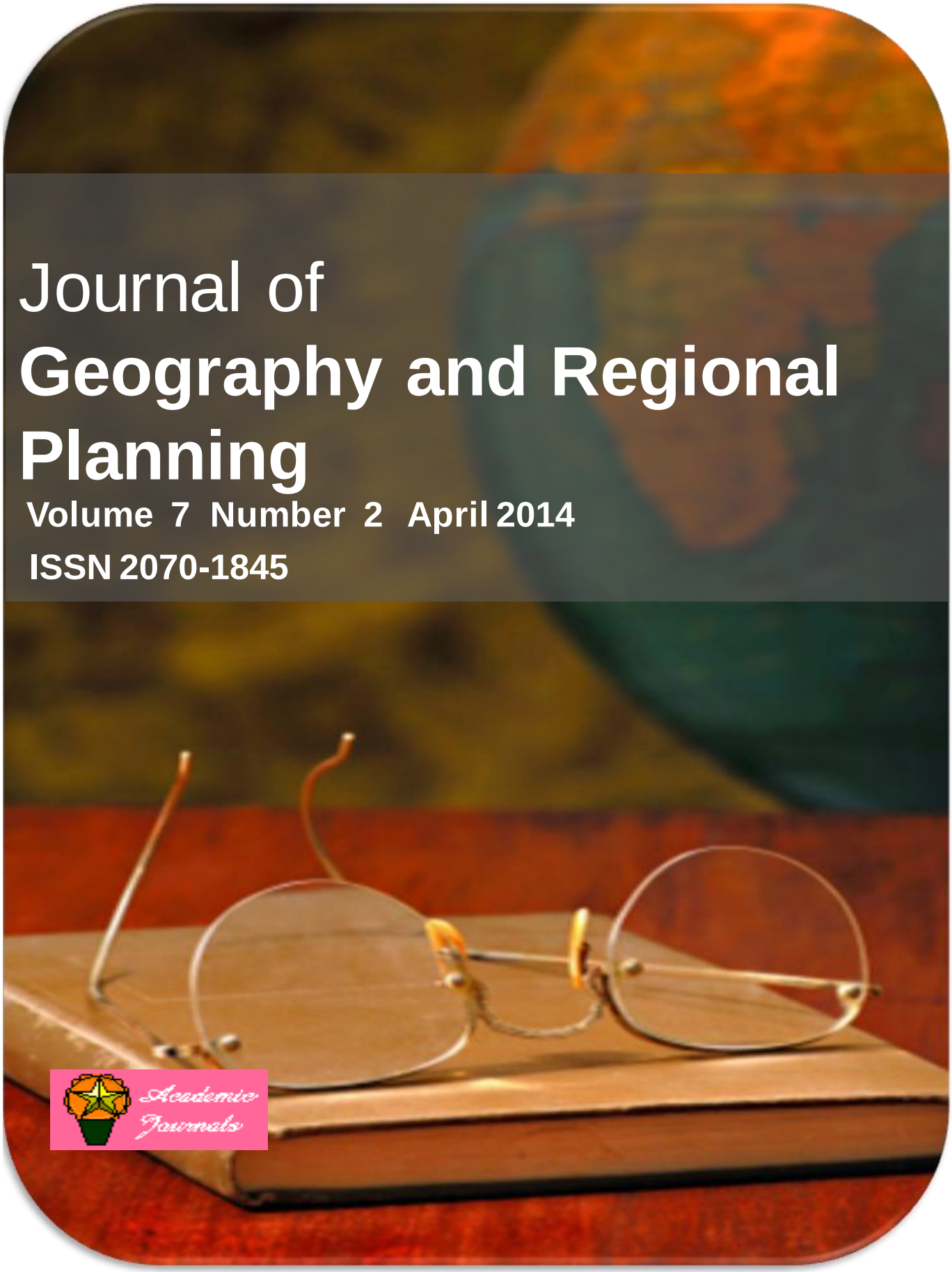

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Journal of Geography and Regional Planning

Full Length Research Paper

Conflicts between the conservation of Elephant and Human activities: In the case of Babile Elephant Sanctuary (BES), Ethiopia

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Conflicts between the conservation of wildlife and human activities occur in all habitats and can impact severely upon socio-economic and biological parameters. Babile Elephant Sanctuary which is located in the semi-arid part of eastern Ethiopia is part of the Somali-Masai Centre of Endemism. It is established to protect the only surviving African Elephant population in the Horn of Africa. The sanctuary is shrinking in size and deteriorating in quality. The vegetation of the sanctuary has been used for fuel wood, construction and other purposes. Grazing, fire and deforestation were intensive, affecting the distribution and conservation of Elephant in the area. Recently, as a result of mass influx of a large number of farmers and their livestock from the east and north, the home range of elephants of Babile has shrunk by about 65.5 %. Moreover, 10,000 hectares of the north western part of the land given recently to a private company engaged in the cultivation of castor used for production of fuel, is being described as a calamity to the already declining elephant population and other wildlife. Of the total land granted to the company, 87.4% was proved to fall within the boundary of the Sanctuary and of this 79.2% were within the present elephant ranges movement corridors and regular feeding grounds for elephants. Recent socio-economic and land use changes in BES such as the demand for more area for agriculture and livestock production have reduced the quality of the Elephants habitat. Local communities around the area are highly dependent on vegetation for fencing, medicine, construction and fuel wood.

Key words: Babile, Conflict, Conservation, Elephant, Sanctuary, Sustainability.

