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ANTROPOPRESJA W REJONIE WODOCHRONNYM BAREKESE I OWABI W REGIONIE ASHANTI, GHANA

ANTHROPOGENIC PRESSURE ON BAREKESE AND OWABI HEADWORKS IN ASHANTI REGION, GHANA

Słowa kluczowe: użytkowanie ziemi, wylesienia, monitoring, zdjęcia satelitarne

Key words: land use, deforestation, monitoring, satellite imagery

Abstract. Increase of population density in Central Africa causes tension on forests and development of agriculture and settlements and as a consequence, changes in land use and land cover. Multi-temporal satellite imagery allows for assessing the extend and intensity of this phenomenon (1986-2007-2011). The results show tremendous decrease in forests from 70% to over 16% as well as the increase in the area of settlements from 10% to 26%, and the area of the farmland from 21% to 56%. The forecast for the nearest years indicates the continuation of the trend.

INTRODUCTION

Remote sensing has been used extensively in monitoring the changing pattern of forest cover. It offers an accurate means of measuring the extent and pattern of changes in forest cover conditions over a period of time [Miller et al. 1998]. Satellite data have become a major application in forest change detection because of the repetitive coverage of the satellites at short intervals [Mas 1999]. Studies by Yang and Lo [2002] explained that Forest cover is altered principally by anthropogenic influence and any idea of global change must include the prevalent influence of human action on land surface conditions and processes.

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times [Singh 1989]. It is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest. Accurate and up-to-date land cover change information is necessary to understanding and assessing the environmental consequences of such changes [Giri et al. 2005]. In particular, land use/land cover (LULC) changes in tropical regions are of major concern due to the widespread and rapid changes in the distribution and characteristics of tropical forests [Myers 1993; Houghton 1994].

STUDY AREA

The Kumasi Metropolis and its environs are supplied with portable drinking water from two surface water treatment plants; Owabi (latitudes 6° 47' 42.7" and 6° 42' 6" North and longitudes 1° 43' 16.8" and 1° 35' 29.4") and Barekese headworks (- 6°44'; 1° 42'W) located 10km and 16km from Kumasi respectively. The study area covers the districts of Atwima, Kwabre and Kumasi Metro in the Ashanti.

The Owabi Headworks is surrounded by a wildlife sanctuary (fig. 1) which is the smallest of the four wildlife protected areas in Ghana. It is about 13km² in size, and lies approximately 23km northwest of Kumasi.



Fig. 1. The Owabi Headworks is surrounded by a wildlife sanctuary which is the smallest of the four wildlife protected areas in Ghana

Source: A. Koranteng

Rys. 1. Zapora Owabi jest otoczona przez rezerwat, który jest najmniejszym z czterech rezerwatów przyrody w Ghanie

Źródło: A. Koranteng

METHODOLOGY

Data employed in estimating land cover change were extracted from three cloud-free Landsat Thematic Mapper (TM) and two Landsat Enhanced Thematic Mapper (ETM) images obtained in 1986, 2007 and 2011. All the three imagery were registered to the Universal Transverse Mercator (UTM), Zone 31 geographic projection. The Landsat Thematic Mapper satellite imagery was preprocessed to convert the image to reflectance for the correction of sun angle and seasonal

differences. The Satellite image was first geometrically corrected to orient the pixels to the real world and geo-referenced using crossroads, landmarks and settlements (fig. 2). ERDAS imagine was especially used for this part of the study. Supervised classification was employed to analyse land use in each particular date and thus land use change (fig 3). Verification of accuracy of classified images was based on field interpretation keys.

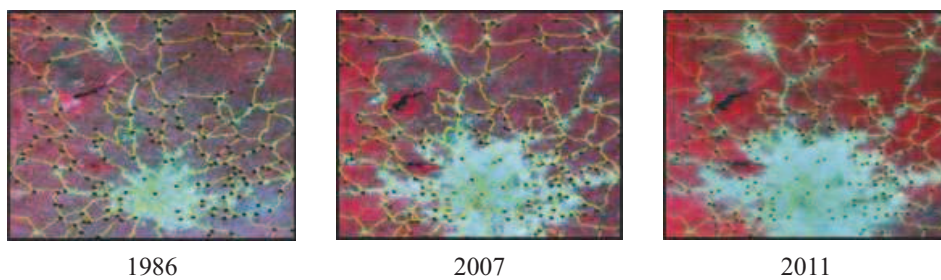


Fig. 2. Geo-referenced satellite images showing the Kumasi and its environs with Barekese and Owabi Headworks

Source: Author's elaboration.

