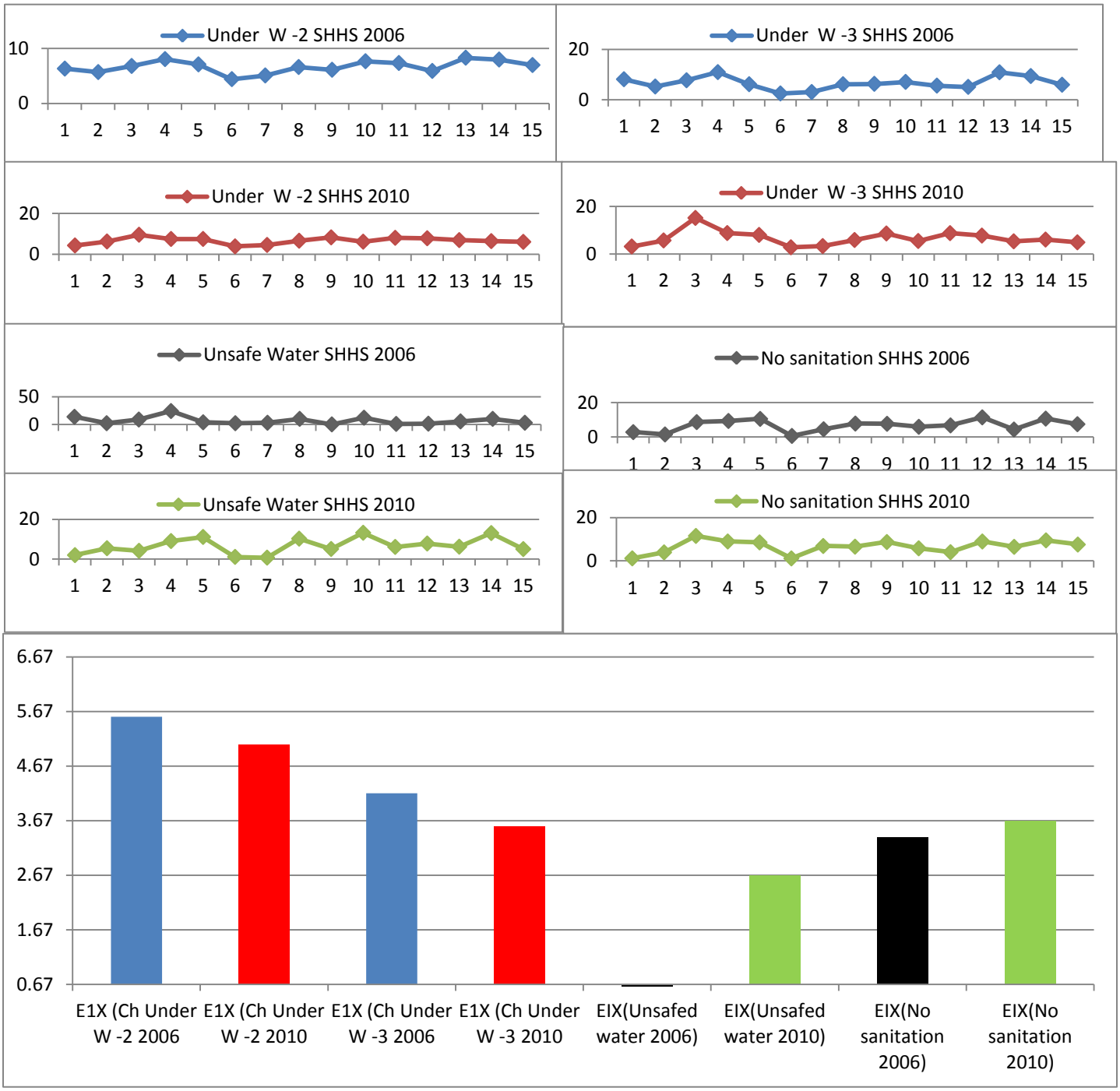
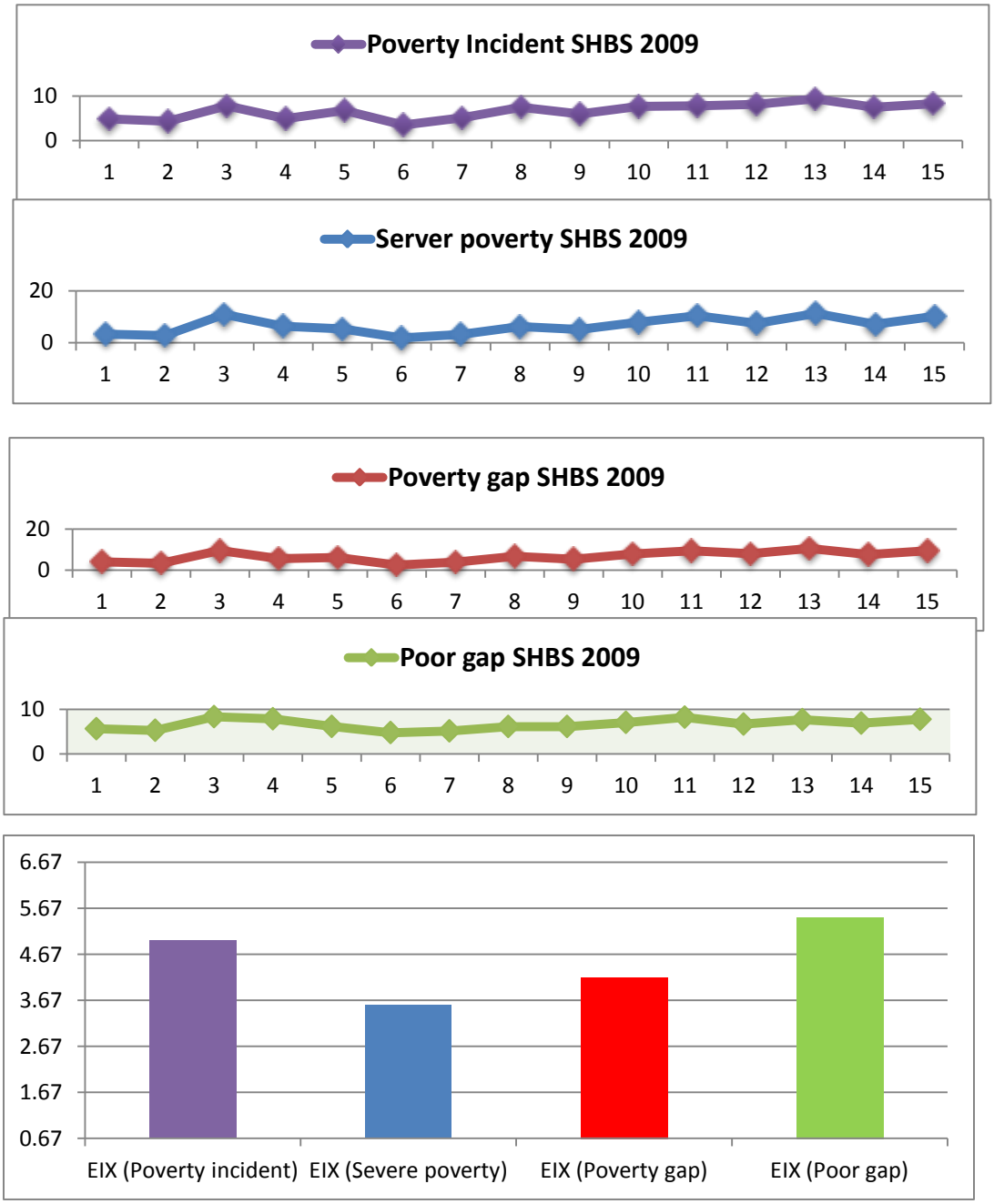