INTRODUCTION

African elephants (*Loxodonta africana* Blumenbach) are ecosystem engineers in that, they create and maintain ecosystems through physically changing the habitat. The elephant is believed to be a crucial keystone species for African savannah and forest ecosystems. They play a major role in maintaining the linkages in a food web and the extermination of this species is expected to cause dramatic changes or extinctions in ecosystems. Moreover, Elephants play an important role as umbrella species, maintaining biodiversity of the ecosystems they inhabit.

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The elephant is also a flagship species, being closely associated with the social and cultural aspects of people and this factor can be harnessed to promote its conservation. However, because of the lack of historical evidence on changes in African vegetation and wildlife, there is little direct evidence to show whether the loss of elephants from particular areas has actually led to the loss of other species. *L. africana* is one of a number of wildlife species being conserved in Ethiopia's protected areas. Until the turn of the 19th century, the African elephant was widely distributed in the country. At present, elephants in Ethiopia are among the 37 mammal species that are threatened by extinction (Yirmed et al., 2006). Since the 1980s, Ethiopia has lost about 90% of its elephant population and hence the species is nationally regarded as critically endangered (Yirmed et al., 2006). Since then, however, the poaching of elephants for ivory and problems associated with human population growth and expansion has reduced the species range and number drastically. As a result, it is restricted to remote protected areas and a few fragmented populations also exist in the eastern part of the country at BES.

BES, located in the semi-arid part of eastern Ethiopia, is part of the Somali-Masai Centre of Endemism (Yirmed et al., 2006). This sanctuary is one of the protected areas in the country established to protect the only viable elephant population in the Horn of Africa. These elephants have been separated from other populations in Ethiopia for more than eight decades. Despite the establishment of the Sanctuary in 1970, their range of distribution has shrunk considerably. As a result of mass influx of a large number of farmers and their livestock from the east and north, the home range of elephants of Babile has shrunk by about 65.5% since 1976 (Yirmed et al., 2006). Moreover, a recent year 10,000 hectares of the north western part of the land given to hjuja private company engaged in the cultivation of castor used for production of biofuel (Yirmed et al., 2006) is being described as a calamity to the already declining elephant population and other wildlife. Of the total 10,000 hectares of land granted to the company, 87.4% was proved to fall within the boundary of the Sanctuary and of this 79.2% were within the present elephant ranges movement corridors and regular feeding grounds for elephants (Yirmed et al., 2006). Local communities around the area are highly dependent on vegetations for fencing, medicine, construction and fuel wood (Anteneh and Feaven, 2008). However studies dealing with conflicts between the conservation of Elephant and human activities are scarcely known in many region of Ethiopia including Babile Elephant Sanctuary where large numbers of Elephants are found (Yirmed et al., 2006). So, the present investigation was aimed to provide information on human impact and interference on conservation of elephant (*Loxodonta africana*) and their wider habitat in the area. This study quantifies the history, type and nature of the conflict between conservation of elephant and human activity in the study area.

STUDY AREA

The study area, BES is located in the eastern lowlands of Ethiopia (Figure 1). The Sanctuary is situated at about 560 km from Addis Ababa. Its geographical position is within latitudes of 08°22'30" to 09°00'30"N and longitudes of 42°01'10" to 43°05'50"E and has an elevations range of 850 m to 1,785 m a.s.l. The mean annual temperature of the area is about 19.6^0 C. The mean annual rainfall is 702.9 mm year. When the Sanctuary was established in 1970, it covered about 6,982 km2 (Yirmed et al., 2006). Most importantly, this protected area supports the only surviving African Elephant in the horn of Africa.

METHODS

Data and information was collected with regard to conflicts between the conservation of Elephant and human activities, both primary and secondary data. (Were used). Direct field observations, questionnaire surveys and group discussions with the local people and Park Scouts were made to collect the relevant information. For each household (and) with the help of local interpreters and guides. A questionnaire was administered to the head of the household or a (present) adult member present. The questionnaire was prepared so that it includes information regarding land use change, human-elephant conflict and the impact of human interference on their ecological status. Field assessments was undertaken during day and night to directly observe the conflict and human impacts. Notes on elephant signs in the area, elephant groups involved in crop raiding, the time in the night when elephants come and leave crop lands, control measures used by the local people and the response of elephants to these measures was recorded. Any illegal activity including elephant killing was also recorded. This included signs and kinds of illegal activity, the time and date of the activity and the possible origin of the individuals taking part in the activity.

RESULTS

Attitude of the local people towards conservation area

Out of the 220 respondents, 86.4% opposed the existing Elephant conservation systems, while 9.5% supported them. However, there was significant difference in attitude towards the conservation of Elephant in the area among village residents (x^2 = 4.3, DF=6, P>0.05). There was a significant difference in the attitude towards wildlife conservation between different age classes (x^2 = 181.24, DF=6, P< 0.05). Younger generation, age class (16 to 30) showed more significantly positive attitude than older age groups (age>31 years). Sex was important in determining the attitude towards conservation area (x2 = 29.2, DF=2, P< 0.05). Male respondents had more positive attitude (81%) than females (19%). conservation systems.