Rys. 2. Zdjęcia satelitarne, zgeometryzowane na podstawie mapy sieci drogowej, obrazujące Kumasi i jego okolice wraz z zaporami Barekese i Owabi

Źródło: Opracowanie własne.

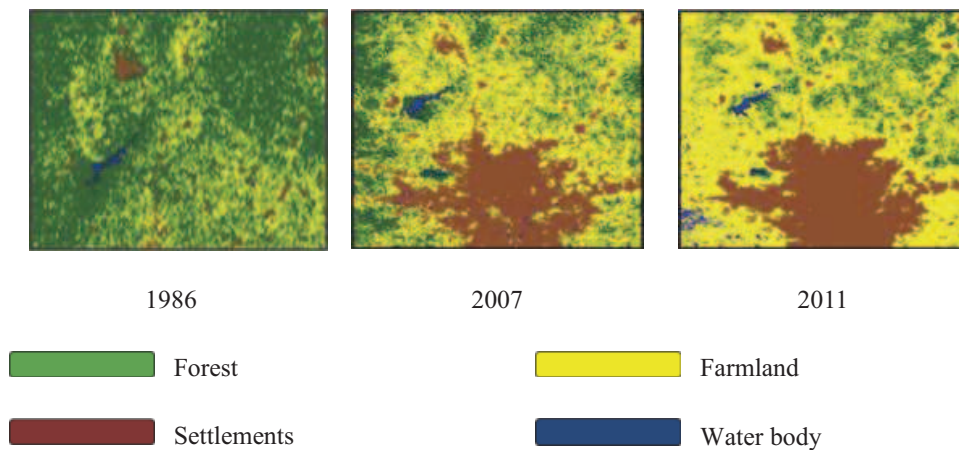


Fig. 3. Classified Image of Kumasi and its environs showing the Barekese and Owabi Headworks

Source: Author's elaboration.

Rys. 3. Sklasyfikowane zdjęcia satelitarne obrazujące zapory Barekese i Owabi

Źródło: Opracowanie własne.

RESULTS

The analysis of land use classification based on satellite imagery (figures 3 and 4, and table 1) indicate the massive loss of forest cover to mostly *Farmland* and *Settlements*. There is massive deforestation from 1986 to 2007 and even from 2007 to 2011 as *Settlements* and *Farmland* increase.

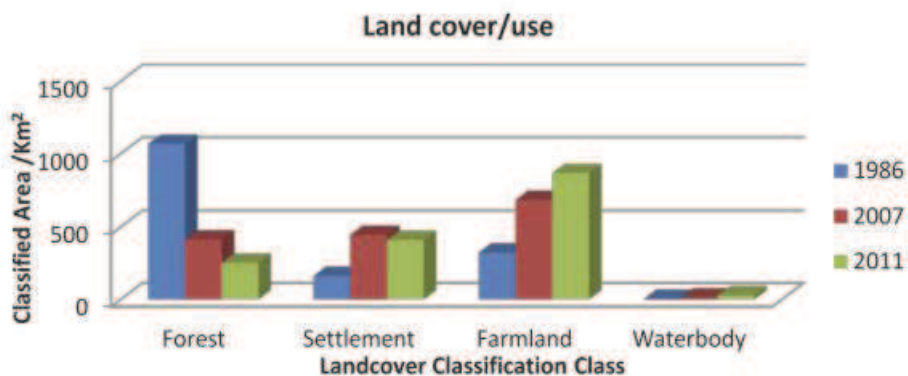


Fig. 4. Land cover/land use evolution in 1986-2007-2011

Source: Author's elaboration.

