Human poverty in Sudan: An Empirical Investigation

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Abstract

This study calculated the human poverty index for the Northern States of Sudan and examined its most important determinants with a view of examining the policy interventions that could have significant impact on human poverty reduction. The study employed secondary data obtained from the Multiple Cluster Indicators Survey for 2000 and the Statistical Year Book for the Sudan also for 2000, that's because Sudan has witnessed the ongoing civil unrest during the years following that time. The results reveal that some states, namely Khartoum, Nahr Al-Nil, and Northern state have the lowest HPIs. This is attributed to lower values of longevity (P_1), poverty in knowledge (P_2), reflecting the concentration of human development programs in these states. On the other hand, Western Darfur, Western Kordufan, Blue Nile, and Southern Kordufan are found to have the highest HPIs, attributed to the higher values of poverty in knowledge (P_2), and a poverty in the decent standard of living (P_3) in these states. Concentration of education and health services in the urban sector is the main reason of the higher gap in human poverty index between urban and rural areas. It is also observed that the difference between males and females in human poverty tends to be low because of the small difference in P_1.
The analysis focused on the impact of education and health policies that will more likely enhance longevity, knowledge and the standard of living, and thereby reduce human poverty in northern Sudan. In addition to doctors, the health variables considered in the analysis include hospitals, hospital beds and maternal and child health workers. The education variables include number of basic schools and high secondary schools, and teachers, as well as enrolment rate in basic schools.

Because of data limitations, simple regression methods are adopted at two levels along the lines of Mahran (2007). In the first stage some sets of data were used to examine the relationship between human poverty and its main determinants, while in the second stage other sets of data were used to examine the impact of health and education policies on human poverty determinants. Based on this analysis, inferences were made about the most effective policies for human poverty reduction.

The results of the first stage suggest that all human poverty sub-indexes have a significant effect on human poverty reduction. The results of the second stage may be summarized as follows: First, with the exception of hospital beds, all health variables considered in the analysis have no significant effect on the longevity index and hence on human poverty reduction. Secondly, enrolment rate in basic schools is the only one education variable that has a significant effect on the knowledge index. Finally, among all variables, doctors and enrolment rate in basic schools turned out to have significant effects on the standard of living index and hence on human poverty reduction. Based on these results, an increase in enrolment rate in basic schools, number of hospital beds or number of doctors tends to be the most important variables in reducing the human poverty index. Thus, to reduce human

poverty more attention should be given to the policies that encourage enrolment in basic schools, together with increasing the number of doctors and hospital beds, particularly in the least developed states. Together with economic growth, these measures could make an enormous difference in people's lives, which are the main goals of development.

{**Citation:** Jamal Eldeen Abd Elrazig Sulieman Jomah. Human poverty in Sudan: an empirical investigation. American Journal of Research Communication, 2015, 3(5): 54-79} www.usa-journals.com, ISSN: 2325-4076.

1. Introduction

Human poverty or impoverishment is a multidimensional concept that extends beyond the lack of what is necessary for material well-being. Among other dimensions, it encompasses the denial of opportunities and choices most basic to human development. Human poverty does not focus on what people do or do not have, but also on what they can or cannot do. In this sense, human poverty means "… deprivation in the most essential capabilities of life, including leading a long and healthy life, being knowledgeable, having adequate economic provisioning, and participating fully in the life of the community" (United Nations Development Program (UNDP), 1997).

Although there may be an association between poverty and underdevelopment, there are a number of reasons why care must be taken in using per capita income alone as a criterion of development. Thirlwall (1989) argues, "The provision of health services, education, housing, sanitation, safe water, and adequate nutrition, have come to be known in development literature in the 1970s as the basic needs approach to economic development.

According to Kaballo (1989), the basic needs approach reflects the necessity to ensure people's access to a bundle of essential goods and services. Generally, this bundle includes education, basic health, nutrition, water, sanitation and shelter". As for education, universal primary education should be basic and necessary, and should also be compulsory and available free to all (International Convention on Economic, Social and Culture Rights, 1986). "Water supply and sanitation are necessary for good health and are cited as "essential conditions for achieving a reasonable level of economic and social development" (Rovan, 1979) and as vital for attaining a reasonable minimum level of existence because water that is unsafe for human consumption carries and spreads disease (Bharier, 1978). Among all human needs, the need for food is perhaps the most basic since "nutrition is central to survival and is a critical factor in an individual's growth and capacity to function in society"" (cited in Berg *et al*, 1980).

1.1 Scope and Aim of the study

The human poverty index has become an important indicator to government and non-governmental organizations in designing poverty alleviation strategies. While a number of studies has been conducted on income poverty in Sudan, human poverty has received little attention. There is a general concensus that poverty in Sudan is associated largely with regional inequality and urban biased development strategies. While the social structure provides different forms of poverty alleviation mechanisms, yet the growth of poverty

indicates the decreasing capacities of these structures in maintaining social solidarity sufficient to eradicate poverty. The large regional disparities have given rise to social conflicts and civil unrest in many parts of the Sudan, including Southern Sudan, Darfur, Kordufan, and Eastern states. These regions are characterized by high death rates at all ages, malnutrition among children, low literacy rates, high levels of morbidity, scarcity in safe drinking water and many other shortages in basic human needs. Since this current phase of the civil unrest in Sudan is continuing from early 2000, this paper aimed at studying the human poverty in Sudan in the year 2000, as it represents an important point of the stability of Sudan, and the results remain very important to be applied after stabilization of the country. The specific objectives are:
to examine the differentials, if any, in human development between Sudan States, as well as the factors that may explain such differentials and to come up with policy recommendations regarding the eradication or elimination of human poverty in the Sudan**.**

2. Poverty in Sudan: A Review

Sudan is the largest country in Africa and the nineth largest in the world, with a total area estimated at 2.51 million square kilometers, representing 1.7% of the world surface area. Because of its sheer size, the country is covered by pervasive climatic and ecological zones. This diversity of geography is also reflected in its people. Thus, the country is multi-cultural, multi-ethnic, multi-lingual and multi-religious. Sudan is also sparsely populated because of its size compared to its total population. It is mostly characterized by arid and unpredictable weather conditions affecting vast stretches of the country that are subjected to bouts of extreme drought and/or substantial flooding.

According to the World Bank (2000), Sudan is one of the poorest countries in the world. Poverty is increasing together with the disparities in income distribution. The recent growth of agriculture has not ensured nation-wide food security, because of income inequality, regional differences in the patterns of agricultural growth and disruption caused by civil war. Social indicators for 16 northern states are lagging behind those of countries at the same level of per capita income. Adult literacy rate is 47 percent (59 percent for women). Basic social services, namely education, health and water and sanitation, have been seriously eroded as a result of the combined impact of civil war and natural disasters. Only some 30 percent of rural residents and 40 percent urban dwellers have access to safe drinking water. Primary school enrolment has declined to about 56 percent, and Access to health services is also limited.

2.1. Income Poverty

Using the Foster-Greer-Thorbecke type of poverty measures, Ali (1994) derived estimates for poverty in Sudan at four time points of critical significance to major economic policy changes in Sudan over the period 1968-93. Notwithstanding data and methodological issues, this work provides the only available estimates of several poverty measures for Sudan over such a fairly long period. Table (1) reproduces some of his results. A number of observations follow from this table: first; measured by the head count index, poverty in Sudan showed an increasing trend at a varying rate of increase over 1978-93. For example, the head count index increased from 54.3 per cent to 77.8 per cent and 91.4 per cent in 1978, 1986 and 1993, respectively. Also, the number of poor households increased at the period end-points from 1.7 million to 2.7 and 3.4 million, respectively. Second; the rate of spread of poverty started high in the rural areas, and over time it was overtaken by the rate of expansion of urban poverty. For

example, over 1968-78 the rate of spread of urban poverty was 2.6 per cent, which increased to 12.6 per cent over 1978-86 before declining to 7.8 per cent over 1986-92. The corresponding rates for the spread of rural poverty were 0.23 per cent, 3.29 per cent and 1.6 per cent respectively. Third; the urban areas were hit worst by both the spread and the incidence of poverty especially over 1986-92. This perhaps reflects the high weight of the poor who joined the urban areas as a result of the displacement by the civil war and other conditions of decline in the rural area.