Benefits from protected area

Out of the respondents, 83.2% believe they did not

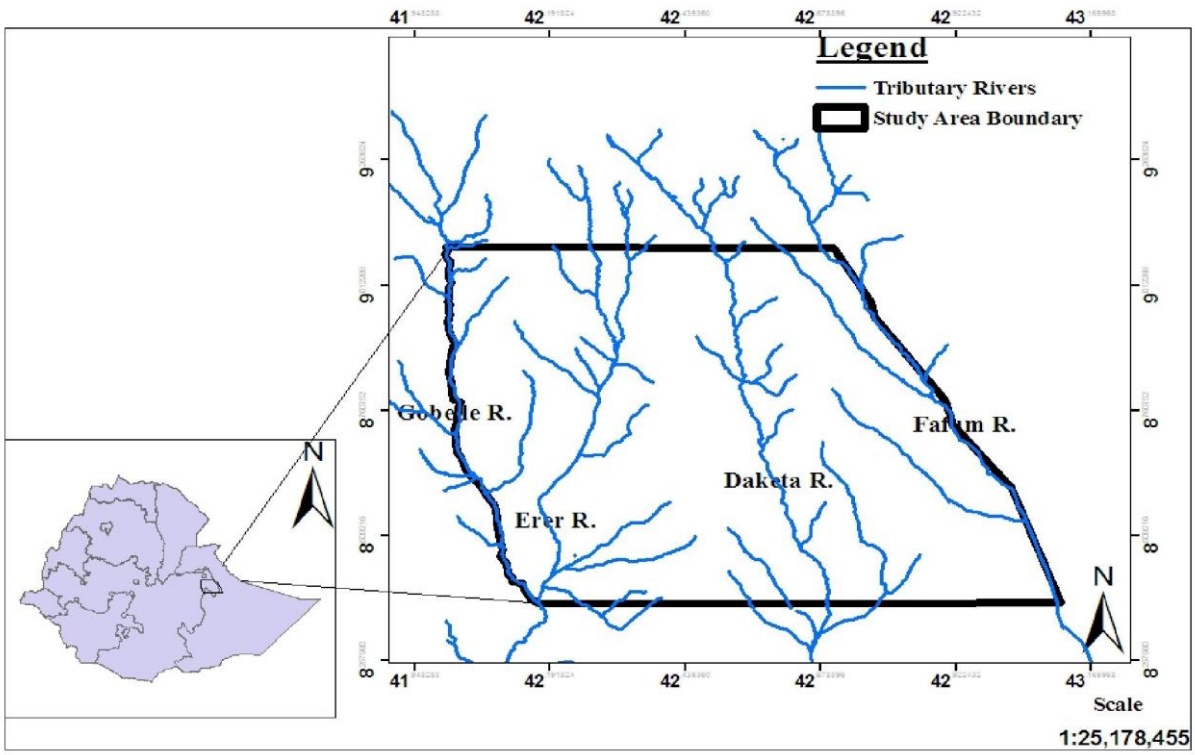

Figure 1. Map of the study area.

receive any benefit from the existence of sanctuary in their area. The expected benefits were opportunities for jobs, social services such as clinics, schools and resources (firewood, free grazing and grass for own use and sale). Few of the respondents (16.8%) noted that they have received benefits from the protected area. There was difference in the vision of benefit (x^2 = 0.876, DF=3, P> 0.05) between respondents among the study sites.

Views of respondents on Elephant

Among the respondents, 40.91% stated that Elephant is not important and the continued existence of Elephant had a negative impact on their livelihood, while 30.45% had no idea on the matter. However, 28.64% of these considered the elephant as important. Reasons given for the importance of elephants includes elephant attracting tourists, enjoyment of seeing and importance for future generations. The views of elephant did not differ significantly (x2= 1.3, DF=6, P>0.05) among respondents from the four study sites.

Trends in Elephant population

The surveys in the villages around BES revealed the views of villagers on trends of elephant populations in the Sanctuary. Most of the respondents (56.8%) have remarked that elephant populations have declined in their areas. However, 27.3% of the respondents remarked that the elephant populations have increased. Only 15.9% of the respondents were unsure whether the population of elephant is increasing or decreasing. The view of respondents among the different villages was statistically significant (x2= 27.8, DF=6, P<0.05).

Resource conflict between human and elephant

The basic premise in the present study, the conflict between conservation of elephant and human activities has escalated because of a change in land use especially, the expansion and intensification of arable farming land in and around the Sanctuary and the high increase in livestock number and settlement in the Sanctuary.

Human population

The Babille ES has been continually under threat from growing human populations, particularly in the northern and northwestern parts of the Sanctuary and its adjacent areas, where agriculture is the predominant activity of the residents. Population pressure in and around the area has resulted in high environmental degradation and loss

of habitat for the elephant. Based on the crude estimates of the Population and Housing Census of 1994, the population density of Babille District had increased from 18 persons per km2 in 1990 to 26 persons per km2 in 1995, an increase of 47.8% (EHPEDO, 2004)

Habitat destruction and disturbance

Results of direct field observations in the study area showed that the habitat and vegetation of the BES has changed dramatically. The major components of habitat destruction and disturbance in the study area were settlement in and around the Sanctuary, overstocking livestock, frequent fire and bush encroachment and tree cutting. Tree cutting was mainly associated with new settlements, expansion of agriculture and use of trees as raw materials for households and for fuel, sale and construction of huts and used the grass primarily for grazing, thatching house and sale which resulted in deterioration of Elephant habitats. This also minimizes the feeding and mating and resting site of the Elephant. Disturbance through the habitat and constant passage of local people on horseback and on foot by uttering and shouting along the length and width of the Sanctuary have become a common activity.

