Urban Development and Deforestation: Evidences from El-Obeid Town (1970-2010), Western Sudan

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Abstract- The study area is located between 30º – 12' East, and 13º -10' North. The Urban Development of the town consists of the residence areas from the first, second, and third classes, in addition to the squatter settlement extensions that planned later and became officially new urban extension. The third class housing represents 70% from the total residential area of the town that expanded at expense of the Urban forests.

The main objective of this study is to show and assess the town's urban development since 1970s, and its impact upon the forests. The study used RS and GIS as integrated tools for application in urban growth effects on El-Obeid Forests. The 1972, 1987, 2000, 2005 and 2010 Land sat TM satellite RS were used to assess El-Obeid town's urban deforestation. The results showed that there was 100% urban deforestation in the study area caused by urban new extensions and development.

Index Terms- Urban Development, Urban Extensions, Urban forests, Urban Deforestation

المستخلص

تقع مدينة الابيض وسط إقليم كردفان بين خطي عرض '10 - 13º شمالاً وخطي طول '12 -30º شرقاً. يتمثل التخطيط العمراني للمدينة في المناطق السكنية من الدرجة الاولى والثانية والثالثة بجانب الإمتدادات العشوائية. تمثل مناطق الدرجة الثالثة 70% من مساحات المربعات السكنية والتي توسعت على حساب الغابات.

تهدف الدراسة الحالية إلى عرض وتقييم التطور العمراني للمدينة منذ السبعينات، وتأثير ذلك على الغابات التي كانت تحيط بالمدينة. أستخدم الباحث تقنية الاستشعار عن بعد ممثلة في صور الاقمار الأصطناعية وتمت معالجة الخرائط بواسطة برمجيات نظم المعلومات الجغرافية (Arc Map). أظهرت النتائج أن التوسع العمراني تسبب في إزالة الغابات بنسبة 100% في كل الاتجاهات حول المدينة.

I. Introduction

Land use and land cover change (LULCC), is a general term for the human modification of earth's terrestrial surface. As humans have been modifying land for different purposes; current rate of modifications is for greater than ever in history. Forest damage caused by urban extensions is currently one of the most serious problems in arid and semi-arid ecosystems, both in Africa and Sudan. FAO's Forest Resources Assessment 2005 gives a global deforestation estimate of 13 million ha per year on average for 2000-2005.

As with so many other environmental problems, there are a lot of things causing the tree trouble. Environmental change as a case of human interference has been continuous phenomenon in the ecosystem balance in the 20th. As the concerns over the society implications of forests conservation and urban extensions goes back to the Mid of the 1970s. In Sudan statistics showed change in forest cover, as about (69.949.000 ha) of Sudan 29.4%, is forested and about 20.0% (13.990.000 ha) is classified as primary forest. During 1990-2010 Sudan lost about 8.4% of its forest cover (6.432.000 ha) (Mongabay.com, 2012).Such loss caused by deforestation of habitat has resulted in widespread impacts and consequences of many environmental problems.

Settlement is the most land use parameter in need through out the history of human beings. New housing in new residences can be needed in urban areas continuously as the population increases. On the other hand, to plan and execute new settlement areas, we need to use a land that may be a forest, an agricultural land or others, which are the approximate cause lead to urban deforestation.

Urbanization is the driving force for modernization, including economic and social development and there is increasing concern about the effects of expanding towns and cities. One strike effect is on the natural resources such as forest lands. The fact is that: high urban populations place increases stress on natural resources (Rees, 1992). The United Nations Population Fund estimated that in 2008, more than half of the World's human population is living in urban areas. Cities are spreading out despite the availability of land for developments within the existing urban envelop (Cegn, 2005).

Generally urban growth becomes the main category that causes strike land use change in recent eras. Transformation, which is a natural phenomenon, is occurred under certain causes related to the human activities such as cutting trees and eradicating forests for urban growth. In many developing countries, urban development often occurs as the result of rural-urban migration. Among developing countries, estimated that 60% of urban growth in 1960-1990 was from natural increase, while 40% from in-migration from rural areas.