Table (1): Poverty Trends in Sudan Over 1968-1993

Poverty Indicators	*Poverty Trends (1968-78)*			*Poverty Trends (1978-86)*			Poverty Trends (1986-93)		
	1968	**1978**	**Annual Change (%)**	**1978**	**1986**	**Annual Change (%)**	**1986**	**1993**	**Annual Change (%)**
Headcount (%)									
Rural	62.68	64.17	0.23	64.17	83.12	3.29	83.12	93.16	1.6
Urban	15.90	20.51	2.58	20.51	52.86	12.56	52.86	84.43	6.9
Sudan	51.59	54.26	0.50	54.26	77.8	4.61	77.8	91.41	2.2
Poverty Gap (%)									
Rural	28.11	30.56	0.84	30.56	51.67	6.79	51.67	62.61	2.8
Urban	4.56	8.58	6.53	8.58	24.38	13.94	24.38	47.78	10 09
Sudan	24.66	23.12	-0.64	23.12	45.43	8.81	45.43	59.35	3.89
No of Poor Households(000)	1181.0	1575.0	2.92	1575.0	2309	4.9	2309	2725	2.39
Rural	51.7	127.4	9.44	127.0	370	14.3	370	705	9.65
Urban	1305.8	1669.0	2.48	1669.0	2706	6.23	2706	3430	3.45
Sudan									
Mean Income of the Poor	75	104	18.43	104	2415	24.93	2415	85450	66.4
Rural	97	452	16.63	452	3440	28.88	3440	117200	65.5
Urban	71	446	20.17	446	2656	24.99	2656	90200	65.5
Sudan									
Poverty line (Ls)	136	777	19.04	777	6384	30.12	6384	270000	70.7
CPI (1987=100)	2.4	10.2	15.60	10.2	82.9	29.94	82.9	3691.9	72.0

Source: Ali (1994, cited in UNDP, 2006[a])
Notes: Estimates for 1968 and 1978 are based on Income and Expenditure Surveys for 1967/68 and 1978/80 by CBS.
Estimate for 1986 is based on the Migration and Labour Force Survey conducted by the Ministry of Labour in 1990 (relating to 1989).
Estimate for 1993 is based on Survey conducted by the Takaful Fund in February 1993.

The 1990s witnessed a massive increase in the number of poor households and a growing gap between income and cost of basic needs in the Sudan. Between 1978 and 1990 the share of the poorest 40% of the population dropped from 12% to 8% paralleled by a rise in the share of the richest 34% from 10% to 59% of GNP (Abdel Ati, 1996).

According to Laabas and Limam (2007), many studies have taken up the issue of the impact of public policies on social outcomes such as poverty reduction. However, the empirical evidence on the impact of public policies on poverty can best be characterized as mixed. Although from principle point of view public policy is expected to affect income distribution and poverty, the empirical evidence is not overwhelmingly in support of this claim.

One element of solution to this puzzle is provided by the World Development Report of the World Bank (2004) which remarked that despite the fact that Governments devote about a third of their budgets to health and education, very little of it goes to the poor. Even if funds

are dedicated to the poor people, the weak systems of incentives and delivery largely explain the lack of a consistent relationship between changes in structure of public spending and poverty.

On the other hand, various studies on the incidence of poverty that differ in nature from those using cross-country evidence reveal that spending on basic services such as primary and secondary education and basic health care, tend to reach the poor, while spending on tertiary services such as university education, hospital services, tend to be pro-rich (Van De Walle, 1996).

In another study Mahran (2007) has tried to identify the most promising public policy and related policy tools for accelerated poverty reduction in sudan. His analysis focus on public policies that will more likely spur economic growth, improve income distribution , and reduce poverty. In addition to investment the public policy variables considered in his analysis include government current expenditure, development expenditure, and expenditure on social services, while development expenditure is also disaggregated according to economic sector.

His results for the period 1971-2002 suggest that from all public policy variables, only investment and government current expenditure have significant effect on income growth and hence on poverty reduction. These results are attributed to a host of problems that the economy has encountered during the last three decades, which culminated in its dismal performance.

2.2 Human Poverty Indicators in Sudan

This section examines some human poverty indicators including Health care services, undernourishment, safe drinking water, sanitation, infant mortality, life expectancy, primary school enrollment and literacy.

2.2.1 Health care services

The health care system in the Sudan is one of the oldest in Africa. Initially, it was established to provide medical services to the colonial armies of Egypt and Britain and to the civil administration. The health system was western-oriented, urban-based and emphasized curative services. Since independence, the health care system infrastructure has undergone considerable expansion, starting in the early sixties, when the first ten-year development plan was formulated, and has continued since then. Table (2) below displays the developments in the health care facilities over the period 1979-2004.

It is desirable from table (2) that during 1979-2004 the number of hospitals has increased by more than doubled, increasing by 125.0 percent, while the number of hospital beds has increased by nearly 46.0 percent. The expansion of the health care infrastructure in the periphery is the most impressive, where health centers and primary health care units (PHCUs) have increased in number by 376 per cent and 171.0 percent, respectively. The irregular patterns of increase and decrease in the dispensaries and dressing stations could be due to errors in reporting, the upgrading of these facilities to conform to the pattern of health centers and PHCUs after the adoption of primary health care approach the closure of facilities due to population movement and/or displacement and to the changing patterns of nomenclature over time or geography. Standarization of health facilities by staffing patterns functions and structure is now underway.

Table(2): Development of health care facilities in Sudan 1979-2004

Year	*Hospitals*	*Hospital beds*	*Health centers*	*Dispensaries*	*Dressing stations*	*Primary Health Care Units (PHCU)*
1979	156	17004	212	870	1828	989
1981	160	17300	206	790	1417	1580
1983	171	17774	251	856	1396	2183
1985	190	18594	288	977	1291	2725
1987	200	18816	330	1145	1205	3080
1989	205	19200	399	1224	1259	3200
1991	216	20135	426	1271	1285	3155
1993	228	21024	477	1346	1388	3013
2000	309	23076	915	1475	1236	2558
2001	315	23168	969	1489	1243	2438
2002	332	23820	1012	1486	1270	2518
2003	334	23976	964	1612	1129	2401
2004	351	24785	1009	1423	771	2679
Cumulative change (%)	125	45.8	376	63.5	-57.8	170.9

Source: Fedral Ministry of Health (FMOH), 1995. Data for 2000-2004 are obtained from the Central Bureau of Statistics (2007).

Regional disparities in the distribution of health personnel mirror those of health facilities. Table (3) gives the distribution of health workers by category and State for 1993 and 2004. Once more, we observe that more than 54 percent of doctors, 53 percent of medical specialists and 59 percent of technicians employed by the government work in Khartoum state in 1993, while the corresponding figures for the year 2004 are 60.7, 62.0 and 69.7 respectively, though only 14 percent of the population lives there. The bias in favor of the urban and socio-economically affluent areas is due partly to the attractions of private practice and partly to the cumulative effects of past distribution of health facilities.

Table (3): Distribution of health workers by category and regions of Sudan, 1993-2004

Region	**Number of Health Workers (Ratio per 100,000 population)**									
	Specialists		**All doctors**		**Technicians**		**Med. assts**		**Nurses**	
	1993	**2004**	**1993**	**2004**	**1993**	**2004**	**1993**	**2004**	**1993**	**2004**
Khartoum	286	701	1,149	4739	991	2727	1,258	361	3,308	4948
	(8.4)	(12.6)	(33.7)	(51.8)	(29.0)	(49.1)	(36.9)	(6.7)	(96.9)	(89.1)
Central	106	203	391	806	206	471	1,005	803	4,173	3870
	(2.0)	(2.7)	(7.2)	(10.8)	(3.8)	(6.3)	(18,6)	(10.8)	(77.0)	(51.9)
Northern	30	58	129	235	83	170	423	396	1,629	1421
	(2.3)	(3.6)	(10.0)	(14.7)	(6.4)	(10.7)	(32.8)	(24.8)	(126.1)	(89)
Eastern	64	66	224	336	93	231	572	309	1,274	1916
	(2.1)	(1.6)	(7.3)	(8.3)	(3.0)	(5.7)	(18.7)	(7.7)	(41.7)	(47.5)
Kordofan	24	48	93	217	85	129	524	286	1,642	1772
	(0.8)	(1.2)	(2.9)	(5.5)	(2.7)	(3.3)	(16.6)	(7.2)	(51.9)	(44.8)
Darfur	18	36	65	154	116	143	463	324	1,009	1715
	(0.4)	(0.54)	(1.4)	(2.3)	(2.4)	(2.2)	(9.8)	(4.9)	(21.3)	(26.1)
Equatoria**	1	4	18	46	59	18	65	129	1,247	564
	(0.1)	(0.31)	(1.6)	(3.5)	(5.1)	(0.14)	(5.7)	(9.8)	(108.4)	(43.1)
B. ElGhazal	1	4	18	28	27	16	249	85	1,013	190
	(0.1)	(0.16)	(0.9)	(1.1)	(1.4)	(0.06)	(13.0)	(3.3)	(52.9)	(7.5)
Upper Nile**	1	4	10	52	18	9	21	73	711	504
	(0.1)	(0.26)	(0.8)	(3.5)	(1.4)	0.06	(1.7)	(4.8)	(56.5)	(3.3)
Sudan	531	1124	2,097	6604**	1,678	3914	4,580	2483	16.006	16900
	(2.1)	(3.3)	(8.3)	(19.1)	(6.6)	(11.3)	(18.0)	(7.2)	(63.0)	(49)

Source: Federal Ministry of Health, 1995. Data for 2004 are obtained from the Central Bureau of Statistics, 2007.