Clearing of the Sanctuary area for investment

The company started its operations inside the Sanctuary in March 2007 with the consent of the Ethiopian Investment Agency (EIA) and the Oromia Investment Commission for plantation of castor seeds for biofuel production. With the help of about 15 tractors, Flora Ecopower cut down the *Acacia commiphora* and bush vegetation in the northern and northwestern sections of the Sanctuary. No Environmental Impact Assessment was prepared by or required from the company before commencing these activities. The consequences of allowing the investment project to operate in this core elephant conservation area were outlined. According to Yirmed (2008) of the total 10,000 hectares of land granted to the company, 87.4% was proved to fall within the boundary of the Babille ES and of this 79.2% were within the present elephant ranges.

Elephant poaching

According to the questionnaire survey, 65% of the respondents claimed that elephant poaching had been practiced in the area while the rest said it was not practiced in the area. Out of those claiming the presence of elephant poaching, 37% said it was practiced until the establishment of EPRDF, while most (63%) claimed it is practiced even now in the area. Regarding the period at which elephant poaching was intense, most of the respondents (86%) said it was very intense during the Transitional Government, 7% of them said it was during the Dergue Regime, while the remaining said they did not know about it. The main causes reported to contribute for intense elephant poaching during the Transitional Government were illegal firearm trade, political and social instability in the country. Subsequent restoration of political and social order in the country, local disarmament of illegal firearms and the initiatives taken by the local governmental body to protect the area might reduced the poaching pressure on elephants.

Elephant induced damage

The result of group discussion with the local peoples revealed that elephants were consistently raiding crops, vegetables and fruits and attacking crop-stores around their home range. They were also causing social problems including preventing people from walking at night. According to the group discussion and direct observation in the study area showed that crop-raiding by elephants is often a severe problem in the area and individual farmers lose an entire year's crop overnight and risk their lives in defense of their crops. Among the households, 58.2% experienced crop damage. The majority of respondents (45%) reported elephant caused very little damage to their crop and none of the respondents faced very much damage. Respondents differed ($x2= 45.43$, $DF=2$, $P<0.05$) in their views on whether or not elephant caused problems in relation to distance from their respective areas. People who live inside the Sanctuary area generally face many problems compared to those living within 4 km vicinity of the Sanctuary. Regarding the seasonal distribution of the crop damage problem, 71.1% said that it occurs during the wet season. When asked about other problems caused by elephants, out of the 73 households surveyed, 46.6% claimed that elephants have not caused any other problem, 33.3% claimed that elephants brought Tsetse flies and as a result livestock are attacked by trypanosome, while 30.2% expressed that elephants caused sleeplessness and extra labor cost on family members.

Protective measures adopted

All the respondents used different traditional methods to mitigate crop damage due to elephants. These include staying in the field watching, throwing objects, producing noise by beating drum or shouting loudly, keeping fire burning, use of brightly colored objects and a wide and deep trench as a barrier and using banging on tins or drums to chase away approaching elephants. The technique has been used for millennia and is successful.

DISCUSSION

Protected areas are a cornerstone of conservation policy.

However, such areas are continually under threat from growing human populations in the tropical developing countries. This is particularly the case in the Babile area, where the growing population has developed as a threat to protected areas directly by encroachment of wildlife area. Community perspectives towards the conservation area stem from a variety of contributing factors including loss of access to resources and benefits generated from conservation area, awareness concerning the importance of wildlife and crop depredation by wild animals. Human-wildlife conflict in BES is longstanding issue (Yirmed et al., 2006). The increased number of human population resulted in a severe competition with the wildlife resources of the conservation area. The Sanctuary is fully affected by human impact throughout the year. Such intense pressure will curtail the normal activities of Elephant. The absence of a proper fence also makes people and livestock easily to move through the Sanctuary in all direction without any limit. The failure to take action to revert illegal firearm possession in the past fifteen years makes the country lose its wildlife resources due to poaching (Shibru, 1995; Yirmed, 1997). Since 1995, however, local disarmament of illegal firearms from the local people and the interest local officials have developed and the action they have taken to bring the area under protection could have played major role in minimizing elephants and other wildlife killing in the area and mentioned that the extent of crop raiding varies depending on habitat type, elephant use pattern and distance from the boundary. The relatively high incidence of crop raiding in BES was also related to the above three factors. Many studies have shown that the cost of conservation is the result in negative attitudes while benefits create a positive outlook. Most communities strongly need free access to grazing for their livestock in the Sanctuary. They also claim that they have the right to utilize the natural resources of their area. To bring sustainable wildlife management and rural community development at Babile, it requires reconciling the interest of stakeholders. These will be achieved only when their interest becomes balanced. To balance, it requires solving the conflict between the interest of the community and the conservationists. Some of the measures to reduce the problems are introducing family planning, reducing the livestock number, emphases on quality, introduction of animal forage extension, awareness program towards wildlife, solving the problems of potable water, grazing land shortage, low production and productivity and introducing other community services.

CONCLUSION

There is a continuing decline in the extent and quality of elephant habitats in BES. Having poor conservation status, BES is faced with many threats attributed to an increase in human activities including intensive agricultural activities, incursions of large number of livestock, deforestation for fuel wood and construction, uncontrolled bush fires for charcoal production, investment for biofuel production and poaching. The activity of humans is increasingly affecting elephant conservation as many elephants get killed (by) illegally by local people in attempts to reduce the conflict. Uncontrolled human activities will ultimately result in considerable loss of biodiversity, hamper movements of large herbivores such as elephants and consequently intensify human wildlife conflicts. The destruction of elephant habitats is caused by alteration of natural habitats for different human uses such as cultivation, livestock grazing, investment and space for human settlement. Changing the attitude of local communities through education and sharing of benefits associated with the wildlife can serve as a means for sustainable conservation measure.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Full Length Research Paper