Deforestation is categorized as one of the most challenges the world face today, and as stated by Manjula *et al* (2011), it has a crucial geographical dimension and component. Deforestation is a continuous process. Therefore efforts have to be geared towards proper inventory and changes monitoring. United Nations Conference on Environment and Development held in 1992 identified deforestation as a policy issue of global importance (Ayoola, 2012).

There is no clear definition of "deforestation", neither there are reliable estimates of its extent nor its primary causes, and – partly – as reflection of these – there is no consensus on the underlying causes (Angelsen, 1995). Deforestation results from complex socio-economic processes (Walker, 1987). Deforestation is the conversion of forested areas to non-forested

land use, which can result from deliberate removal of forest cover for urban development or for agriculture (Giri, 2007). The narrow definition of deforestation that is used by FAO is "the removal of forest cover to an extent that allows for alternative land use".

Western Sudan has witnessed a rapid shrinkage in its forest resources in recent decades. The scale and impact of declining forest resources vary greatly by provinces depend on population density as well as natural resource utilization patterns. Between 1980s and 2000s, complete forests clearance in the study area has been occurred, all forests surrounding the town had been converted into urban residential lands.

In writing this research the main objective was to map the different periods of forest degradation in last 40 years (1970-2010). In the study area, effective factors mainly of human origin are leading to land resource degradation, which is a process of forest conversion into urban land. So, in the study area single factor causation of deforestation is considered. Urban deforestation is taken to mean in this research complete eradication of forest vegetation to provide land for new urban residential extensions.

II. Material and Methods

The study area: The study area is located between 30º 12' East, and 13º 10' North Fig (1). This area has summer rainfall with an average of 250 mms and temperature of 35º C during summer season. El-Obeid town is the capital of North Kordofan State, characterized by rapid urban development mainly residential areas, since 1970s.The town urban population is developing with the value of economic assets; it has a population close to 301.400 persons in 2002.

III. Urban Extension and Deforestation

Urban areas are the most dynamics, their size has been increased during the past and this process will go on in the future. In less developed countries there is a strong trend towards concentration of people in urban areas that can be observed (Moeller, N.D). Urban deforestation has recently received considerable attention. Over the state, there are many other potential causes of deforestation, land degradation and land use change, including shifting cultivation, firewood, and climate change. This research focuses on the urban new extensions as a main cause of forest change in the area.

IV. Forest Lands Quantification View

North Kordofan is an area where forest resources are characterized by over utilization. Sheikan province where El-Obeid town is located has 1900000 fedans of forests, about 2.03% of the greater Kordofan region forest land (92820000) fedaans. Table (1) shows reserved forests in greater Kordofan, their coverage and changes assessment.