Notes: 1. Data for Bahr ElGhazal relate to posts approved in the annual budget for 1987, while that for Equatoria and Upper Nile are posts approved for the 1984/85 budget. 2. Figures in brackets are ratios per100000 population.** 1862 of doctors from the total are in the House officers department.

2.2.2 Undernourishment

Good nutrition is the cornerstone for survival, good health and development for current and succeeding generations. On the one hand, well-nourished children perform better in school, grow into healthy adults and in turn give their children a better start in life. Well-nourished women face fewer risks during pregnancy and childbirth, and their children set off on firmer developmental paths, both physically and mentally. On the other hand, undernourished children have lower resistance to infection, and are more likely to die from common childhood diseases such as diarrhea and respiratory infections. Furthermore, those who survive such infections always suffer from frequent illness, which reduces their nutritional status, making them more vulnerable to recurring sickness and faltering growth.

The underlying causes of undernutrition vary across regions and countries. Poverty, low levels of education, and poor access to health services are major common causes of childhood malnutrition. In Sub-Saharan Africa, the underlying causes of malnutrition include extreme poverty, inadequate caring practices for children, low levels of education and poor access to health services. Conflicts and natural disasters have further exacerbated the situation in many of these countries. The increase in the number of undernourished children in Africa also reflects a rapid rate of population growth. Furthermore, the devastating effects of HIV/AIDS in many African countries, particularly in the second half of the decade, have reversed some of the gains made in the decade's early years. In the case of Sudan, the UNICEF (1996) observed that information is available on several anthropometric measures to assess protein energy malnutrition in children less than five years of age. First, height-for-age (stunting), which reflects the long term effects of inadequate food intake and is thus helpful in identifying chronic malnutrition. Second, weight-for-height, which measures the current nutritional status, whereby any acute loss is indicated by thinness. Third, weight-for-age, which is a good measure of both current and past nutritional patterns and experience.

The results of Sudan Emergency Recovery Information and Surveillance System (SERISS) conducted in 1986/87, by far the first country-wide attempt at assessing the nutritional status of children in the aftermath of the drought of 1983-85, indicated that malnutrition was widespread with significant geographic variations. Of a total of 24 thousand children less than five years surveyed using weight-for-age, nearly 16.0 per cent were found to be malnourished, and of whom 2.2 per cent were severely malnourished (UNICEF, 1996).

The Sudan Maternal and Child Health Survey (SMCHS) conducted in 1993, and the Multiple Indicators Cluster Survey (MICS) conducted in mid-1995, provide the most recent comparable data on protein energy malnutrition among young children. The SMCHS reveals that in 1993, about 33 per cent of under-fives were stunted (height-for-age), 13 per cent suffered from wasting (weight-for-height) and 34 percent were underweight (weight-for-age). Results on wasting (weight-for-height) based on MICS revealed that 15 per cent of under-five in North Sudan and 29 in South Sudan were malnourished. The severely malnourished accounted for 6 per cent in the north and 15 percent in the south (UNICEF, 1996)

Older children (12-34 months) were affected more than others by both severe and moderate underweight. However, more rural children (13 per cent) were underweight than their urban peers (6 per cent). Darfur had the highest rate of acute underweight children in the country (16 percent) while Khartoum has the lowest (5 per cent). The Eastern region showed the highest prevalence of moderate underweight (16 per cent) and Khartoum the lowest (2 per cent). The SMCHS also indicates that the highest rate of acute and moderate underweight is to be found among children born to uneducated mothers at birth intervals of less than 2 years and (UNICEF, 1996).

Table (4) reports some comparative data on the percentages for Sudan and some selected countries of the population suffering from undernourishment, as defined by the FAO (2006). It is clear from the table that during 1990-1992, the average percentage of population suffering from undernourishment in developing countries is 20.0 percent, decreasing to 17.0 percent during 2001-2003. Eritrea registered the highest percentage of undernourished, estimated at 68.0 percent during the first period, which increased to 73.0 percent during the second period. The Democratic Republic of Congo is the second worst, witnessing a phenomenal increase in the percentage of the undernourished from 31.0 to 72.0 percent. During 2001-2003, Sudan ranked 24 in the list of developing countries with 27.0 percent of the population suffering from undernourishment, falling from 31.0 percent during 1990-1992.

Table (4): Population suffering from undernourishment in Selected Countries (%), 1990-2003

Rank	Country	Average % population suffering from undernourishment 1990-92	2001-2003
	Developing World	20.0	17.0
1	Eritrea	68.0	73.0
2	Democratic Republic of the Congo	31.0	72.0
24	**Sudan**	**31.0**	**27.0**
24	Dominican Republic	27.0	27.0
24	Nicaragua	30.0	27.0
48	Poland	2.5	2.5
48	United Arab Emirates	4.0	2.5
48	South Korea	2.5	2.5

Source: FAO (2006).

2.2.3 Safe Drinking Water

On the one hand, it has become obvious that access to adequate and safe drinking water is not only a fundamental need and human right, but also has considerable health and economic benefits to households and individuals. On the other hand, the lack of access to adequate and safe drinking water contributes to deaths and illness, especially among children. Thus, the improvement of access to adequate and safe drinking water is a crucial element in the reduction of under-five mortality and morbidity, in both rural and poor urban areas.

Drinking contaminated water is responsible for the transmission and outbreak of water-based diseases such as cholera, typhoid, diarrhea, schistosomiasis, and dysentery. Water-washed diseases occur when there is a lack of sufficient quantity for washing and personal hygiene, which facilitates, among others, the spread of skin and eye infections e.g. (trachoma).

Diarrhea is the most important public health problem affected by water and sanitation and can be both waterborne and water-washed. Hygiene promotion, which includes the simple act of washing hands with soap and water, can prevent one third of diarrhea disease and is therefore key in the prevention of waterborne diseases.

In the case of Sudan, it is observed that wells, surface water from rivers, and stored rain water are the main sources of drinking water in both urban and rural areas. According to the UNICEF (1996), “the underground sources primarily comprise deep boreholes equipped with motorized pumps called water yards, slim boreholes with hand pumps, and hand-dug wells; the surface water supply sources comprise the seasonal runoff catchment reservoirs called haffirs, and limited scale filtration plants constructed along the Nile (Rahad Scheme). However, these sources are not available to the majority of rural households which rely on

ponds, untreated water from rivers and other unsafe sources of surface water (Table 5).

Table (5): Sources of water in Sudan (1993)

Source	Number	Capacity (Cubic Meters/Day)	
		Installed	Actual
Water yards	4252	447600	146000
Hand pumps	8000	48000	32000
Dug wells	7000	56000	44800
Haffirs/dams	856	142000	56800
Sand filters	333	16500	8200
Total	20441	710100	287800

Source: National Water Corporation, cited in UNICEF (1996).

Rain water is channeled through hand-dug dams (hafirs) or natural ponds (folas). Water from haffirs and dams is usually unfiltered, and is consumed directly. As such, it is considered as unsafe source of drinking water. Livestock are also watered from the same sources and consume about 40 per cent of available supplies.

2.2.4 Sanitation

Lack of sanitation is a major public health problem that causes disease, sickness and death. Highly infectious diseases such as cholera still affect whole communities in developing countries.

Furthermore, through its impact on health and environment, inadequate sanitation has considerable implications for economic development. People miss days at work due to sickness resulting from excreta-related diseases. The increasing pollution of rivers and shorelines negatively affects businesses such as tourism and agriculture that are often vital to nations' economies.

As with access to safe drinking water, differences within the Sudan regarding the provision of sanitary services are evident. Estimates by the Central Bureau of Statistics (CBS, 2000), suggest that 40.3 percent of the population in Northern Sudan are not using sanitary means of extra disposal. Table (6) reports for 1993 the percentages of population with no access to sanitary services according to region and mode of living. We observe that more than 50 per cent of the population in Eastern and Central regions have no access to any sanitary facilities, compared to 15 per cent of the population in Khartoum. The disparities between rural and urban areas are even more apparent. The Eastern region registered the highest percentage of rural population with no access to such services, estimated at 68 percent, followed by the Central region with 57 percent, both of which are more than three times the percentage for Khartoum.