Farmer's adaptation to climate change in Ondo State, Nigeria: A gender analysis

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In combating the problem created by adverse climatic change, farmers in the areas had been introduced to climate change adaptation practices for the purposes of increasing yields for better livelihood and food security. The study used multi-stage sampling technique to collect information from 120 respondentsts. Data collected were subjected to descriptive, gross margin and multinomial logit analyses. Results of the descriptive analyses reveal that the mean age of the male farmers was 46.3 years while that of the female farmers was 45.5 years. The mean farm sizes were 3.8 hectare and 1.4 hectare for male and female farmers, respectively. The results of the gross margin analysis reveal that the total revenue to an average male maize farmers was N101,443.8 and that of an average female farmer was N78,551.1. The gross margin for and average male farmer was N71,905.8 while that of an average female farmer was N58,098. Multinomial logit analysis revealed that credit access positively influenced mulching, irrigation and tree planting practices. Extension visits positively influenced varying time of planting and tree planting practices. Government and development agencies should introduce policies and programme that would enhance strong and virile extension and credit units.

Key words: Climate change, adaptation, multinomial logit, gender.

INTRODUCTION

Agriculture is an important sector in Nigeria as it provides employment for over 60 percent of the entire population. This population operates subsistence agriculture which is almost entirely weather dependent (Sofoluwe et al., 2011). The declining productivity of agricultural crops and food wastes had been traced to adverse climatic change and variability. Climate change and variability (CC and V) is rapidly emerging as one of the most serious global problems (Mary and Majule, 2009). Rising temperature and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in irrigation water availability. These as well affect many sectors in the world and are considered to be one of the most serious threats to sustainable development with adverse impact on environment, human health, food security, economic

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activities, natural resources and physical infrastructure (IPCC, 2007; Huq et al., 2006, Adeloye and Sotomi, 2013).

Studies have shown that the developing countries, in which Nigeria is one, are the most vulnerable regions to climate change and variability in the world because of their dependence almost on weather. Previous assessments (IPCC, 1998; Hulme, 1996) concluded that Africa is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution and over dependence on rain-fed agriculture. Ngana (1983) in his study on drought and famine in Dodoma District asserted that the presence of dry spells in critical periods for most crops contributed considerably to crop failure and famine. Given the over-dependence on rain-fed agriculture by the majority of people living in rural areas, CC and V has been one of the major limiting factors in agriculture production thus resulting in food insecurity and low-income generation (Sofoluwe et al., 2013). For example, droughts and floods have been reported to cause failure and damage to crops and livestock leading to chronic food shortages (Liwenga et al., 2007; Kangalawe and Liwenga, 2005). The studies conducted by Rosenzweig et al. (2002) revealed that changes in rainfall patterns and amounts have led to loss of crops and reduced livestock production. Because of concerns for the growing threat of global climate change from increasing concentrations of greenhouse gases in the atmosphere to incessant high temperature and consequent reduction in rainfall which had called the attention of the international organizations such as Framework Convention on Climate Change (FCCC), United Nations (UN) and FAO on the needs for adaptation for the purposes of conserving the world bio-diversity and hence achieving food security through maintaining agricultural productivity (UNEP, 2002). Adaptation has been variously defined by authors. According to Kreft et al. (2010), it is an initiative, approach, measures or practices to reduce the menace of or vulnerability of natural or human resources to climate change.

Fakoya et al. (2006) established the involvement of farmers of both sexes in farming activities. They added that there are variations in the level of involvement across gender depending on the technology and energy needed. It therefore becomes imperative that the evolving trend in climate change adaptation practices among farmers looks at the attitude of men and women towards maintaining sustainable agricultural productivity in arable food crop production as a pathfinder to understanding the sustainability of the system. According to Verma (1992), farmers of both sexes engage in both pre-planting, planting and post-planting activities but vary is the level and time of involvement. Studies (Kreft et al.,2003; Parry et al., 2004; Burke and Lobell, 2010) examined the effects of climate change on agricultural productivity and farmers' adaptation in Nigeria's agriculture and Sofoluwe et al. (2011) investigated the perception of farmers to climatic changes and factors influencing the choice of adaptation methods. However, no known study has been conducted on farmers' adaptation to climate change on gender basis. The study therefore achieves the following objectives. Broadly, the study examines farmers' adaptation to climate change in Ondo State on gender basis. The specific objectives are to analyze the socio-economic characteristics of maize farmers in the study area on gender basis; identify adaptation strategies on gender basis; determine farmers' costs of adaptation practices; determine the gross margins on maize as well as examining the factors influencing farmers' choice of adaptation practices in the study area.

METHODOLOGY

Area of the study

The study area is Ondo state. The study was conducted in the southern part of the state. The southern part of the state comprises of six local Government Areas (LGAs) - Irele, Okitipupa, Ilaje, Ese-Odo, Odigbo and Ile-Oluji/Oke-Igbo. The state is located in the Southwestern part of Nigeria. It is in the rainforest belt with an average annual rainfall of over 2000mm and daily temperature of between 230^0C to 300^0C (Ojo and Afolabi, 2003). Ondo state with a land area of about 14,769 square kilometer was carved out of the defunct old Western Region on the 3rd February 1976 out of which Ekiti state emerged in October 1996. Geographically, the state is located within longitude 4^0 and 6^0 E of the Greenwich Meridian and latitude 6^o and 8^0 N of the Equator. It is bounded by Kogi and Ekiti states in the North; Edo and Delta states in the East; Ogun and Osun states in the West and in the south by the Atlantic Ocean. Two distinct vegetation belts predominate in the state, the southern rainforest in which the southern part of the state falls and the northern derived savanna. Food crops such as cassava, maize, cocoyam, plantain, yam and vegetables, etc., are widely grown in the area. Both men and women engage in farming in the area.