Fig (1): Location of the Study area

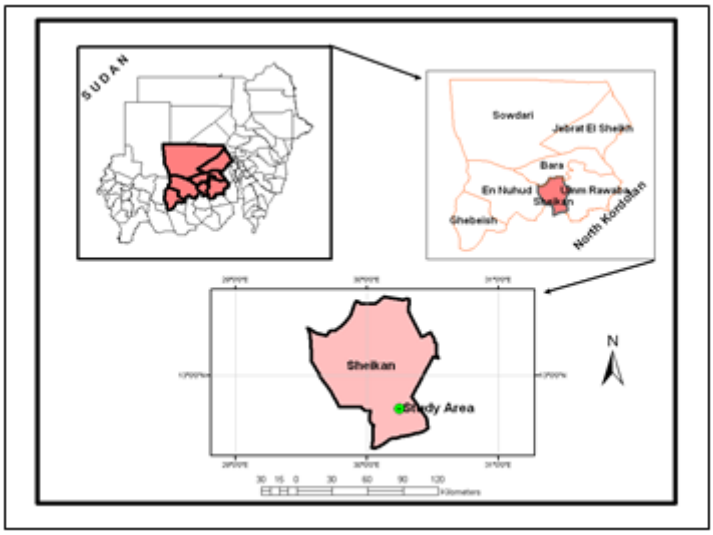


Table (1): Reserved Forests in Greater Kordofan Provinces

Provinces	Forest area (fed)	Coverage %	Exist Status Assessment
Sheikan	**1.900.000**	**9.5**	**Severe to moderate change**
Um Ruwaba	**4.600.000**	**13.4**	**Severe to moderate change**
Bara	**4.600.00**	**2.7**	**Severe to moderate change**
Al Nuhud	**13.000.000**	**0.8**	**Severe to moderate change**
Sodari	**32.800.000**	**0.6**	**Severe to moderate change**
Al Salam	**14.700.000**	**0.9**	**Severe to moderate change**
El Dilling	**4.600.000**	**3.8**	**Less change observed**
Kadogli	**2.800.000**	**1.6**	**Less change observed**
Rashad	**1.200.000**	**15.8**	**Less change observed**
total	**92.000.000**		

The table shows that severe to moderate change over forest areas occurred in six provinces attributed to different deforestation drivers. Sheikan province where the study area is located witnessed severe deforestation mainly occurred at zones surrounding towns and villages. On the other hand, El-Obeid town forest status is presented in table (2). Historically there are eleven big forests in the study area. These were subjected to severe degradation and complete eradication attributed to the urbanization development.

From the table we can obviously quantify the area of forests converted into new urban extensions. About seven forests closely surrounded the town were completely eradicated. On the other hand, Bara road forest and El Dilling road forest were affected only partially as the nearest part to the town converted into urban extensions. From all tables we can conclude that no forest land remain of no change, either completely as that in towns' forests, or at varies rate of deforestation depends on causes and rate of forests utilization.

Table (2): The Study Area Forest Status Assessment

Forest name	Locality	Area (fed)	Dominant Species	Date	Status 2011
Water resource	S/ ElObeid	2080	Mohogni	15/5/1952	Complete eradication
N/reserved forest	N/ ElObeid	2285	Kiter+hashab	15/5/1952	Complete eradication
El Dilling road	s-w/ ElObeid	2110	Kiter+hashab	15/5/1952	45% change
Bara road	N/ ElObeid	850	Hashab	15/5/1952	40% change
Ganzara	n-w/ ElObeid	960	Kiter+haraz	15/5/1952	Complete eradication
Qoz Ashgar	E/ ElObeid	1165	hashab	15/5/1952	65% change
El Ain forest	S/ ElObeid	24809	Kiter	15/4/1954	35% change
Al Ain extension	S/ ElObeid	18800	Varies	15/4/1962	30 % change
Qoz Ashgar extension	E/ ElObeid	220	hashab	15/4/1975	30% change
Megigh	W/ ElObeid	-	Subag+Arad	-	Complete eradication
Sheikan forest	N-E/ ElObeid	198905	Kiter+hashab	15/5/1952	75% change
Fellata Forest	N-w/ ElObeid	5580	Hashab+Kiter	-	Complete eradication
ElPetrol Forest	E/ElObeid	605	Hashab+heglig	15/5/1952	Complete eradication
Abu Safia forest	W/ElObeid	504	Kiter	15/5/1952	Complete eradication

Source: Compiled from Forest Office – ElObeid and Field Survey (2011)

V. METHODS

Views of deforestation have changed, we can now see the clearing of forests taking place in satellite images, accessible worldwide to anyone with a computer through Google Earth (Doug Boucher, et al 2011). A number of change detection techniques has been developed over the last 20 years. Remote sensing is a uniquely versatile tool, since the same data can be analyzed in different way for different applications (Reene, 2001). With the combination of the Geographical Information System and Remote Sensing can render reliable information on land use dynamics (Ayoola, 2012). Since 1970s remotely sensed data as a reliable source were used in conjunction with geographic information system analysis to develop a model of land use change as an effective, accurate and potential tool for monitoring forest degradation as well as deforestation.