Rys. 4. Zmiany pokrycia terenu/użytkowania ziemi w latach 1986-2007-2011

Źródło: Opracowanie własne.

Tab. 1. Satellite imagery classification results

Tab. 1. Wyniki klasyfikacji zdjęć satelitarnych

Classification	Classified Area / km ²			Percentage of Classified Area		
	1986	2007	2011	1986	2007	2011
Forest	1068.42	412.53	251.83	68.69	26.52	16.19
Settlement	161.08	444.72	409.29	10.36	28.59	26.31
Farmland	322.24	685.40	866.58	20.72	44.07	55.72
Waterbody	3.59	12.68	27.63	0.23	0.82	1.78
Total	1555.33	1555.33	1555.33	100.00	100.00	100.00

Source: Author's elaboration.

Źródło: Opracowanie własne.

There is a marginal increase in the water body from 1986 through to 2011 what might be a result of seasonal changes of water amount.

The immediate forests around the Barekese and Owabi Headworks are fairly intact from all the scenes (that results from both formal protection and a traditional taboo - sanctuary forest surrounding water bodies), but the forests which are not in their immediate vicinity are vanishing.

The population census of Ghana from 1960-2010 (table 2 and figure 5) indicate a fast growing population for Ghana. Ashanti Region where the Barekese and Owabi headworks are located the share of the population is the highest and keeps increasing as the years pass by. However, the classification 2007-2011 show a small decrease in settlements. It might be a result of people migration and concentration in bigger villages.

Tab. 2. Population census of Ghana

Tab. 2. Spis ludności w Ghanie

Period	Ghana Population	Ashanti Region share	% Ashanti Share of Ghana's Population
1960	6,726,815	1,109,133	16.3
1970	8,559,313	1,481,698	17.3
1984	12,296,081	2,090,100	17.0
2000	18,912,079	3,612,950	19.1
2010	24,658,823	4,780,380	19.4

Source: GSS 2013.

Źródło: GSS 2013.

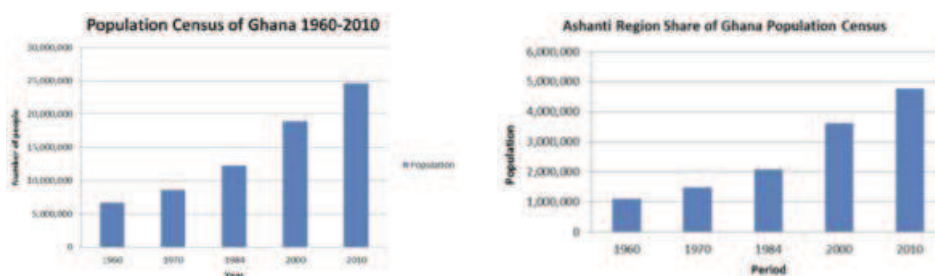


Fig. 5. Population grows in Ghana and in Ashanti Region in 1960-2010

Source: GSS 2013.

Rys. 5. Przyrost ludności Ghany i regionu Ashanti w latach 1960-2010

Źródło: GSS 2013.

DISCUSSION

The Barekese and Owabi headworks have been degraded through anthropogenic activities along its catchment area contributing to deteriorating water quality. The water level has been gradually reduced foreshadowing a looming water crisis in Kumasi in the coming years. The degradation of the reservoirs is attributed to clearing of land for farming and illegal sawn lumber of the forest reserve that is responsible for protecting the catchments of the Rivers Offin and Owabi. This deforestation has resulted in reduced inflow and increased evaporation of the reservoir. The Kumasi metropolitan area is also responsible for dumping tonnes of solid waste into the surrounding areas adding to the deteriorating quality of the reservoir.

Overall, Ghana's population and characteristics pose serious challenges for her development and unless Ghana achieves a considerable fertility decline within the next few years, the nation's development efforts will be frustrated. Its annual population growth rate is among the highest in the world. It has hovered around and 3.1% since 1984 compared with the average rate of 0.6% for the developed world.

For the foregoing, the following problems may be identified among others:

- High population growth rate induced by sustained high fertility and declining mortality rate arising from increased access to health delivery system.
- High pressure on land arising from increasing population growth rate and increasing competing demand for land for economic and residential purposes.
- High age and economic dependency and rising level of unemployment.