Sampling procedure and data collection

A multistage sampling procedure was used to collect data from the respondents. The first stage involved purposive selection of three LGAs based on the predominance of agricultural activities. These were Irele, Odigbo and Okitipupa LGAs. The second stage involved a random selection of two villages in each of the LGAs. The final stage involved random selection of 20 respondents per village. A total of 120 respondents were selected in all for interview. Data were collected with the aid of structured questionnaires which were administered to farmers across sexes. Out of the 120 questionnaires administered, 117 of them were suitable for analysis. Data were collected on the socio-economic characteristics such as sex, age, educational information, family size, costs and returns associated with crops grown and knowledge about climate change adaptation practices among others.

Analytical techniques

Data collected were analysed using descriptive statistics; budgetary technique and multinomial logit model.

Table1. Description of expectation signs of independent variables

Variable	Expected sign
Age	+/-
Number of adult male	+
Level of education	+
Farm size	+
Employment income	+
Credit access	+
Extension visit	+
Crop income	+
Farming experience	+
Social capital	+

Descriptive statistics

Descriptive statistics such as mean and percentages were employed to describe the selected socio-economic variables and the average cost of adaptation practices.

Budgetary techniques

Budgetary technique was used to compute the costs and returns to selected arable crops by estimating the revenue, gross margin and the net farm income realized at the end of production process. Gross margin is the difference between the total revenue and total variable cost. According to Alimi and Manyong (2000), a budget is the quantitative expression of total farm plan summarizing the income, cost and profit (a residual of total cost from total revenue).
The total cost component is expressed as:

TC = TFC + TVC
Where;
TC = Total Cost; TFC) = Total Fixed Cost; TVC = Total Variable Cost
To calculate gross margin GM,
GM = TR – VR;
Where;
TR = Total Revenue; VC = Variable Cost
Multinomial legit model

The Multinomial logit model was employed to package the various categories of adaptation practices into a five-model scenario. The model was employed instead of Tobit model because Tobit model assumes that non-adopter of a given practice does not adopt any other. This is because when there is more than one practice choice to choose from, that the farmer does not pick one does not mean he is a non-adopter. Hence, non-adoption of one does not necessarily puts the farmer in non- adopter category. This supports the model appropriateness.
The model was specified as

$$U_i = \beta_i X_i + \varepsilon_i$$

Which implies that the utility, U_i, of choosing a particular

practice is a stochastic linear function of farm, farmers and practice specific attributes (X_i). In this Multinomial logit, the probability,

$$\text{Prob(choice } j\text{)} = \frac{\exp(\beta_j X)}{\sum_j^n \exp(\beta_j X)}$$

of choosing a given practice, j , is equal to the probability that the utility of that particular technology is greater than or equal to the utilities of all other soil fertility technology in the model. The dependent variable in this model was a discrete variable taking the value 0, 1, 2, 3 and 4 for cases of non-adaptation, mulching, irrigation, varying time of planting and tree planting.
The empirical model specified is:

$Y_i = \beta_O + \beta_1 AGE + \beta_2 ADULTMAL + \beta_3 EDULEV + \beta_4 FARMSIZE + \beta_5 CREDIT + \beta_6 EXTVIST + + \beta_8 CROPINCM + \beta_9 FARMEXP + \beta_{10} SOKAL$
Where; Y_i = Adaptation to climate change. (0= non-adaptation 1=mulching, 2= irrigation, 3=varying time of planting, 4= tree planting.
β_O = constant
β_1 *AGE* = age of respondents in year)
β_2 *ADULTMAL* = number of adult male
β_3 *EDULEV* = level of education extension visit
β_4 *FARMSIZE* β_7 *EMPLINCM* = land size owned
β_5 *CREDIT* = credit access
β_6 *EXTVIST* = extension visits
β_7 *EMPLINCM* = extension visits
β_8 *CROPINCM* = crop income
β_9 *FARMEXP* = farming experience
β_{10} *SOKAL* = social capital (proxy by members of association)

The multidisciplinary independent variables included farmer, farm and institutional factors postulated to influence adaptation practices. These variables include were age of farmers (*AGE),* number of adult male *(ADULTMAL),* level of education *(EDULEV),* farm size *(FARMSIZE),* employment income *(EMPLINCM),* credit access *(CREDIT*), extension visits *(EXTVIST),* crop income *(CROPINCM),* farming experience *(FARMEXP)* and social capital *(SOKAL).* It is hypothesized that a farmer's decision to either adapt or otherwise to climate change is influenced by the combined effect of a number of factors related to farmers' objectives and constraints. (Sofoluwe *et al.*,2011). The variables in the model were hypothesized to influence farmers adaptation positively (+), negatively (-), or both positively and negatively (+/-). The expected signs of the independent variable are shown below. (Table 1).