A satellite images within 38 years (1972-2010) was generated and analyzed with aid of GIS analytical functions. An integrated quantitative and qualitative investigation of the changes and signs of changes in the urban forests of the study area have been used in this study. The evidence and documents

for assessing this study were obtained from a variety of sources. The data used in analysis and interpretation were field data, Remote Sensing (satellite images), and from other related records, such as maps and other relevant written materials.

VI. Data Collection

Proper forest monitoring and management can be achieved by using remote sensing techniques that are extensively and increasingly used for monitoring and assessing of urban deforestation. To accomplish this study, the researchers used: time series of Landsat images; MSS image land sat2 (14 Jan.), spectral 4bands for the year 1972; TM image landsat4 (20 Jan.), spectral 7bands for the year 1987 and ETM+ image landsat7 (14Jan.), spectral 9bands for the years 2000, 2005, and 2010. The ground resolution of these instrument are 79 m*79 m, 30 m*30 m and 30 m*30 m for MSS, TM and ETM+ respectively.

VII. Results and Discussion

Results are presented in a three folds manner. First, a clear image of maps detected urban deforestation is provided as main source; second in showing different periods scales of changing in forests, the researchers applied the overlap technique to show comparison between periods and estimate the real conversions of forest lands in the area; third buffering system using ERDAS imagine also used to recognized the area deforested.

VIII. Urban Extension and Overlapping Maps Results

Fig (2-a) shows that the area of the town in 1972 was 6.181 Km^2, with an increase urban area of 10.543 Km^2 up to the year 1987, while Fig (3-a) shows the two maps of 1972 and 1987 overlap that reflects the initial history of El-Obeid town urban development at expense of the forest land with strike expansion. The total urban area of the town continuously increased to reach 16.724 Km^2 in 1987 with an increasing urban area of 7.062 Km^2 up to the year 2000. The overlap had been done for the years 1972 and 2000 maps, shows that new urban extensions were increasing eastward as well as southward, and this indicated the pattern of El-Obeid town's urbanization, which attributed to social service accessibility eastwards than the westwards. This also recognized as the value of the land increasingly rose eastwards than westwards. During 2000s, the urban new extensions continued and the town's area expanded to be 23.786 km^2 in 2000 fig (2-c). Fig (3-b) presents the overlap for the years 1987 and 2000 that showed the east and westward expansions, while fig (2-d) shows the urban total expansion in 2005 with an increasing urban area of 3.197 up to the year 2010. Overlap also had been done for the years 1972 and 2010, during these 38 years the total urban converted into urban new extensions was 22.871 Km^2. The town reached its climax of expansion in all directions during 2010. The area between Khor Tagat (8 Km) east and ElObeid had been converted completely into residential land use, and to the west the town expanded far than 15 km. Also southward of the town (9 km) witnessed severe change in its forest lands that converted into new urban extensions. Historically, the northward area was much stocked hashab forest converted to industrial as well as residence extends. Fig (2-e) shows the present image of the town 2010 with a total urban area 29.052 Km^2.

Fig (3-c) shows the spatial growth of El-Obeid Town from 1972 -2010. Several factors are responsible for such growth; the town is headquarters of greater Kordofan region, junction of transport routes, and the main trade center in the western Sudan. These have caused a tremendous increase in its population that required increase demand in land, which led to forest degradation surrounding the town.

IX. Buffering System Showing Urban Deforestation

Four maps had been produced to show the real status of urban forest degradation surrounding ElObeid town. Buffering system as a method of the remote sensing techniques had been used. Fig (4-a) shows the buffering around town's area in 1972 that detected about 10.543 km^2 was area deforested between 1972 and 1987. The area converted to urban new extensions occurred in semi equal distances 2228 meters (2.228 Km) length. The image showed deforestation between 1987-2000 seems to be very clear and obvious and the distance increased to 2309 meters (2.309 km), while the image illustrated deforestation between 2000-2010 extended about 1951 meters (1.951 km), and being less than (1987-2000) because the urban plan for more housing had been stopped and the town took it's present shape of urbanization fig (2-e).