Population-Environment linkages: The impact of population on the environment has often been mathematically given as: $I = P \times A \times T$,

where:

I = environmental impact,

P = population size,

A = affluence (which is measured by the average person's consumption of resources), and

T = technologies (which disrupt the environment to provide goods consumed) [Ehrlich and Ehrlich 1990, Zaba and Clarke 1994].

For example, an increase or decrease in P, A, or T will correspondingly raise or lower the environmental impact although equal change in either P, A, or T with the other factors remaining constant may not have the same effect in all regions of the world. At the Rio conference in 1991 countries of the South felt that those of the North, through their excessive consumption and advanced technologies, have more adverse effects on the environment than countries of the South. Developing countries also with their large populations but limited economic advancement can generate a vast impact on the environment if only the P multiplier on the A and T factors is so large [Ehrlich and Ehrlich 1990]. Thus population pressure due to high growth rates is one of the main proximate causes of environmental degradation in the South.

The United Nations Conference on Environment and Development at Rio de Janeiro in June 1991, there has been increased awareness that problems of the environment cannot be fully addressed without first considering population–environment linkages. It is clearly stressed in the final document of the United Nations International Conference on Population and Development (ICPD) held in Cairo in September 1994.

“Pressure on the environment may result from rapid population growth, distribution and migration especially in ecologically vulnerable ecosystems. Urbanization and policies that do not recognize the need for rural development also create environmental problems.” [UNICPD, 1994]. The major objective of ICPD, 1994 is to integrate both the environment and population in development planning and activities.

CONCLUSION

The year time span, 1986-2007-2011, considered in this study is relatively a short increment of time in a long history of land use dynamics, but even then the changes were tremendous. This means that changes in the tropics are much faster than in other parts of the world. These changes result from mainly anthropogenic forces such as rapid population growth, agriculture, timber exploitation and other economic ventures.

The Barekese and Owabi catchment area have endured tremendous changes from 1986-2007-2011 as a result of anthropogenic activities and this has unfavorably impacted the quality and quantity of the raw water and the feeder streams. The forecast of the catchment areas predicts that vegetation cover will continue to experience a decline in forest cover in the year 2043 resulting in feedbacks in regional climate and weather. The four most highly ranked causes of land cover change in the Barekese catchment are poverty-driven agriculture, lack of alternative to the rural wage employment other than farming, household population levels, and conflict in traditional land practices.

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STRESZCZENIE

Wzrost zaludnienia Afryki Zachodniej powoduje presję na lasy, a co za tym idzie zmiany użytkowania ziemi i pokrycia terenu. Zastosowanie wieloterminowych zdjęć satelitarnych pozwala na określenie zasięgu i natężenia tego zjawiska. Artykuł omawia zmiany lesistości i użytkowania ziemi w okresie 1986-2007-2011 w regionie Ashanti (Ghana), w którym znajdują się dwa obszary wodochronne wokół zbiorników wodnych Barekese i Owabi. Pomimo krótkiego okresu poddanego analizie, jej wyniki pokazują dramatyczne zmniejszanie się obszaru lasów, a zwiększanie terenów zabudowanych i upraw rolniczych. Najważniejsze czynniki zmian pokrycia terenu i użytkowania ziemi, to tradycyjne, ubogie rolnictwo, brak zatrudnienia poza nim oraz wysoki przyrost naturalny.

SUMMARY

Increase of population density in West Africa causes a remarkable change in land use and land cover, mainly deforestation. Multi-temporal satellite imagery allows for assessing of the extend and intensity of this phenomenon. Paper describes change in forest cover and land use in the period 1986-2007-2011 in the Ashanti region (Ghana), in which water protective forests are located around Barekese and Owabi headwords. In spite of relatively short period of analysis, the results show tremendous decrease of forests and increase of settlements, as well as farmlands. The most highly ranked causes of land cover change are poverty-driven agriculture, lack of alternative rural wage employment other than farming, household population levels, and conflict in traditional land practices.