RESULT AND DISCUSSION

Descriptive analyses of socio-economic characteristics of respondents

The results of the descriptive analyses (Table 2) reveal that the mean age of the male farmers was 46.3 years while that of the female farmers was 45.5 years. The mean farming experience was 21.1 years for male and 14.7 years for female farmers, respectively. The mean farm sizes were 3.8 hectare and 1.4 hectare for male and female farmers respectively. The mean employment income among male farmers was ₦ 23,211.4 and that of female farmers was ₦13,768.7. This implies that farmers of both sexes engaged in non-agricultural activities. The mean cost of adaptation practices incurred was highest (₦ 4,664.3) among the male farmers compared to

Table2. Demographic and socio-economic characteristics of respondents

Variable	Mean	
	Male (68)	Female (49)
Age (years)	46.3	45.1
Farming experience (years)	21.1	14.7
Farm size (ha)	3.8	1.4
Emloyment income (₦)	23,211.4	13,768.8
Cost of adaptation practices(₦)	4,664.3	489.7
	%	
Extension Visits		
Yes	9.6	2.6
No	90.4	97.4
Total	100	100
Credit access		
Yes	3.8	0
No	96.2	100
Total	100	100
Perceived temperature		
Too hot	78.9	84.3
Hot	21.1	15.7
As before	0	0
Total	100	100

Source: Field survey, 2011

Table 3. Farmers' adaptation technique across gender

Adaptation practices	%		
	Male	Female	Difference
None	21.4	56.3	-34.9
Mulching	44.8	29.7	15.1
Irrigation	4.1	0	4.1
varying time of planting	12.4	11	1.4
tree planting	17.3	3	14.3
Total	100	100	

Source: Field survey, 2011

Table 4. Gross margin analysis for maize production (average)

Items	Male	Female	Pooled
Total revenue (₦)	101, 443.8	78, 551.5	89,9977
Variable cost			
Seed	2,122.8	2,119.4	2121.1
Labour	19,339.6	9,566.7	14,453.2
Chemicals	4,632.4	3,878.9	4,255.7
Others	3,443.3	4,888.5	4,165.9
Total variable cost(₦)	29,538.3	20,453.5	24,995.9
Gross margin	71,905.8	58,098	65,001.9

Source: Field survey, 2011

₦ 489.7 for female farmers. This implies that farmers of both sexes adapt to changes in the climate but the investment rate is low among female farmers compared to their male counterpart based on the result of the cost of adaptation practices. The contact farmers had with extension agents in the last production season was low. Analyses reveal that only 9.6% of the male farmers had contact with the extension agents while few 2.6% of the female farmers had contact with extension agents in the last production season. Results also reveal that while 3.8% of the male respondents had access to credit, none of the female respondents had access to credit. This implies that female respondents still do not have equal access with their male counterparts to productive resources. Analyses further revealed that none of the respondents of both sexes responded that temperature remained as before. Approximately 79 and 84% of male and female farmers responded that the weather proxy by temperature is too hot.

Farmers' adaptation technique across gender

Table 3 reveals the farmers' adaptation technique across gender. Results in the table reveal that greater proportion of the female respondents (56.3%) were never involved in any adaptation practices while just 21.4% of the male respondents did adapt to changes in climate. Mulching was the mostly employed technique by the farmers of both sexes as 44.8 and 29.7% of male and female farmers employed the technique. While 4.1% of the male farmers employed irrigation, none of the female respondents did. This might be due to the skills and cost involvement in the technique. Analysis further revealed that 12.4 and 11% of male and female farmers employed tree planting, respectively. However, while 3% of the female farmers employed tree planting, 17.3% of the male farmers employed tree planting. The results above conform with Verma (1992) that female farmers involvement in farming operation is dependent on skills and energy involved. This might be the reason for the non-employment of irrigation by the female farmers.

Gross margin analysis

The results of the gross margin analysis (Table 4) reveal that the total revenue to an average male farmers was ₦ 101,443.8 and that of an average female farmer was ₦ 78,551,1. The labour cost incurred by an average male farmer was higher (₦ 19,339.6) than that of an average female farmer. The higher cost of labour might be due to the cost incurred in adapting to climate change. The gross margin for and average male farmer was ₦ 71,905.8 while that of an average female farmer was 58,098. It can be deduced that adapting to climate change enhances better income.

Table5. Multinomial Logit model for the determinants of choice of adaptation options

Variable	Mulching	Irrigation	Varying planting time	Tree planting
AGE	-0.0175	-0.1325*	0.3374	-0.0778
ADULTMAL	-0.3533**	0.1107	0.2166	0.0056
EDULEV	0.2188	0.0055	0.0007	0.0045
FARMSIZE	0.4339	0.2432	0.0023	0.0441*
CREDIT	0.2221***	0.7878**	0.0256	0.0190**
EXTVISIT	0.0064	0.3035	0.1038**	0.0435*
EMPLINCM	-0.3452	-0.2868*	2.1101	0.0031
CROPINCM	0.0133	0.04421	-0.0253	0.0138
FARMEXP	0.0397	0.0067	0.3486***	0.0601
SOKAL	0.0691*	0.0286	0.2438	0.0122
Log likelihood Function = -53.6587				
Chi-square value 21.0076				

Source: Field survey, 2011
Note: ***=significant at 1%; **= significant at 5%; *=significant t 10%