Urban sanitation facilities are fully financed by the house owners except for community sewege systems, which are financed from the government budget. The operation and maintenance costs of such systems are usually recovered from users through the charges. No records are available of significant government funding for rural sanitation. The limited coverage available is mainly due to the externally aided projects of WHO, UNICEF, the Netherlands, and international and national NGOs. Community contribution and participation are an integral part of these initiatives.

Table (6): Population (%) in Sudan with no access to sanitary facilities by region and mode of living, 1993

Region	Urban	Rural	Total
Northern	14	37	31
Eastern	34	68	53
Khartoum	15	18	15
Central	31	57	50
Kordufan	28	42	39
Darfur	10	35	32

Source: CBS, 1994, Derived from the 1993 Census of Sudan Advanced Sample Tabulations, Volume3.Khartoum.

2.2.5 Infant Mortality

The infant mortality rate (IMR) is defined as the number of deaths of infants (less than one year old) in a given year per 1,000 live births in the same year. This rate is often used as an indicator of the level of health in a country. According to UNECIF (2008), the world average infant mortality rate is estimated at 49.0 in 2006, falling from 64.0 in 1990. Table (7) reports the infant and under-five mortality rates for Sudan and some other selected countries during the period 1990-2006. Sierra Leone ranks as the country with the highest infant and under-five mortality rates, while Sweden, together with other countries, ranks as the country with the lowest such rates. Sudan ranks number 41 among 195 countries, with infant and under-five mortality rates estimated in 2006 at 61.0 and 89.0, respectively, falling from their 1990 levels of 74 and 120, respectively.

Table (7): Infant mortality rate in selected countries, 1990-2006

Country	Mortality rate (deaths/1,000 live births)				
	Infant		Under-five		
	1990	2006	1990	2006	Rank
Sierra Leone	169	159	290	270	1
Angola	154	154	260	260	2
Afghanstan	168	165	260	257	3
Central African Republic	114	115	173	175	15
Ethiopia	122	77	204	123	30
Sudan	**74**	**61**	**120**	**89**	**41**
Eritrea	88	48	147	74	51
Sweden	6	3	7	3	189
Developing Countries	**70**	**54**	**103**	**79**	**--**
Developed Countries	**9**	**5**	**10**	**6**	**--**
World	**64**	**49**	**93**	**72**	**--**

Source: UNICEF: State of World's Children, New York, 2008.

2.2.6 Life Expectancy

Life expectancy at birth is defined as the average number of years to be lived by a group of people born in the same year, if mortality at each age remains constant in the future. No doubt that life expectancy is influenced by a whole range of factors, of which the health status is probably the most important.

Table (8) below reports estimates of life expectancy for Sudan and some selected countries in 2006, as well as expected values by sex for the period 2005-2010. We observe that, estimates of overall average life expectancy at birth for the period 2005-2010 ranges from 82.6 years in Japan to 39.6 years in Swaziland. For Sudan, the estimate of life expectancy for males is 3% less than that of females(57.1years and 60.1years respectively) with an overall value of 58.6

yars, which is 12.8 percent below the world average. It may be observed that many of the countries with the lowest life expectancies, such as Swaziland, Lesotho, South Africa, Namibia, Malawi, and Mozambique, also suffer from very high prevalence rates of HIV/AIDS infection, with adult prevalence rates ranging from 13.2 in Mozambique to 38.8 percent in Swaziland (table on HIV). It is also observed that in countries with high infant mortality rates, life expectancy at birth will more likely be lower and may not reflect the life expectancy that of a person who has survived his/her first year of life.

Table (8): Life Expectancy (years) at Birth in Selected Countries, 2005-2010 Estimation

Rank	Country/territory	2005-2010			2006
		Male	Female	Overall	Overall
	World average	**65.0**	**69.5**	**67.2**	**68.0**
1	Japan	79.0	86.1	82.6	82.0
156	**Sudan**	**57.1**	**60.1**	**58.6**	**58.0**
169	Namibia	52.5	53.1	52.9	52.0
178	South Africa	48.8	49.7	49.3	50.0
180	Malawi	48.1	48.4	48.3	47.0
194	Mozambique	41.7	42.4	42.1	42.0
195	Swaziland	39.8	39.4	39.6	40.0

Source: United Nations: World Population Prospects (2006 Revision) and UNECIF (2008)

2.2.7 Primary School Enrollment

Although it might seem a relatively straightforward goal, universal education has proven as difficult as any to achieve. Decades after commitments and reaffirmations of those commitments have been made to ensure a quality education for every child. However, table (9) reports some basic indicators on education in Sudan and selected countries for the period 1996-2006. It is clear that in many countries, the net total primary school enrolment/attendance ratio has improved over the years. For Sudan, the ratio has improved from an average of 53 during 1996-2004 to an average of 58 percent during 2000-2006. Although the enrolment ratio favours males, the attendance ratios are almost the same for both sexes, estimated at 54 and 52 percent, respectively.

Table (9): Primary school enrollment and attendance Ratio in Selected Countries, 1996-2006

Region	*Primary school enrolment/attendance Ratio*		*Primary school enrolment ratio (2000-2004)*				*Primary school attendance ratio (1996-2004)*	
	1996-2004	2000-2006	Gross		Net		Net	
	Net Total	Net Total	Male	Female	Male	Female	Male	Female
Afghanistan	53	53	120	63	-	-	66	40
Ethiopia	31	45	79	61	55	47	33	28
South Africa	89	87	108	104	89	89	93	94
Sudan	**53**	**58**	**64**	**56**	**50**	**42**	**54**	**52**
Swaziland	72	93	102	94	75	75	72	71
Zimbabwe	79	82	94	92	79	80	85	86
World	82	86	108	101	88	85	76	72

Source: UNICEF: The State of the World's Children 2006, 2008.

The above estimates for Sudan are not significantly different from those reported by the Central Bearau of Statistics (CBS), which also provide some more disaggregated enrolment ratios. Thus, according to the CBS (1999), wide divergencies still exist at all levels of education between urban and rural as well as male and female. Table (10) reports estimates of

enrolment ratios by sex and mode of living for northen Sudan in 1999. The gross enrolment ratio in primary education for Sudan northern states reached 59.8 percent, with 78.1 percent for urban areas and 49.7 percent for rural areas, while the gross enrolment ratio in secondary schools reached 58.8 percent, 77.3 percent for urban areas and 46.6 percent for rural areas.

Table (10): Gross enrolment ratio in primary and secondary education for Northern Sudan by Sex and Mode of Living, 1999

Indicator	Gross enrolment ratio in primary education	Gross enrolment ratio in secondary education
Total	59.8	58.8
Male	61.8	62.9
Female	57.7	54.7
Urban	78.1	77.3
Male	78.9	78.8
Female	77.3	75.9
Rural	49.7	46.6
Male	52.6	52.6
Female	46.8	40.7

Source: Central Bureau of statistics, 1999

2.2.8 Literacy

Adult literacy rate is also considered one of the main indicators of human development. In countries with high literacy rates, the Human Development Index is also expected to be high. For Sudan, estimates by the Central Bearau of Statistics (CBS, 2000) suggest that 50 percent of the population aged 15 years and over were illiterate. Only 48.3 percent of children of primary school age were attending school, with the corresponding figures for males and females estimated at 49.7 and 46.9 percent, respectively. About 71 percent of children entering first class of primary school eventually reached class five (CBS, 2000)

Table (11) reports for some selected countries the adult literacy rates for the year 2005 and the adult female-male literacy ratio. We observe that in 2005 the adult literacy rate for the Sudan was nearly 61.0, which represents 78 percent of the World average estimated at 78 percent. This rate ranks Sudan as number 115 out of 177 countries. On the other hand, the adult literacy rate for females as percentage of males is nearly 73.0, which puts Sudan at a rank of 129 out of 177 countries. Compared to estimates reported by the CBS (2000), these estimates may indicate that some progress has been made since 2000 toward illiteracy eradication. Despite these efforts, poverty in knowledge still remains a tremendous challenge and the way to go toward realizing the MDG on literacy seems to be very long. According to the Federal Ministry of Education (2001), in 2000/2001 there were a total of 12,539 primary schools in Sudan, one school available for every 512 children in the school-going age of 6-13 years. While the ratio is one school for every 431 children in the north, it is one for every 3,417 children in the south.

Table (11): Total Adult Literacy Rate in Selected Countries, 2004 and 2005

Female-Male Ratio (%) 2004			***Adult (15+) literacy rate (%) 2005***		
Rank	**Country**	**Literacy rate**	**Rank**	**Country**	**Literacy rate**
1	Lesotho	122.5	1	Georgia	100.0
127	Ghana	75.0	113	Malawi	64.1
128	Mauritania	72.9	114	India	61.0
129	**Sudan**	**72.8**	**115**	**Sudan**	**60.9**
130	Malawi	72.1	116	Burundi	59.3
131	Egypt	71.5	117	Ghana	57.9
152	Afghanistan	29.2	139	Burkina Faso	23.6
				World	78.0

Sources: United Nations Development Program Reports 2004, 2005, New york, 2005-2006.