Fig (4-d) gives the longevity and history of the town's real image of urban development. From the figure, the distance of buffering extended about 3888 meters (3.888 km), and all forests surrounding the town had been gone and completely converted into urban land use patterns (residence, industrial, government institutions).

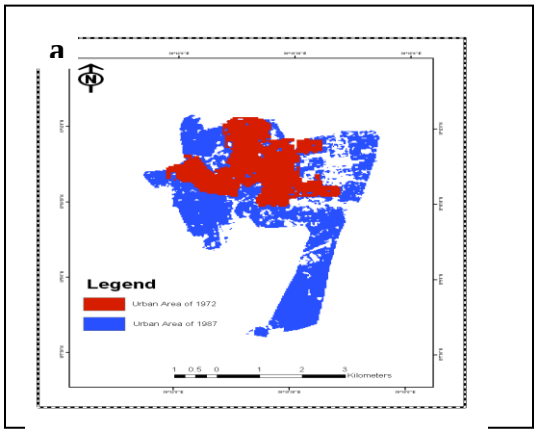
Table (3) gives brief calculations about annual change rate (km^2). From the table negative number represents deforestation. The change rate was more obviously during 1970s, 1980s and 1990s attributed to the urban planning strategy as more housing had been established, while during 2000s less negative change was observed as the urban planning strategy stopped.

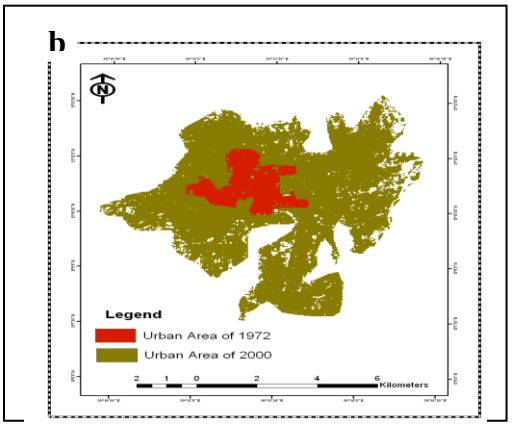
Table (2): Annual Change Rate (Km^2)

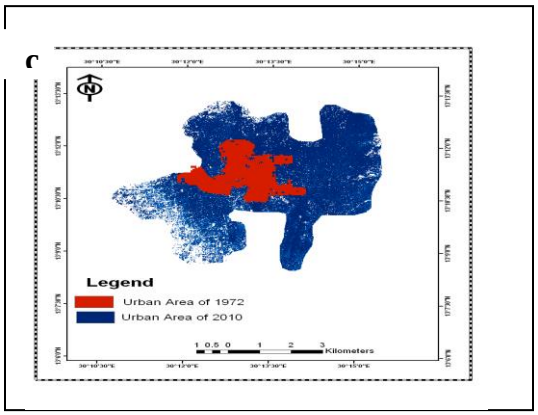
	periods	Change / area
1	1972 – 1987	- 10.543
2	1987 – 2000	- 07.062
3	2000 – 2005	- 03.197
4	2005 - 2010	- 02.099

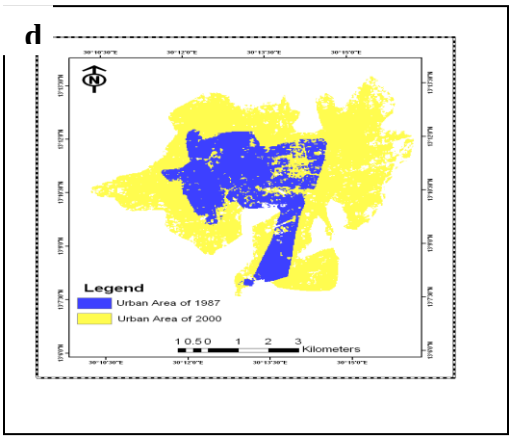
Fig (2-a b c d e): Urban Extensions in ElObeid Town – North Kordofan State (1972-2010)