Figure 3: The Graphs of Percentage Distribution of Poverty Indices deprivation for Sudan State as Obtained from the 2009 Sudan Household Baseline Survey Data, and the Equality Index Value (EIX) for each distribution



In the above discussion we used the Equality Index (EIX) defined as the difference between the standard mean (SM) and the Standardized Standard Deviation (SSD) to measure equality levels for a 15 administrative units of a country that assigns to standard mean SM equals 6.67. To our view this measure acquires comparability validity to compare equality levels across different variables and through time for this number of administrative units. However, to compare between equality levels in specific variable between countries or regions with different number of administrative units there would be some limitation in the validity of this comparison. This is because the value of SM increases a little bit with increasing number of units. To solve this problem we can use the EIX as percent of SM; and denote it as EIX%. The following is an example to compare equality in the standard of living index P3 between Sudan (15 country subdivisions) and South Sudan (10 country subdivisions) calculated by Mr. Sulieman from the 2008 Population Census that conducted before the separation of the South. This index includes unsafe water, poor sanitation and children under weight. Table 5 shows the equality index values for the two countries. The table shows that the value of EIX% of P3 for South Sudan was higher than that of Sudan (81% versus 69%) which means that equality in standard of living among South Sudan states populations was higher than that among Sudan states populations. Although Sudan was better off than South Sudan equality in standard of living was higher in South Sudan than Sudan. This means that equality behaves differently in different welfare situations so that we find poor populations are more equal in standard of living than well-of populations, the case which is shown now between Sudan and South Sudan. An adverse case is what we showed above that the populations of the 15 states of Sudan were more equal in general poverty than severe poverty.

Table 5
Equality Index values of P3 (unsafe water, poor sanitation and children under weight) for Sudan and South Sudan Calculated from the 2008 Population Census Data

Index	Sudan	South Sudan
SSD	2.10	1.89
SM	6.67	10.00
EIX	4.57	8.11
EIX%	69%	81%

Calculated from Appendix 3

4. Equality targets and trends

In this section we are going to follow the way to equality among subdivisions from evaluation, monitoring and planning perspective. We are going first to evaluate equality levels among subdivisions between two points of times for different areas. Second, we are going to estimate the time to reach equality based on fixed target for the different areas, and the gap between the pace of change to reach this level and the actual experienced pace during specific period.