3. The Statistical Methodology and Data

According to the UNDP (1997), the Human Poverty Index (HPI) is measured on the basis of deprivation from three aspects of human development, namely: longevity, knowledge, and a decent standard of living. Deprivation in longevity, denoted (P_1) is measured by the percentage of newborns not expected to survive to age 40. More formally, we have:

$$P_1 = 1 - P(40) \quad (1)$$

Where P(40) is the probability of surviving to a specified age (40 years) for a given cohort.

Deprivation in knowledge, denoted (P_2) is measured by the percentage of adults who are illiterate. More formally, we have:

$$P_2 = 1\text{-}AL \quad (2)$$

Where: (AL) denotes the percentage of literate adults.

Deprivation in a decent standard of living denoted (P_3) is measured by the arithmetic average of three variables; the percentage of people not using improved drinking water ($P_{3.1}$), the percentage of children below the age of five who are underweight ($P_{3.2}$) and percentage population with no sanitation ($P_{3.3}$). More formally:

$$P3 = (P_{3.1}+P_{3.2}+P_{3.3})/3 \quad (3)$$

Where: $P_{3.1}$, $P_{3.2}$ and $P_{3.3}$ are defined as mentioned above.

Accordingly the HPI may be calculated as:

$$HPI=[(P_1^3 + P_2^3 + P_3^3) / 3]^{(1/3)} \quad (4)$$

The analysis is based on primary data from the tabulations of fifth census for the Sudan in 2008 and some secondary data obtained from the Statistical Year Book for the Sudan 2006 and 2008. the empirical model is applied to the data and some regression methods are also adopted to identify the most important variables that impact on human poverty in Sudan as seen in the next section.

4. The Empirical Results:

4.1 The Human Poverty index:

This section reports the empirical results on human poverty in Sudan and the results of the regression methods applied to examine the most important determinants of human poverty, together with the impact of public policy on the human poverty index.

The human poverty index is calculated using equation (4) above. The results are reported in table (12) below, together with the rank for each state where the rank of one indicates the highest value of the HPI. Table (13) reports summary statistics of the results.

Table (12):Human Poverty Index (%) by States of Northern Sudan, 2000

State	P_1	P_2	P_3	HPI	Rank
Khartoum	24.8	25.1	22.0	24.0	16
Northern	20.4	28.5	39.9	31.7	15
Nahr-Elnil	18.2	28.3	41.2	32.0	14
Al-Gazira	25.1	41.4	34.3	34.9	13
Sinnar	28.3	50.0	38.4	40.8	12
Red Sea	39.2	48.0	37.2	42.0	11
Northern Darfur	32.1	51.9	44.9	44.4	10
White Nile	37.1	48.4	49.4	45.6	9
Al-Gadarif	37.3	56.7	42.8	47.1	8
Kassala	27.7	62.0	41.1	47.9	7
Southern Darfur	33.4	59.3	47.1	48.9	6
Northern Kordufan	29.9	59.8	49.8	49.5	5
Southern Kordufan	40.8	64.8	30.8	49.7	4
Blue Nile	23.5	63.3	49.6	50.6	3
Western Kordufan	33.7	65.6	41.3	50.7	2
Western Darfur	39.3	74.1	55.5	59.7	1

Source: Own calculations based on data from Multiple Indicators Cluster Survey, 2000.

Table (13):Descriptive Statistics for HPI and the Sub-Indices

	Number	Minimum	Maximum	Mean	Std. Deviation	Coefficient of Variation
HPI	16	24.00	59.70	43.718	9.093	0.21
P_1	16	18.20	40.80	30.675	7.056	0.23
P_2	16	25.10	74.10	51.700	14.566	0.28
P_3	16	22.00	55.50	41.581	8.226	0.20

Source: Own calculations based on data from table (12).

The values of the percentages of adults who are illiterate in all northern states range between 25.1 and 74.1 with an average of 51.7 percent (table 13), compared to ranges of 18.2-40.8 and 22.0-55.5 for newborns not expected to survive to age 40 and people not having a decent standard of living, with averages of 30.7 and 41.6 percent, respectively. These results may suggest that illiteracy among adults is the major cause of the high human poverty index in northern Sudan. The estimated values of the human poverty index and its three components suggest larger disparities between states in poverty in knowledge measured by (P_2) with a coefficient of variation of 0.28 compared to 0.23 and 0.20 for (P_1) and (P_3), respectively (table 13); the coefficient of variation of the HPI is estimated at 0.21.

In line with common beliefs, the concentration of services, particularly those related to health and education, in the capital city ranks Khartoum state at the bottom of the list of northern States with the lowest HPI of 24 percent (table 12). Northern State and Nar-Elnil State rank second and third, with values of HPI estimated at 31.7 and 32.0, respectively (table 12). These relatively low HPI values in these states correspond to the low values of P_1 and P_2 which, in turn, may be attributed to the high number of basic schools, high secondary schools, enrolment rate in basic schools (table A.1), together with the high number of hospitals, hospital beds and number of doctors (table A.2). In line with commonly held views, the states with highest HPI are Western Darfur (59.7%), Western Kordufan (50.7%), Blue Nile (50.6%), Southern Kordufan (49.7%), Northern Kordufan (49.5%) and Southern Darfur (48.9%). Once more, the high HPI in these states may be attributed to the corresponding high values of P_2 and P_3 recorded by these states. These, in turn, may be attributed to the lack of schools, teachers, hospitals and maternal and child health workers, particularly in Western Darfur and Western Kordufan states.

Although poverty in knowledge as measured by P_2 exhibits relatively higher variation among states, its high mean may suggest that illiteracy is one of the important causes of human poverty in the northern states of Sudan, with an index estimated at an average of 43.7 percent. This is confirmed by the correlation results reported in table (14). It is clear from these results that although HPI is highly and positively correlated with all its three components, its correlation with P_2 as measured by the simple (Pearson) correlation coefficient is the highest and most significant.

Table (14): Pearson Correlation coefficients for HPI with Sub-Indices

Sub-Index	*Pearson Correlation Coefficient*	*Significance Level*
P_1	0.654	0.006
P_2	0.973	0.000
P_3	0.711	0.002

Source: Own calculation based on data of table (13).

To conclude this section, we examine the results on the human poverty index by sex and mode of living as reported in table (15). We observe from these results that, with the exception of the minor difference in the percentage of newborns not expected to survive to age 40 (P_1), no significant difference is observed between males and females in all other indices, including the HPI. In contrast, a significant difference in all indices is observed between rural and urban areas. For rural areas, the values for P_1, P_2 and P_3 are estimated at 33.4, 61.6 and 47.5, respectively, compared to 27.7, 34.0 and 31.1 respectively for urban areas. These significant difference have given rise to difference in HPI between rural and urban areas, estimated at 50.1 and 31.1 respectively.

Table (15): Human Poverty Index by Sex and Mode of Living, Northern Sudan, 2000

Sex/Mode of Living	**P_1**	**P_2**	**P_3**	**HPI**
Males	33.0	49.4	41.8	42.5
Females	28.6	50.8	40.7	42.0
Urban	27.7	34.0	31.1	31.1
Rural	33.4	61.6	47.5	50.1
Northern States	30.9	50.1	41.3	42.2

Source: Own calculations based on data from Multiple Indicatorss Cluster Survey, 2000.

4.2 Public Policy and Human Poverty Reduction:

Mahran (2007) argues that, while the links between public policy and poverty reduction are not well understood, the methods for rigorous analysis of the impact of policy on poverty reduction remain underdeveloped. A number of approaches were proposed at the theoretical level to examine the policy impact on poverty. One approach, known as the quantitative approach, is based on an explicit geneal equilibrium model where the impact of policy on poverty is traced through the interaction of a large number of equations within a computable general equilibrium model. However, these models have been subject to a number of criticisms, most important of which are the data requirement and the classification of the institutions on which they are built. Needless to mention, the general equilibrium framework also requires the endogenization of the particular poverty measure. Since poverty is multi-dimensional in nature and is affected by a large set of complex and interrelated endogenous and exogenous factors, the interaction between policy variables with the poverty index could alternatively be captured by a simultaneous equations model. Once more, such a framework faces some problems and constraints. The size of such a system will increase as more poverty-related variables are incorporated, which will more likely give rise to specification

problems and measurement errors, particularly with sample data. Based on these difficulties, this section adopts a rather simple two-stage approach due to Mahran (2007) for analysing the links between public policy and human poverty in Sudan. Before doing so, however, we briefly outline the two-stage approach similar to that one proposed by Mahran (2007).