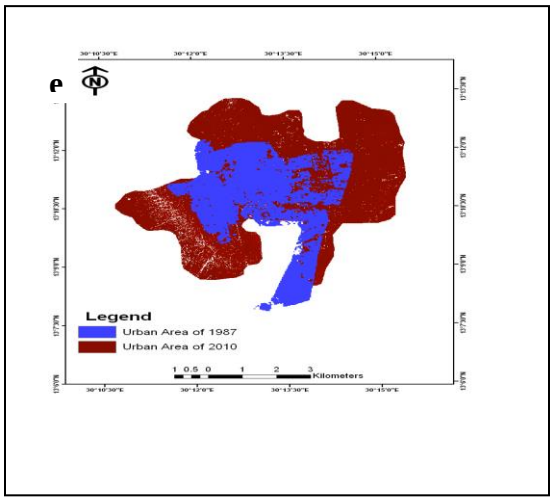
Fig (3-a b c d e f): Overlap maps for Different Urban Extensions Periods











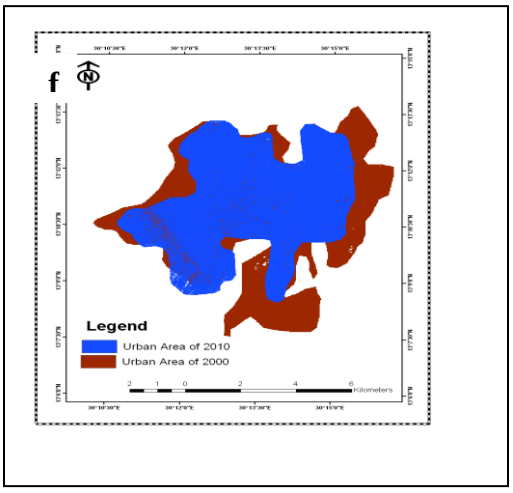
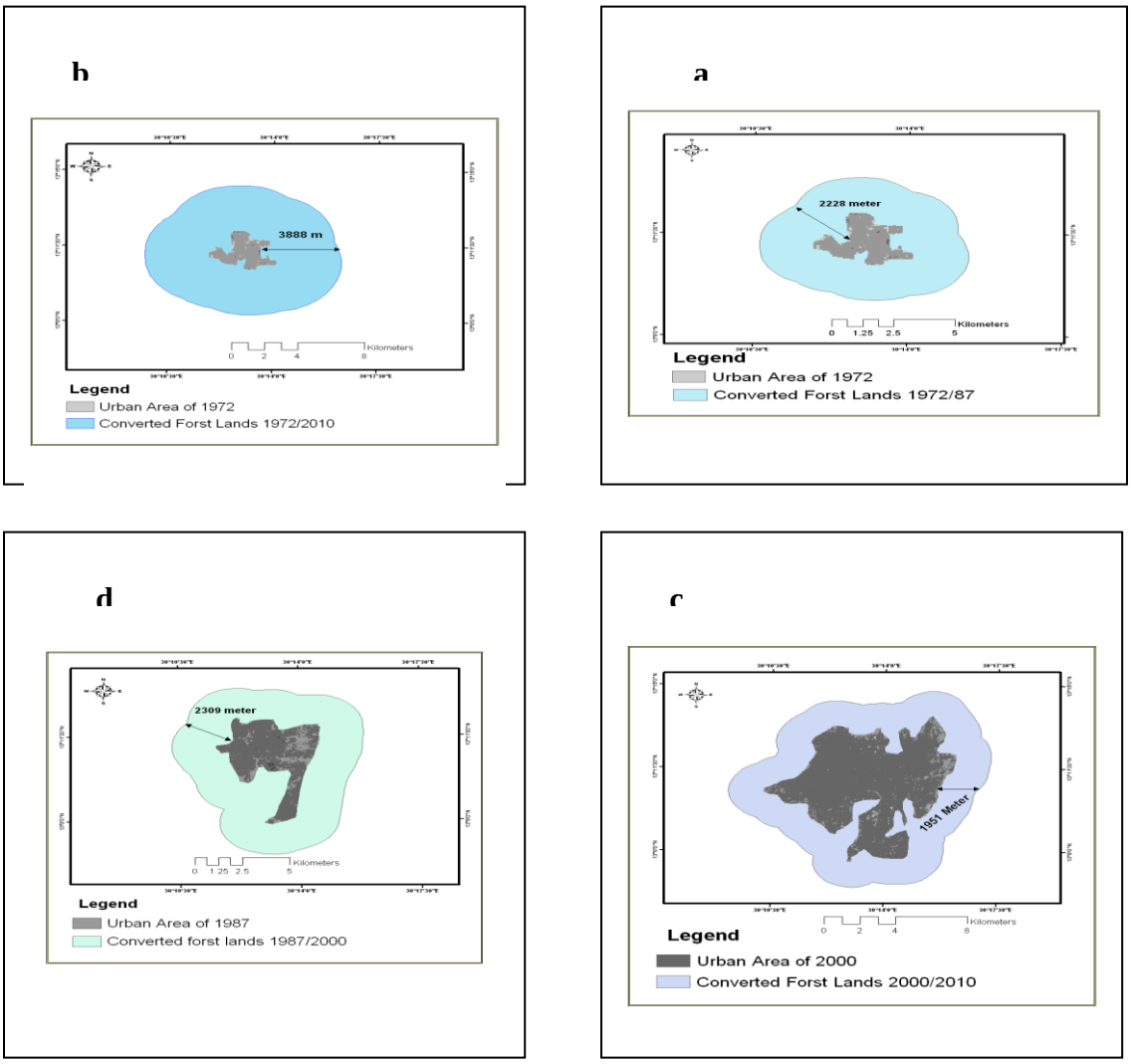