With respect to evaluation of equality trend we are going to use in addition to the SSD measure the Correlation coefficient statistic (CC). We found that as indicated in the Methodology Section a significant CC value between the welfare index values of subdivisions in a base year point and the differences of these values from a following point of time values would be an indicator of the level of improvement in equality between the two points of time. For a complete equality the CC between the two sets of elements would be -1; that is to say the higher the level of welfare of a subdivision the lower the improvement it would undertake during the period. On the other hand for a complete un-equality the CC value between the two set of elements would be +1. A significant value of CC between – 1 and +1 would indicate whether the direction of welfare trend among subdivisions during the period is going towards equality (negative CC) or un-equality (positive CC) and shows the level of this trend during the period. Table 6 presents the CC value between P1 (longevity deprivation) from the 1993 Population Census data and its differences from the 2008 Population Census data, and the Children underweight indicator from the 2006 SHHS Survey data and its differences from the 2010 SHHS Survey data. The table also presents a hypothetical trend of P1 with 5% decrements proportional to the value of the index for each subdivision to result in an inequality trend. As the table shows the CC value of the correlation between longevity index P1 in 1993 and its differences from P1 in 2008 is - 0.792**; this indicates a significant improvement in longevity equality of 0.79 CC level among Sudan states during the 15 years between 1993 and 2008. There was no evidence of improvement in equality in children health welfare level between 2006 and 2010 as the table shows. The improvement in equality for longevity between 1993 and 2008 through Sudan states resulted in a drop of SSD value from 1.6 to 1.4 as shown earlier in Table 2. In fact; from a demographic point of view longevity experiences inertial trend towards equality targeted on the long run by the life span. According to this mechanism the populations with higher longevity level tend to progress by slower rate than those with lower longevity levels irrespective of the advantages in the health services.

However, this behavior works in population with high life expectancies at birth. The hypothetical trend exercise indicate a complete un-equality in longevity of + 1** CC value as shown in the table.

Table 6
Evaluation of Equality Improvement for Longevity during
1993 & 2008 and Children Underweight between 2006 and 2010

Welfare area	Correlation coefficient between levels at the base year and differences during the period
Longevity P1(1993) _P1(2008)	- 0.792**
Children underweight -2 **2006_2010**	- 0.224
Children underweight -3 **2006_2010**	- 0.234
Hypothetical trend of P1	+ 1**

Calculated from Appendices 2, 3 and 4

With respect to strategic planning for equality we have to identify first the present situation of deprivation or welfare levels of the subdivisions; second, the time desired to reach equality, third the target level of equality. Then, we calculate the percent change of the value of the index per year during the period from the base year to the target year for each subdivision. This would be done by subtracting the values of deprivation index in the base year from the required target value, which always a fixed value, and divide the result by the number of years between the required points of time to reach equality. We identify here four scenarios to fix the equality target. The first one, we call it the ideal target, is a fixed level below the minimum deprivation level, where all subdivision would progress to reach it. The second one, we call it forward equality target, is the minimum value of the deprivation level in the country subdivisions where all other subdivisions would progress forward to reach it. The third one is an intermediate fixed level where some of the subdivisions would progress forward to reach it and some would deteriorate backward to reach it. The fourth, we call it backward equality target, is the maximum level of deprivation where all other subdivisions retard backward to reach it. The first two scenarios represent a prosperous situation with development potentials that should grantee the required achievements. The second two scenarios represent a ruined situation that sacrifices the welfare levels of part or all of the subdivision to go down to it.

However, it is very hard to take the last two scenarios strategies whatever the ruined situation is; in this case one may say that equality is no more a merit.