In the first stage a relationship is specified between the human poverty index and its components through the percentage share of each component in HPI. The second stage involves an examination of the public policy variables that may have favourable impact on human poverty components. Both relationships could then be used at the empirical level to identify the most important public policy tools that could lead to poverty reduction. In a nutshell, once the effects of public policy on the three determinants of human poverty are known, inferences could easily be made on the effects of policies on human poverty through their effects on the three sub-indices. This is the approach that will be adopted here. It may be noted that this approach resembles the direct quantitative approach proposed by Kanbur (1987) and Kakwani (1990), which involves tracing the mechanism of the impact of policy on a convenient poverty index

Although human poverty is influenced by a wide range of factors, its components are the three sub-indices that enter directly in the calculation of the human poverty index, namely P_1, P_2, and P_3. Thus, with (P) denoting the human poverty index, we have:

$$3(\mathrm{HPI}^3) = \mathrm{P}_1^3 + \mathrm{P}_2^3 + \mathrm{P}_3^3 \qquad (5)$$

Then with (P_{ip}) denoting the percentage share of a given sub index in the human poverty index, we have:

$$P_{ip} = \frac{\mathrm{P}^3\mathrm{i}}{3(HPI^3)} \qquad (6)$$

These three components of human poverty, in turn, are influenced by a large set of policy variables, which constitute the core variables for any meaningful analysis of the causes of human poverty and its alleviation. Our next task, therefore, is to outline the contentions related to public policy and human poverty.

Based on the above, the first step in the approach adopted here involves calculation of the percentage share of each HPI sub-index in the human poverty index as specified in equation (6), namely poverty in longevity index (P_1), poverty in knowledge index (P_2) and poverty in standard of living index (P_3). For this purpose, equation (6) is applied to the data reported in table (12). The results are reported in table (16).

It is clear from these results in table (16) above that the percentage shares of deprivation in knowledge denoted P_{2p} are almost high in the majority of the states ranged from 74 percent in Southern Kordufan state to 23 percent in Nahr-Elnil state, while the percentage shares of deprivation in longevity denoted P_{1p} have the lowest values in almost all states in exception of Khartoum and Red Sea states.

Having estimated the percentage shares of poverty in longevity, poverty in knowledge and poverty in the standard of living as important ingredients of human poverty, the question that arises now relates to the policies that accelerate human development and reduce the human poverty index. In particular, what are the policy variables that lead to significant reductions in

human poverty? This constitutes the task of the second step of the two-stage approach to which we now turn our attention.

Table (16): Contribution of Human Poverty Sub-Indeces (%) to Human Poverty Index for Northern Sudan, 2000

State	P_{1p}	P_{2p}	P_{3p}	HPI
Khartoum	37	38	25	100
Northern	9	24	67	100
Nahr-Elnil	6	23	71	100
Al-Gazira	12	56	32	100
Sinnar	11	61	28	100
Red Sea	27	50	23	100
Northern Darfur	13	53	34	100
White Nile	18	40	42	100
Al-Gadarif	17	58	25	100
Kassala	7	72	21	100
Southern Darfur	11	59	30	100
Northern Kordufan	7	59	34	100
Southern Kordufan	18	74	08	100
Blue Nile	3	65	32	100
Western Kordufan	10	72	18	100
Western Darfur	9	64	27	100

Source: Own calculations based on Data from table (12).

At this stage, three regressions will be estimated by ordinary least squares method to identify the most important policy variables that influence each of the three sub-indices of human poverty. Along the lines of Mahran (2007), it may be argued that since the majority of States in northern Sudan have higher values of human poverty indexes as reported in table (12), all policy instruments become relevant for a comprehensive poverty reduction strategy. Despite this, our focus here will be on the most important policy variables that affect human poverty. These encompass all variables related to education and health services. Health-related variables include hospitals, doctors, maternal and child health workers, and hospital beds, while education-related variables include basic schools, high secondary schools, teachers, and the enrolment rate in basic schools. Data related to these two sets of variables are calculated from the 2000 Statistical Year Book, and are reported in tables (A.1) and (A.2). Ordinary least squares method is applied to this data to estimate the relationships mentioned above. Despite the limitations related to data coverage and quality, it is hoped that our results will provide some valuable insights with regard to the states where government interventions are mostly needed for human poverty reduction.

Having discussed the data on education and health variables, our next step is to identify the set of policy variables that impact on each of the three sub-indices of human poverty. Thus, as we noted earlier, we have three relationships to estimate. The first attempts to identify the health-related variables that impact on deprivation in the longevity index. The second relationship examines the education-related variables that impact on deprivation in knowledge index, while the third relationship attempts to identify the most important education and health related variables that impact on deprivation in the decent standard of living index. To this end, we have applied the OLS method on the cross-section data reported in tables (12)) above, (A.1) and (A.2) below to estimate these relationships. The health-related policy variables include the number of hospitals (H), doctors (D), maternal and child

health workers (M) and hospital beds (B), while the education-related policy variables include the number of basic schools (S_1), high secondary Schools (S_2), teachers (T), and enrolment rate in basic schools (E). With the exception of the enrolment rate in basic schools, all other variables are measured in numbers per one thousand, ten thousand, or hundred thousand population as indicated in tables (A.4) and (A.5).

We begin with the relationship between deprivation in longevity (P_1) and the health-related policy variables. Table (17) below reports the regression results where the figures inside the brackets are the t-ratios and those within the square brackets are the significance levels of the estimated coefficients. It is clear from these results that with the exception of the constant term, all the variables that appeared in the first three equations are statistically insignificant in explaining P_1. Furthermore, with the exception of hospital beds, all other variables turned out to be statistically insignificant; hospitals (H) and maternal and child health workers (M) also turned to have unexpected signs. Finally, while hospital beds (B) is consistently statistically significant in explaining deprivation in longevity in the last three equations, equation (6) turned out to be the best fitted equation, with the coefficient of (B) estimated at (-0.076).

Table (18) reports the regression results for the relationship between poverty in knowledge (P_2) and the education-related policy variables, where the figures in parentheses are the t-ratios of the estimated parameters and those inside the square brackets are the significance levels of the parameters. We observe that enrolment rate in basic schools (E) is the only statistically significant variable in explaining deprivation in knowledge in all equations. Furthermore, while the coefficient of high secondary schools per 100,000 Population (S_2) has the expected sign, it turned out to be statistically insignificant. The coefficients of (S_1) and (T) are insignificant and have the wrong signs. Equation (5) figured out as the best fitted equation, with a coefficient of (E) estimated at (-0.791).

Table (17): Regression of Health Variables on Deprivation in longevity Index (P_1) Northern Sudan Sates, 2000

Eq. No.	*Constant*	*Estimated Coefficient of*				R^2	*Adj.* R^2	*F*	Sig. Level
		B	**D**	**H**	**M**				
1	35.056	-0.131	-0.001	0.178	0.084	0.425	0.216	2.031	0.159
	(7.033)	(-1.230)	(-0.018)	(0.413)	(0.672)				
	[0.000]	[0.244]	[0.986]	[0.688]	[0.515]				
2	35.044	-0.132		0.182	0.085	0.425	0.281	2.945	0.075
	(7.419)	(-1.783)		(0.511)	(0.744)				
	[0.000]	[0.100]		[0.619]	[0.471]				
3	37.670	-0.110	-0.006	0.195		0.401	0.251	2.680	0.094
	(12.370)	(-1.109)	(-0.243)	(0.463)					
	[0.000]	[0.289]	[0.812]	[0.652]					
4	33.969	-0.099			0.100	0.412	0.322	4.559	0.032
	(8.272)	(-2.742)			(0.936)				
	[0.000]	[0.017]			[0.366]				
5	37.076	-.067	-0.013			0.390	0.297	4.164	0.040
	(13.849)	(-2.142)	(-0.616)						
	[0.000]	[0.052]	[0.548]						
6	36.930	-0.076				0.373	0.328	8.316	0.012
	(14.166)	(-2.884)							
	[0.000]	[0.012]							

Source: Own calculations based on Data from tables (12)and (A.2)

Table (18): Regression of Education Variables on Deprivation in Knowledge Index (P_2) for Northern Sudan, 2000

Eq. No.	*Constant*	*Estimated Coefficient of*				R^2	*Adj.* R^2	*F*	Sig. Level
		E	S_1	S_2	T				
1	88.446	-0.606	0.005	-1.444	0.313	0.868	0.820	18.134	0.000
	(12.262)	(-3.947)	(0.034)	(-1.331)	(0.266)				
	[0.000]	[0.002]	[0.973]	[0.210]	[0.795]				
2	88.625	-0.607		-1.436	0.329	0.868	0.835	26.374	0.000
	(18.504)	(-4.336)		(-1.415)	(0.318)				
	[0.000]	[0.001]		[0.183]	[0.756]				
3	88.048	-0.602	0.022	-1.282		0.867	0.834	26.183	0.000
	(12.993)	(-4.102)	(0.159)	(-1.486)					
	[0.000]	[0.001]	[0.876]	[0.163]					
4	88.815	-0.609		-1.204		0.867	0.847	42.444	0.000
	(19.370)	(-4.507)		(-1.769)					
	[0.000]	[0.001]		[0.100]					
5	90.333	-0.791				0.835	0.823	70.959	0.000
	(18.684)	(-8.424)							
	[0.000]	[0.000]							

Source: Own calculations based on Data from tables (12) and (A.1)

Finally, table (19) below reports the best regression results of the relationship between deprivation in the standard of living (P_3) and the education and health policy related variables, where the figures in parentheses are the t-ratios of the estimated parameters, and those inside the square brackets are the significance levels of the parameters. It is clear from these results that equations (3) and (4) are the best fitted equations, with the coefficients of enrolment in basic schools (E) and the number of doctors (D) estimated at (-0.281) and (-0.068), respectively.