Fig (4- a b c d): Buffering Zones Show Urban Deforestation



X. Discussion

Many authors conceptualized the link between proximate causes of deforestation; social underlying driving forces, land use and land cover change (Meyer and Turner 1992, Turner et al 1993, Ojima et al 1994, and Lambin et al 1999). The approximate causes are human activities (Land uses) that directly affect the environment and this contribute proximate source of change (Helmut, 2001). So, the direct causes of urban forests change in western Sudan are population growth in towns and industrial area development. On the other hand, inspection of the remote satellite based dataset indicates that significant increase in deforested areas in the west Sudan began in 1980s.

From all findings which have been calculated and observed, it can be clearly seen that a drastic decrease in forest cover as a result of urban expansion was occurred.

The processes of transformation of land use from forest land to urban can be clearly passed through the fallowing periods:

1- During 1970s (no problem of urban deforestation noticed).
2- During 1980s (Start period towards ElObeid forest change).
3- During 1990s (urban extensions more intensified eastwards)

XI. Conclusion

To conclude this research, final remarks must be made with regard to deforestation impacts, with the fact that forests are still undergoing significant change, as the urban new extensions plan to be continued. The loss of forests was detected to result in widespread change in land use. In some towns of the North Kordofan, including ElObeid, Bara and Um Rwaba, the new urban extensions are still regularly pointed to as a primary cause of deforestation, and forest land declining is predicted for the immediate future.

In view of increasing forest, and future demand of housing, the loss of forest will be stretched further beyond the exist limit

of the town and will become even more critical in larger areas. Like other important environmental studies, urban deforestation should be evaluated periodically to determine if it still causing impacts upon forest resources, and whether there are plans to stop it.

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