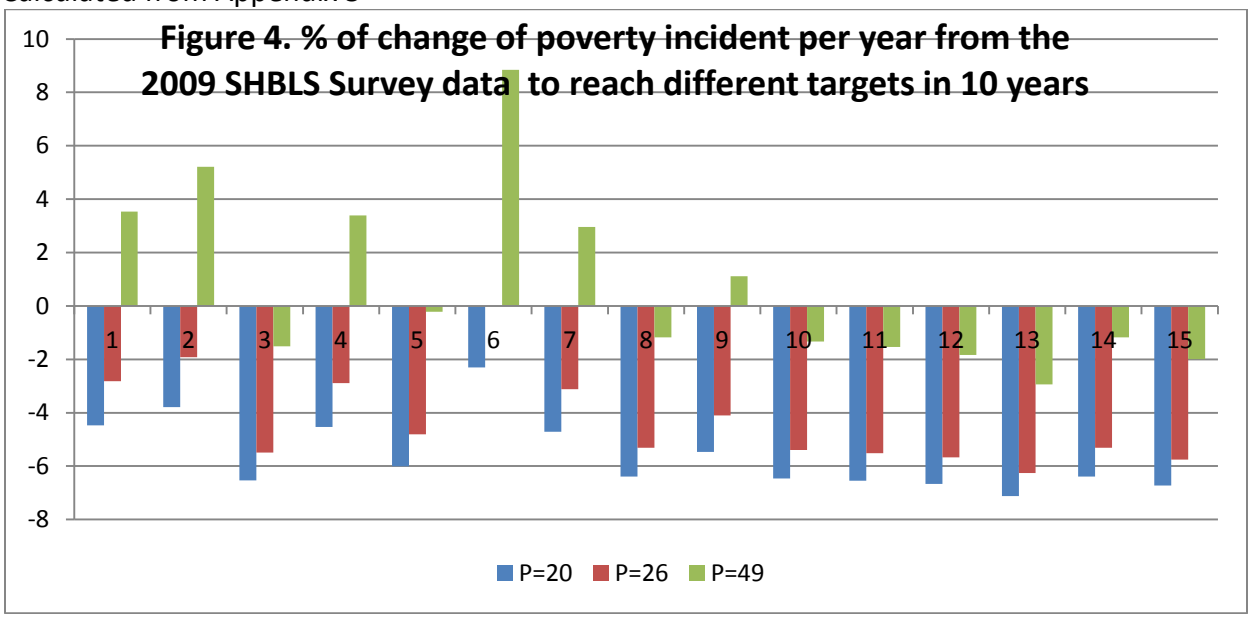
In the following examples we are going first to use the first, second and third scenarios for the poverty incidents indices from the 2009 SHBLS Survey data to find percentages of change per year of poverty in the different states to come to the ideal level, minimum and average level of the 15 states by 2019 (10 years period). Second we are going to use the second scenario to find percentages of change per year in longevity deprivation indices from 2008 Census data to reach by 2018 the minimum level registered by the states in 2008; and find the gaps between this rate and the rate derived from the actual trend between the year 1993 and the year 2008.

Table 7 presents the poverty incident index for Sudan states from the 2009 SHBLS Survey data and the percentages of changes to reach three targets: an ideal target of poverty incident index = 20; a forward target of index = 26, the minimum index of the 15 states; and the intermediate target with index = 49, the average index of the 15 states. Figure 4 is a graphic representation of these percentages. As shown in the table and figure, for the ideal and forward scenarios all states should have to experience improvements in their poverty levels by different rates to reach the fixed targets (except the state with the minimum incident index for the forward scenario; its poverty index would be constant during the period). For the intermediate scenario six states should have to experience deterioration in their poverty levels to be equal with other states. The state with the highest poverty incident index in 2009 (69.4) should have to decrease its poverty incident index by 6.25% per year to be equal with other states in 2019 at the 26 poverty index level according to the forward scenario. For the intermediate scenario the poverty index of the state with the minimum index (26) should be increased by 8.8 % per year to be equal with other states in 2019 at the 49 poverty incident index level.

Table 7
Poverty Incident Index from the 2009 SHBLS Survey Data and the Percentages of Changes to Reach the Required Target Level in 10 Years Period by State and Target

State	Poverty Incident	Percentage of Change per Year		
		Ideal target Index = 20	Forward Scenario Index= 26	Intermediate Index = 49
Northern	36.2	-4.48	-2.82	3.536
River Nile	32.2	-3.79	-1.93	5.217
Red Sea	57.7	-6.53	-5.49	-1.51
Kassala	36.6	-4.54	-2.9	3.388
Al-Gaadarif	50.1	-6.01	-4.81	-0.22
Khartoum	26.0	-2.31	0	8.846
Al-Gezira	37.8	-4.71	-3.12	2.963
White Nile	55.5	-6.4	-5.32	-1.17
Sinnar	44.1	-5.46	-4.1	1.111
Blue Niile	56.5	-6.46	-5.4	-1.33
Northern Kordofan	57.9	-6.55	-5.51	-1.54
Southern Kordofan	60.0	-6.67	-5.67	-1.83
Nrthern Darfur	69.4	-7.12	-6.25	-2.94
Western Darfur	55.5	-6.4	-5.32	-1.17
Southern Darfur	61.2	-6.73	-5.75	-1.99