Table (19): Regression of Education and Health Variables on Deprivation in Standard of Living Index (P_3) for Northern Sudan, 2000

Eq. No.	*Const.*	*Estimated Coefficient of*			R^2	*Adj.* R^2	*F*	Sig. Level
		E	S_2	D				
1	51.060	-0.135	0.119	-0.051	0.488	0.359	3.806	0.040
	(8.613)	(-0.690)	(0.147)	(-1.818)				
	[0.000]	[0.503]	[0.885]	[0.094]				
2	50.826	-0.114		-0.052	0.487	0.408	6.161	0.013
	(9.252)	(-.887)		(-1.981)				
	[0.000]	[0.391]		[0.069]				
3	55.329	-0.281			0.332	0.284	6.948	0.020
	(10.063)	(-2.636)						
	[0.000]	[0.020]						
4	46.328			-0.068	0.456	0.417	11.714	0.004
	(22.111)			(-3.423)				
	[0.000]			[0.004]				

Source: Own calculations based on Data from tables (12), (A.1) and (A.2).

Before adopting the estimated equations in the analysis related to the impact of public policy on human poverty, it might be instructive to consider some common diagnostic tests. In particular, we examine whether the estimated equations suffer problems of specification errors. For this purpose, Ramsey RESET Test is applied to the estimated models for testing their linearity, while the Lagrange Multiplier Test is also applied to these for testing their correctness. The results of these tests are reported in table (20) below, and suggest that all models are linear and have the correct specifications.

Table (20): Test for Model Specification

Dependent Variabl	*Explanatory Variables*	*Ramsey Test*		Lagrange Multiplier Test		
		F. value	**Sig. evel**	R^2	nR^2	$X_{(no.\ of\ restrictions)}$
P1	B	0.052	0.823	0.046	0.736	5.990
P2	E	2.909	0.114	0.583	9.328	9.490
P3	E	0.044	0.837	0.146	2.336	5.990
P3	D	0.053	0.822	0.009	0.144	5.990

Source: Own calculations based on Data from tables (12), (A.1), (A.2) and (A.3).

So far we have calculated the percentage share of the three sub-indices of HPI in human poverty index, and also estimated the three regressions for these three indices. Having also examined diagnostic tests for the specification of these models, we are now in a position to use these estimated equations to calculate the elasticities policy variables with respect to human poverty sub-indices. The ultimate objective of such an exercise is to gain some insight into the ease or otherwise with which these indices respond to public policy with a view to reduce human poverty. Needless to mention, these elasticities are calculated at the mean values of the relevant variables. It is also important to note that only the most significant coefficients in the most significant regression equations are used in calculating these elasticities.

The elasticity (e_{P_i}) of each sub-index (P_i) of human poverty with respect to the policy variable (V) may be calculated according to the formula:

$$e_{P_i} = \frac{\partial P_i}{\partial V} \cdot \frac{\overline{V}}{\overline{P_i}} \qquad (7)$$

For clarity, this elasticity measures the percentage change in the human poverty sub-index (P_i) resulting from a change in the policy variable by one percentage point. Using equation (6) in table (17), equation (5) in table (18) and equations (3) and (4) in table (19), together with the mean values of the variables involved (as reported in table 16), into the formula in (7) we obtain the elasticities of the human poverty sub-indices with respect to the policy variables. These results are reported in table (21) below.

Table (21): Estimated Elasticities of HPI Sub-Indices with respect to Policy Variables

HPI *Sub-Index*	***Education Variable***	***Health Variables***	
	E	**B**	**D**
P_1	--	-0.203	--
P_2	-0.747		
$\mathbf{P_3}$	-0.330	--	-0.115

Source: Own calculations based on regression results of tables (17), (18) and (19).

Table (21) shows the results of the elasticities of the human poverty sub-indices with respect to the most important policy variables that have a significant effect on these sub-indices, we observe from the table that the elasticity of (P_2) with respect to the enrolment rate in basic schools, estimated at -0.747, is the highest among all responses of other indices. Once more, this suggests that an increase in the enrolment rate in basic education could contribute significantly to efforts made toward eradicating human poverty in knowledge. In particular, an increase in the enrolment rate in basic schools by one percentage point decreases

deprivation in knowledge by 0.747 percent. The elasticity of (P_1), estimated at (-0.203), suggests that an increase in the number of hospital beds per 10,000 people by one percentage point decreases the poverty in longevity index by 0.203 percent. Finally, the results suggest that there are two policy options with regard to poverty in the standard of living, either to improve enrolment into basic education or to increase the number of doctors. The elasticities of poverty in the standard of living with respect to the enrolment into basic schools (E) and the number of doctors (D) are estimated at -0.330 and -0.115, respectively. Thus, an increase in the enrolment rate into basic school by one percentage point will reduce deprivation in the standard of living index by 0.33 percent, while an increase in the number of doctors per 100,000 persons by one percentage point will reduce the deprivation in standard of living index by 0.115 percent. As we noted earlier, although some policy variables, notably hospitals per 1,000,000 populations (H), basic schools per 100,000 population and high secondary schools per 100,000 persons have the expected signs, they turned out to be statistically insignificant. Furthermore, other policy variables, notably maternal and child health workers per 100,000 populations (M), teachers per 1000 populations (T), and hospital beds per 10,000 populations (B) are observed to have unexpected signs.

Based on the results reported in table (21), and following Mahran (2007), it is now a straightforward exercise to calculate the impact of policy variables related to education and health on human poverty through the impact of these policies on the three sub-indices of human poverty. More specifically, we focus on the impact of policy-induced change in deprivation in longevity, deprivation in knowledge and deprivation in a decent standard of living on the sub-indices of human poverty index and the passthrough to human poverty. For this purpose, we calculate the change in the human poverty index attributed to changes in the three sub-indices due to a change by one percentage point in the education or health policy variable. Given the definitions of the variables in the regressions, the relative change in the human poverty index (HPI), denoted ΩHPI, resulting from policy-induced change in a given human poverty sub-index (P_i), is given by:

$$\Omega\text{HPI} = \frac{P_1^3}{3(HPI)^3}\frac{\partial P_i}{\partial V} \qquad (8)$$

where (V) denotes the policy variable. Applying the formula in (8) to the results of table (16) together with those of tables (17), (18), and (19) we obtain the results reported in table (23). It is clear from these results that, while hospital beds (B) and number of doctors (D) are the only two health variables that have significant impact on the human poverty index, enrolment in basic school (E) is the only one among the education-inducing policy variables turned out to have double role to play in human poverty reduction, first through a reduction in the deprivation in knowledge index (P_2) and second through a reduction in the deprivation in a decent standard of living index (P_3). Its clear also although two variables (D) and (E) have a significant effect on deprivation in a decent standard of living, the deprivation in knowledge with its only one variable affecting it namely enrolment in basic school (E) comes to be more important in explaining changes in human poverty index. This is not to reduce the importance of hospital beds that will play an important role in reducing the deprivation in longevity or that for doctors in reducing the deprivation in a decent standard of living, but to explain the importance of beginning by increasing enrolment in basic schools.

Table (22): Policy-Induced change on Human Poverty Index for Northern Sudan States, 2000

	Policy-Induced change (%) on Human Poverty Index			
	B through	***E through***	***E through***	***D through***
State	**P_1**	**P_2**	**P_3**	**P_3**
Khartoum	.075	.284	.008	.029
Northern	.018	.179	.022	.077
Nahr-Elnil	.012	.172	.023	.082
Al-Gazira	.024	.418	.011	.037
Sinnar	.022	.456	.009	.032
Red Sea	.055	.374	.008	.026
Northern Darfur	.026	.396	.011	.039
White Nile	.037	.299	.014	.048
Al-Gadarif	.035	.433	.008	.029
Kassala	.014	.538	.007	.024
Southern Darfur	.022	.441	.010	.035
Northern Kordufan	.014	.441	.011	.039
Southern Kordufan	.037	.553	.003	.009
Blue Nile	.006	.486	.011	.037
Western Kordufan	.020	.538	.006	.021
Western Darfur	.018	.478	.009	.031

Source: Own calculations.