Multinomial Logit model of the determinants of choice of adaptation practices

The results of the multinomial logit (Table 5 reveal that the log likelihood function was -53.6581 and the chi-squared value was 21.0076. These support the fitness of the model. The results reveal that credit access and social capital increased probability of adaptation to climate change by mulching. An increase in credit accessed by ₦1 would increase the probability of adaptation by 22.21% and an increase in the number of association a farmer belongs to by 1 would increase probability of adaptation by 35.33. These agreed with the expectation of the study. Number of adult male reduced the probability of adaptation to change in climate by mulching application. An increased in the number of adult male by 1 would reduce the probability of adaptation by 35.33%. This is contrary to the expectation of the study. The increased number of adult male might be diverted to activities other than farming. While credit access increases irrigation adaptation, age of household head and employment income reduced probability of adaptation. An increase in the credit accessed by ₦1 would increase adaptation 78.78%. However, an increase in the age of household head by 1 year would reduce probability of adaptation by 13.25%. This agreed with the expectation of the study that age could take either sign. In the same vein, an increase in employment income by ₦1 would reduce probability of adaptation by 28.68%. This did not agree with the expectation of the study. The reason for this might be due to the diversion of income from employment to enterprises other than farming for the purpose of ensuring uninterrupted inflow of income or guide against crop failure. Analyses further reveal that just extension visits and farming experience positively influenced probability of adaptation by varying the time of planting. An increase in the extension contacts by 1 would increase the probability of adaptation by 10.38% and an increase in the farming experience by 1 year would increase the probability of adaptation by 34.84%. This agreed with the expectation of the study. Finally, farm size, credit access and extension visits positively influenced farmers adaptation by tree planting. An increase in farm size by 1 hectare would increase the probability of adaptation by 4.41%. Also, an increase in credit accessed by ₦ 1 and extension contacts by 1 would increase probability of adaptation by 1.9 and 4.35%, respectively.

CONCLUSION

The study has revealed clearly the difference between men and women adaptation options. Men in the area invested more on adaptation technique than their female counterpart. Credit access affected mulching, irrigation and tree planting. Extension visits also positively influenced varying time of planting and tree planting. Therefore, there is need to encourage farmers of both sexes on the needs to adapt to climate change through the cheap but effective practices available to them and a policy thrust that makes extension and credit available and affordable.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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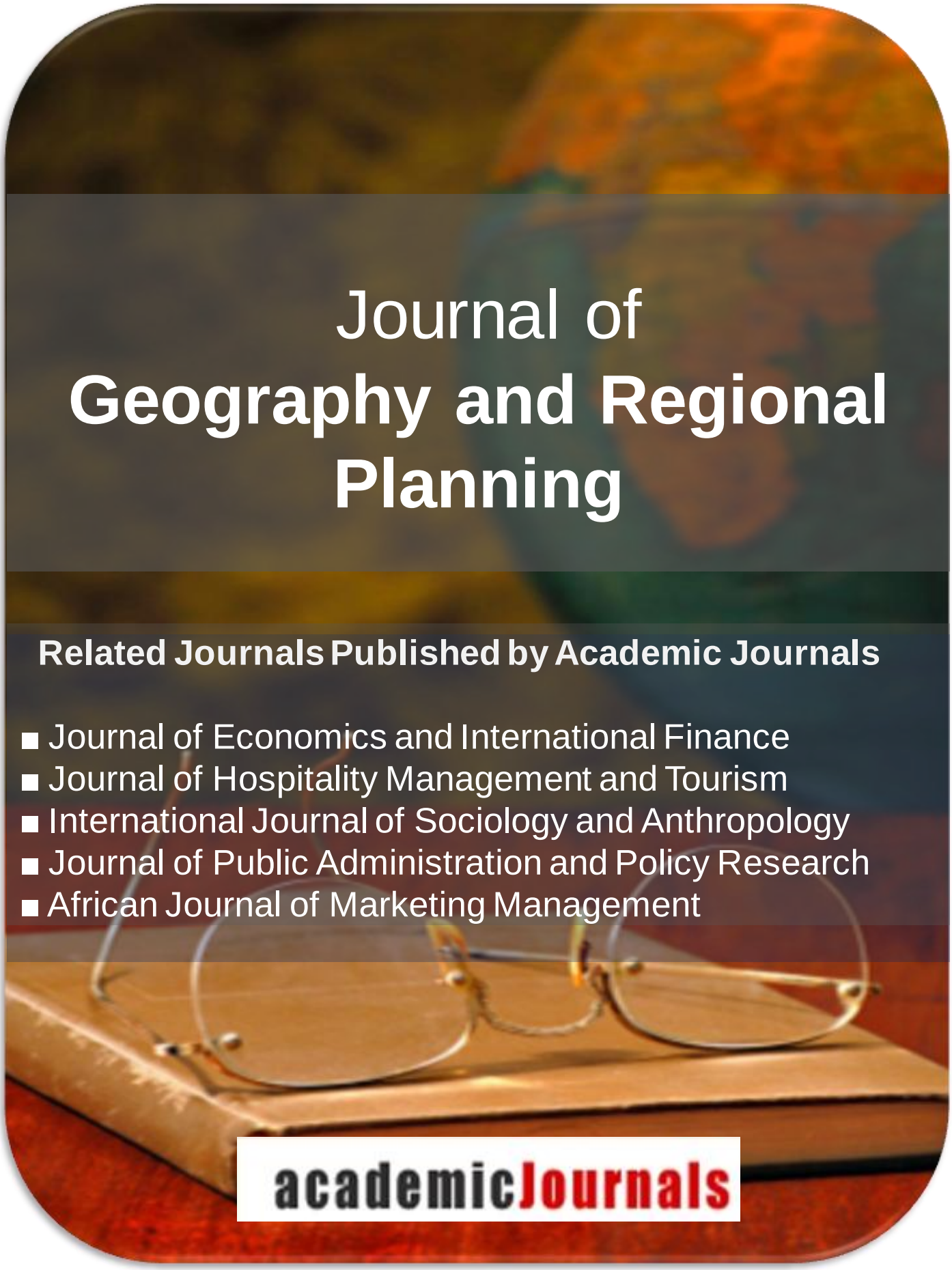

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