Calculated from Appendix 5



With respect to the longevity deprivation, generally speaking, as indicated above, there is evidence of improvement of equality in longevity between 1993 and 2008 from the significant - 0.792 correlation coefficients between the longevity deprivation index values and the differences of the index values between 1993 and 2008. However the rates of change of the index for the different states would never lead to complete equality of CC = -1 at any time. To adjust these rates according to a forward equality target in 10 years period from 2008 to 2018 Table 8 shows the rates of decrease of longevity deprivation index for the 15 states of Sudan between 1993 and 2008 and the rates that have to be experienced to reach equality at the 7.53 level (the minimum value of the index of the 15 states) in 2018; and the gaps between the two sets of rates. Figure 5 is a graphic representation of the data in this table. As shown in the table, for the actual trend all states (except the state with the minimum level) experienced a decrease in their longevity deprivation indices; but the pace of this decrease varies inconsistently with the longevity deprivation levels of the states in 1993. The gaps between the actual trend and the forward trend presented in the table show that some states improved with pace of decrease of longevity deprivation index lower than that required for the forward equality levels and some with pace higher than that required for the forward equality levels. Figure 5 presents the gaps between the two sets of rates. In the upper part of the figure the blue/light color represents the states with rates of decrease of longevity deprivation index during 1993-2008 lower than the required rate to achieve forward equality target in 2018; in the lower part of the figure the pink/dark color represents the states with rates of decrease of longevity deprivation index in 1003-2008 faster than the required target. As shown in Figure 5 the states with rate of decrease of the longevity deprivation index during 1993-2008 faster than the required equality target rate (Negative gaps in Table 8, pink/dark color in the lower part of Figure 5) are more than those with the slower rate (Positive gaps in Table 8, blue/light color in the upper part of Figure 5).

Table 8
Longevity Index from the 2008 Population Census Data, the percent rate of change per year between 1993 and 2008, the Percent rate to Reach Equality in 10 and the Gap between the two rates

State	Longevity Index	Percentage of change		Gap to achieve equality
		Actual trend 1993-2008	Forward Scenario Index= 7.53	
Northern	7.55	-1.90	-0.02	1.88
River Nile	8.46	-1.03	-1.10	-0.07
Red Sea	8.70	-3.57	-1.34	2.22
Kassala	9.61	-3.09	-2.17	0.92
Al-Gaadarif	11.56	-1.01	-3.49	-2.47
Khartoum	7.89	-2.43	-0.45	1.98
Al-Gezira	7.53	0.08	0.00	-0.08
White Nile	9.29	-1.93	-1.89	0.04
Sinnar	10.73	-1.57	-2.98	-1.42
Blue Niile	15.35	-1.45	-5.09	-3.64
Northern Kordofan	9.76	-1.14	-2.28	-1.15
Southern Kordofan	11.86	-2.09	-3.65	-1.56
Nrthern Darfur	8.47	-2.61	-1.11	1.50
Western Darfur	11.10	-1.49	-3.22	-1.73
Southern Darfur	9.37	-1.87	-1.97	-0.09