One of the most important conclusion from the above analysis is that any policy to reduce human poverty must begin with the lifting of enrollment in basic schools, which in turn will reduce both the deprivation in knowledge and the deprivation in a decent standard of living, the variables have more role to play in reducing human poverty index. In this context, to encourage interest in basic education, increased attention to school infrastructure and the lifting of all school financial obligations from families, will enable many of the poor families to enroll their children in basic schools. Furthermore, as rural sudan is more underdeveloped than urban (all deprivation indexes for rural are higher than that for urban (table 15) more attention should be given to rural in poverty reduction polices.

5. Summary, conclusion and recommendations:

This study calculated the human poverty index for the Northern States of Sudan and examined its most important determinants with a view of examining the policy interventions that could have significant impact on human poverty reduction. The study employed secondary data obtained from the Multiple Cluster Indicators Survey for 2000 and the Statistical Year Book for the Sudan also for 2000. For the purpose of calculating the human poverty index for the states, standard methods are used to calculate the values of the sub-indices (P_1, P_2, and P_3), which were then used to compute the human poverty index for each state as well as for northern Sudan.

The results reveal that some states, namely, Khartoum, Nahr Al-Nil, and Northern state have the lowest HPIs. This is a direct result of lower P_1 and P_2 in these states, which reflects the concentration of human development programs in these states. On the other hand, Western Darfur, Western Kordufan, Blue Nile, and Southern Kordufan are found to have the highest HPIs. This could be attributed to the higher values of P_2 and P_3 in these states. Concentration of education and health services in the urban sector is the main reason of the higher gap in human poverty index between urban and rural areas. It is also observed that the difference

between males and females in human poverty tends to be low because of the small difference in P_1.

The analysis focused on the impact of education and health policies that will more likely enhance longevity, knowledge and the standard of living, and thereby reduce human poverty in northern Sudan. In addition to doctors, the health variables considered in the analysis include hospitals, hospital beds and maternal and child health workers. The education variables include number of basic schools and high secondary schools, and teachers, as well as enrolment rate in basic schools.

Because of data limitations, simple regression methods are adopted at two levels along the lines of Mahran (2007). In the first stage some sets of data were used to examine the relationship between human poverty and its main determinants, while in the second stage other sets of data were used to examine the impact of health and education policies on human poverty determinants. Based on this analysis, inferences were made about the most effective policies for human poverty reduction.

The results for the first stage suggest that all human poverty sub-indexes considered in the analysis have had a significant effect on human poverty reduction. These results are attributed to the fact that they are the main components of the human poverty index; therefore their effects have been significant. The results of the second stage may be summarized as follows: First, based on health policy variables, with the exception of hospital beds, all other health policy variables considered in the analysis have had no significant effect on the longevity index and hence on human poverty reduction. Secondly, based on education policy indicators, enrolment rate in basic schools is the only one policy variable that has a significant effect on the knowledge index. Finally, among all other variables, doctors and enrolment rate in basic schools turned out to have significant effects on the standard of living index and hence on human poverty reduction. Based on these results, an increase in enrolment rate in basic schools, number of hospital beds or number of doctors tends to be the most important variables in reducing the human poverty index at the state level. Based on these results, peace achievement in all over the country is the more important step that enhances promoting human development programs. More attention should be given to the policies that encourage enrolment in basic schools, especially in the rural areas such as reducing the burden of the schools of the rural population, exempting rural students from tuition fees and the encouragement of agriculture the main craft of the rural population in the Sudan. Increasing the number of doctors and hospital beds, particularly in the least developed states, and improving health by establishing health centers in rural villages and provide them with basic needs will reduce regional disparities and human poverty. It is very important to note that the provision of safe drinking water in all parts of Sudan will reduce diseases, lead to improved health status and reduce mortality rates, which in turn will reduce human poverty index. All of this can be achieved only through concerted effort, the government, private sector and citizens of the areas. Together with economic growth, good health and education can make an enormous difference in the lives of poor people, which are the main goals of development. The latest population census of the Sudan in the year 2008 provided a broad base of data that will enable researchers for deeper studies on human poverty and human development in the Sudan as a whole and for each state separately in order to know the detailed requirements of development for each state.

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Appendices

Table (A.1): Education variables by States of Northern Sudan, 2000

State	Basic Schools per 100,000 Population (S_1)	High Secondary Schools per 100,000 Population (S_2)	Teacher per 1000 population (T)	Enrolment Rate in Basic Schools (E)
Khartoum	28.84	7.53	3.29	76.8
Northern	75.13	14.09	11.63	71.8
Nahr-Elnil	65.02	10.22	7.56	76.4
Al-Gazira	50.45	10.88	6.43	59.7
Sinnar	45.11	7.76	4.68	46.1
Red Sea	38.70	4.44	4.01	51.3
Northern Darfur	61.09	4.88	3.97	50.8
White Nile	48.45	7.18	9.35	57.7
Al-Gadarif	35.77	4.91	3.32	47.0
Kassala	24.51	3.00	2.33	52.8
Southern Darfur	44.68	3.55	2.42	24.3
Northern Kordufan	69.74	4.32	4.68	36.3
Southern Kordufan	53.36	3.24	3.32	36.6
Blue Nile	25.00	3.30	3.31	27.9
Western Kordufan	53.91	6.76	3.50	40.0
Western Darfur	29.99	2.03	1.42	26.0
Northern States	44.09	6.30	4.33	48.3

Source: Statistical Year Book, 2000.

Table (A.2): Health variables, Sudan Northern States (2000)

State	Hospitals per 1,000,000 Population (H)	Hospital Beds per 10,000 Population (B)	Doctors per 100,000 Population (D)	Maternal and Child Health Workers per 100,000 Population (M)
Khartoum	8.00	111.00	350.00	32.03
Northern	52.00	246.00	135.00	86.77
Nahr-Elnil	25.00	156.00	85.00	56.78
Al-Gazira	13.00	79.00	62.00	50.36
Sinnar	11.00	90.00	60.00	37.17
Red Sea	23.00	103.00	106.00	68.24
Northern Darfur	6.00	38.00	15.00	65.02
White Nile	11.00	83.00	46.00	66.12
Al-Gadarif	10.00	67.00	46.00	50.92
Kassala	8.00	74.00	42.00	49.35
Southern Darfur	3.00	22.00	20.00	29.20
Northern Kordufan	9.00	88.00	55.00	67.50
Southern Kordufan	6.00	46.00	17.00	32.40
Blue Nile	11.00	42.00	53.00	36.95
Western kordufan	8.00	54.00	21.00	26.69
Western Darfur	2.00	14.00	10.00	17.82
Northern States	10.00	74.00	160.00	45.16

Source: Statistical Year Book, 2000.

Table (A.3): Regression of Education and Health Variables on Deprivation in A decent Standard of Living Index (Northern Sudan Sates 2000)

Variable	Equation Number					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	54.807 (5.672) [0.001]	52.222 (6.347) [0.000]	51.060 (8.613) [0.000]	50.826 (9.252) [0.000]	55.329 (10.063) [0.000]	46.328 (22.111) [0.000]
E	-.303 (-1.030) [0.337]	-0.142 (-0.682) [0.511]	-0.135 (-0.690) [0.503]	-0.114 (-.887) [0.391]	-0.281 (-2.636) [0.020]	
H	-0.203 (-0.325) [0.755]	0.187 (0.810) [0.437]				
M	0.082 (0.385) [0.712]					
S_1	-0.119 (-0.582) [0.579]	-0.009 (-0.054) [0.958]				
S_2	-0.649 (-0.386) [0.724]	-0.347 (-0.303) [0.768]	0.119 (0.147) [0.885]			
T	1.760 (0.931) [0.383]					
B	0.053 (0.322) [0.757]					
D	-0.041 (-0.979) [0.360]	-0.051 (-1.571) [0.147]	-0.051 (-1.818) [0.094]	-0.052 (-1.981) [0.069]		-0.068 (-3.423) [0.004]
R^2	0.627	0.519	0.488	0.487	0.332	0.456
Adj. R^2	0.201	0.279	0.359	0.408	0.284	0.417
F	1.473	2.161	3.806	6.161	6.948	11.714
Sig. Level	0.312	0.140	0.040	0.013	0.020	0.004

Source: Own calculations based on Data from tables (A.1)-(A.2)