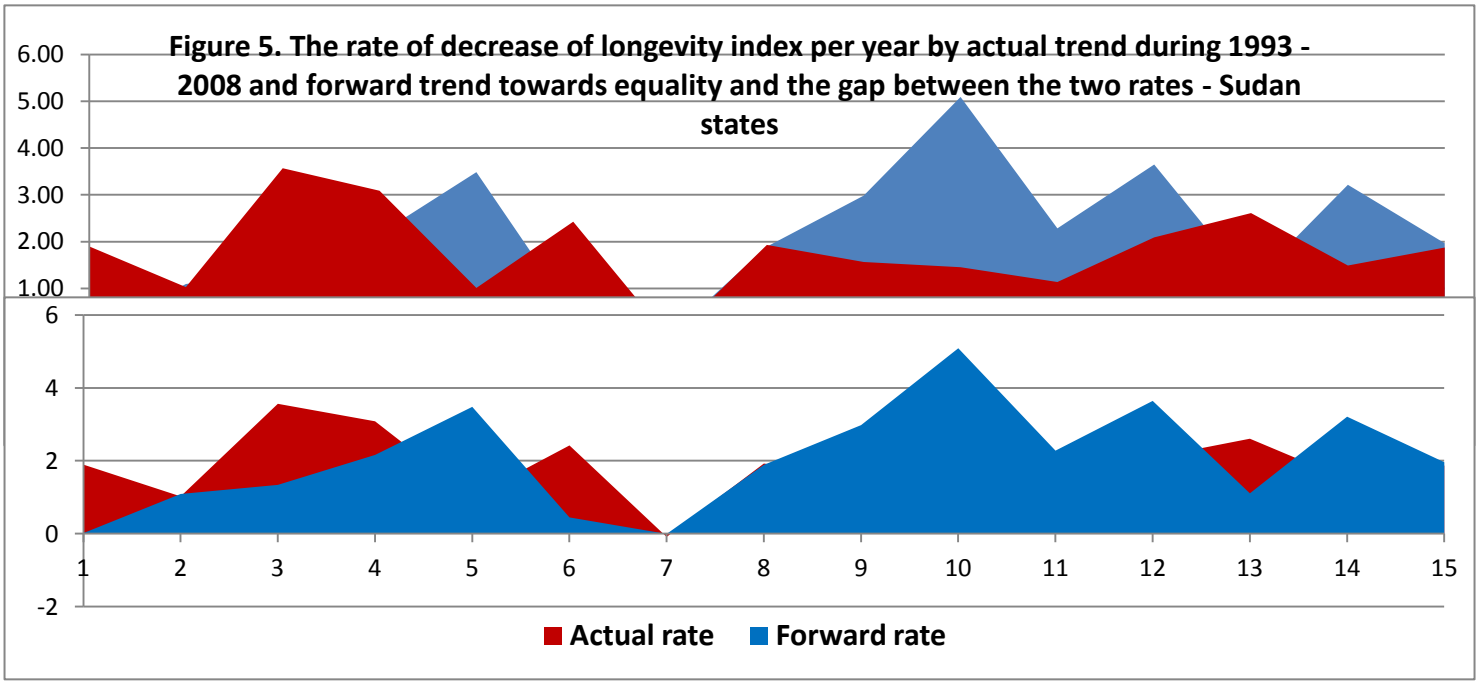


Figure 5. The rate of decrease of longevity index per year by actual trend during 1993 - 2008 and forward trend towards equality and the gap between the two rates - Sudan states

5. Relationship between poverty and unmet needs

In the previous sections we discussed equality issues using both poverty and unmet need indices and indicators. By poverty indices we mean indices that reflect the levels in income deprivation and by unmet indices/indicators we mean those which reflect deprivation in vital services. A question may arise in this respect which is more beneficial for equality of welfare among populations, equality in income levels or equality in vital services levels. Somewhere earlier in this paper we pointed that equality in socioeconomic services depends mainly on the distribution of these services; but this does not wash the proposition that it depends also on equality in household income. In fact three cases can be pointed out to detect the effectiveness of income poverty and unmet needs: first, the case where the services are there but they are not affordable; second, the case where the services are there but they are not used by the community population not because of its cost but because of other social or traditional factors; third, the services are not there or they are not adequately available In-depth research could be made to study these three cases. In this section we are going to throw some lights on the relationship between the income poverty and different unmet needs. We are going to use linear regression of income poverty as independent variable against other unmet need variables as dependent variable. We use here the poverty incident index from the 2009 SHBLS Survey data and other indices/indicators on unmet need from the 2008 Population Census and the 2010 SHHS Survey. Table 9 presents the dependent variable coefficients and the Adjusted R^2 values from the regression operations between the poverty incident indices and the different deprivation indices of other poverty related variables. The first clear observation in the information presented in this table is that the there is strong relationship between poverty index variable from the 2009 SHBLS Survey and longevity index variable P1 calculated by Mr. Nur, knowledge index variable P2 calculated by Mr. nur, and economic deprivation index variable P3 calculated by Mr. Sulieman. These relationships are significant at the 0.002 significance level or lower for the three variables coefficients. The adjusted R^2 values indicate that 50% or more of the variation in these three variables are accounted by the variation of the poverty incident variable. This means that most of the longevity, knowledge, and socioeconomic levels represented in the deprivation indices of Mr. Sulieman (see Appendix 1) are affected by the household income level. The children underweight -2 and the illiterate variables registered a significant relationship with poverty incident from the 2009 SHBLS Survey but with low R^2 value as shown in the table. The unsafe water and the

sanitation variables from the 2010 SHHS data, which included in Sulieman's P3 index from the 2008 population census data, show relatively weak relationship with the 2009 poverty incident variable. This may be justified by the fact that the Sulieman's P3 includes also the children underweight variable from the 2008 population census data which proved to have significant relationship with poverty; in addition to the fact that the unsafe water and sanitation variables from the 2008 population census treated as a combined indicator in Sulieman's P3 whereas those from the 2010 SHHS treated as individual variables.

Table 9
Regression Statistics of Poverty Incident Indices of
Sudan States as Independent Variable by Different Unmet Needs as
Dependent Variables

Dependent Variable	Constant Coefficient/ Significance Level	Variable Coefficient/ Significance Level	Adjusted R^2
P1 (Sulieman)	3.74 (0.027)	0.12 (0.001)	0.53
P2 (Sulieman)	5.2 (0.358)	0.54 (000)	0.63
P3 (Sulieman)	4.5 (0.650)	7.6 (0.002)	0.51
Children Under weight -2 SHHS 2010	17.4 (0.037)	0.34 (0.037)	0.24
Unsafe water SHHS 2010	- 1.7 (0.90)	0.51 (0.084)	0.15
Poor sanitation SHHS 2010	4.5 (0.768)	0.61 (0.059)	0.19
Illiterates 2010	32 (013)	0.52 (0.036)	0.24

Calculated from Appendices 3 and 4

6. Summary of findings

A. Methodological issues

- The percentages of the Standard deviation is used to measure equality of welfare among subdivisions of a country; it is denoted in the paper as Standardized Standard Deviation (SSD).
- The mean of the percentages of values of different variables of subdivisions of a country is found to be constant for the specific number of subdivisions; it is dented in the paper as Standardized Mean SM.
- The compliment of the SSD to the SM is found to be a measure of equality of welfare among subdivisions with minimum value equals zero and maximum value equals the SM; it is denoted in the paper as Equality Index (EIX).
- The percentage of EIX from the SM (EIX%) is taken to be a measure to compare equality in different welfare items between countries with different number of subdivisions.
- The correlation coefficient between values of welfare index and the differences of these values from values of the index in subsequent time is taken to be a measure of improvement of equality between the two points of time.

B. Analytical issues

- According to Mr. Nur's estimates, equality level in longevity and knowledge components of poverty among Sudan states was the same in the long past and higher than that of economic component; and equality among populations of rural areas of the states was higher than that of urban populations of the states.
- Equality in Longevity and knowledge components of welfare depends highly on health and education services whereas on economic components of welfare depends mostly on individuals economic activities.
- According to Mr. Nur's estimates and estimates from the 2008 population census data equality in longevity and knowledge components of poverty improved by the same level in the period between Mr. Nur's reference time and the year 2008.
- Equality in levels of children health among Sudan states was higher than equality in level of quality of water and sanitation among these states according to both 2006 and 2010 SHHS surveys. However, this equality dropped down for children health level between 2006 and 2010 while went

highly up for quality of water and with small increase for quality of sanitation.

- Equality levels of satisfaction in different needs including education, health among Sudan states was higher than that of satisfaction in nutritional requirements.
- According to the 2009 SHBL Survey equality level in severe poverty gap among Sudan states populations was higher than that in poverty gap.
- According to the 2008 Population Census data equality level in standard of living among South Sudan states populations in 2008 was higher than that among Sudan states populations.
- The data from the 1993 and 2008 Population Censuses showed that there was considerable improvement in equality level of longevity among Sudan states populations between the years 1993 and 2008.
- According to the forward scenario the poverty incident index of the state with the highest index in 2009 (69.4 poverty index level) in Sudan should be decreased by 6.25% per year to be equal with other states in 2019 at the 26 poverty index level.
- According to the intermediate scenario the value of poverty incident index of the state with the minimum index (26) should be increased by 8.8% per year to be equal with other states in 2019 at the 49 poverty incident index level.
- According to the 2008 Population Census and the 2009 SHBLS Survey data 50% or more of the variation in longevity knowledge and economic deprivation levels among Sudan states were accounted by the variation of poverty incident levels in these states.
- The 2010 SHHS and the 2009 SHBLS Surveys data showed a significant relationship between poverty incident and children underweight -2 variables; and poverty incident and illiterate variables.

Appendix 1
Poverty Indicators

Mr. Nur's Poverty Indicators

Deprivation in survival Index (P1)

- The probability that a person will die before age 40
- The probability that a child will die before his fifth birth day
- The probability that a child will die before his first birth day

Deprivation in knowledge Index (P2)

- Adults (15*) who are unable to read and write (%)
- Children at the age of education who never attended and/or dropout of basic education (%)
- Adolescents at the age of secondary education who never attended and/or dropout of secondary education (%).

Deprivation in economic provisioning Index (P3)

- People with no access to electricity (%)
- People with no access to safe drinking water (%)
- People with poor sanitation (no toilets) (%)
- People dependent on biomass energy (%)
- People with income below the food poverty line (%)

Mr. Sulieman's Poverty Indicators

Standard of living Index (P3)

- % of population with no safe source of water
- % of population underweight children
- % of population with no sanitation

Sources:

[1] Nur, Eltahir Mohamed Nur, Income and Human Poverty in Sudan, an Empirical Assessment, 2003.

[1] Sulieman, Jamaleldeen Abd Elrazig Sulieman, Human Poverty in Sudan, An Empirical Analysis, 2008.

Appendix 2

Nur's Poverty Index Values for Longevity (P1). Knowledge (P2) and Economic Provisions (P3) by Mode of Residence and State - Sudan

State	P1 Total	P2 Total	P3 Total	P1 Urban	P2 Urban	P3 Urban	P1 Rural	P2 Rural	P3 Rural
Northern	10.56	24.30	57.56	9.57	27.99	40.38	10.7	23.86	63.07
River Nile	10.00	42.23	51.73	8.03	19.29	37.24	10.83	44.78	62.32
Red Sea	18.73	40.74	68.63	16.43	21.1	44.44	21.47	45.27	85.27
Kassala	17.91	49.10	66.62	14.93	36.21	55.04	19.2	51.91	77.78
Al-Gaadarif	13.63	48.16	65.30	11	34.2	56.83	14.5	50.36	73.16
Khartoum	12.40	45.33	37.75	12.2	18.12	32.05	13.4	49.18	42.47
Al-Gezira	7.44	35.40	52.83	3.67	14.07	38.65	8.33	37.11	60.6
White Nile	13.08	41.54	66.13	11.67	20.01	50.57	13.8	44.78	77.19
Sinnar	14.03	43.12	59.22	12.97	27.93	52.24	14.37	45.6	64.52
Blue Nile	19.63	64.62	73.04	17.93	35.52	60.79	20.07	71.73	95.41
North Kordofan	11.77	67.86	66.34	9.97	27.24	56.96	12.33	73.28	86.14
South Kordofan	17.28	50.29	72.20	16.4	26.02	65.95	17.47	55.36	78.53
North Darfur	13.93	56.15	66.23	10.4	23.4	55.28	14.63	61.45	80.26
West Darfur	14.30	65.83	71.76	12.43	39.42	64.53	14.5	70.24	85.69
South Darfur	13.04	54.82	65.50	10.9	35.11	55.58	13.43	57.78	77.53

Source: [1] Nur, Eltahir Mohamed Nur, Income and Human Poverty in Sudan, an Empirical Assessment, 2003.

Appendix 3

Poverty Index for Longevity (P1) and Knowledge (P2) Calculated from the 2008 Population Census Data and those for Longevity (P1), Knowledge and Standard of Living (P3) Calculated by Sulieman

State	*P1 2008 Census	*P2 2008 Census	**P1 Sulieman	**P2 Sulieman	**P3 Sulieman
Northern	7.55	20.44	7.24	29.80	20.18
River Nile	8.46	26.72	8.87	23.50	28.79
Red Sea	8.70	57.28	10.40	28.50	58.74
Kassala	9.61	56.34	10.64	29.90	55.20
Al-Gaadarif	11.56	41.07	9.78	39.50	48.94
Khartoum	7.89	18.24	5.66	14.40	15.20
Al-Gezira	7.53	27.00	5.89	18.30	29.55
White Nile	9.29	34.59	8.87	33.40	45.68
Sinnar	10.73	38.20	10.40	26.00	34.65
Blue Nile	15.35	49.50	11.84	37.10	47.11
North Kordofan	9.76	51.66	9.78	33.50	46.28
South Kordofan	11.86	50.86	11.27	36.70	42.71
North Darfur	8.47	40.94	11.52	40.00	49.73
Wes Darfur	11.10	56.19	12.00	42.80	52.32
South Darfur	9.37	56.18	11.52	40.90	49.82

Source: * Calculated from the 2008 Population Census data. ** Sulieman, 2008

Appendix 4

Different Indicators from the 2006 SHHS and the 2010 SHHS Surveys (%)

State	Children Un W-2 2006	Children Un W-2 2010	Children Un W-3 2006	Children Un W-3 2010	Unsafe water 2006	Unsafe water 2010	Poor sanitation 2006	Poor sanitation 2010	Illiterates 2010
Northern	30.1	22.2	11.5	6.8	3.3	6.8	14.3	6.1	37.40
River Nile	27.1	32.2	7.4	12.3	0.5	18.9	7.5	20.4	50.00
Red Sea	32.4	49.2	10.9	32.7	2.1	14.4	43.8	59.7	57.90
Kassala	38.4	38.5	15.5	19	5.8	31.5	47.2	46.4	67.10
Al-Gaadarif	33.8	38.6	8.7	17.3	0.9	38.7	53.2	44.3	66.20
Khartoum	21	19.9	3.5	6.1	0.5	3.7	3.1	6	41.60
Al-Gezira	24.2	23.5	4.3	7.2	0.7	2.4	22.8	35.6	40.80
White Nile	31.5	34.1	8.7	12.7	2.4	35.7	39.5	34	54.00
Sinnar	29.1	42.6	8.9	18.6	0	17.6	38.8	45.1	60.50
Blue Nile	36.5	31.7	10	11.8	2.9	46	30	30.1	69.80
North Kordofan	35	41.4	7.9	18.9	0.2	21.2	34.1	20.8	61.20
South Kordofan	28.1	40.3	7.2	16.7	0.3	27.2	57.8	46.4	63.10
North Darfur	39.6	35.7	15.4	11.5	1.3	21.6	22	33.6	54.90
West Darfur	38	33.1	13.3	13.1	2.4	45.5	54.1	49.1	83.10
South Darfur	33.2	31.2	8.4	10.6	0.7	17.4	37.7	39.1	65.10

Sources: The 2006 Sudan Household Health Survey and the 2010 Sudan Household Health Survey

Appendix 5

Poverty Indices from the 2009 SHBLS Survey

State	Poverty Incident	Sever Poverty	Poverty gap	Poor gap
Northern	36.20	4.20	10.50	29.10
River Nile	32.20	3.50	8.80	27.30
Red Sea	57.70	13.70	24.90	43.10
Kassala	36.60	8.00	14.70	40.60
Al-Gaadarif	50.10	6.70	15.90	31.80
Khartoum	26.00	2.40	6.40	24.70
Al-Gezira	37.80	4.10	10.10	26.60
White Nile	55.50	7.80	17.60	31.70
Sinnar	44.10	6.40	14.00	31.70
Blue Nile	56.50	9.90	20.60	36.50
North Kordofan	57.90	13.10	24.60	42.50
South Kordofan	60.00	9.40	20.70	34.50
North Darfur	69.40	14.20	27.40	39.60
Wes Darfur	55.50	8.90	19.80	35.60
South Darfur	61.20	12.70	24.50	40.10

Source: The 2009 Sudan Household Baseline Survey