wjert, 2022, Vol. 8, Issue 5, 298-310. Original Article ISSN 2454-695X

World Journal of Engineering Research and Technology

WJERT

www.wjert.org

SJIF Impact Factor: 5.924

EFFECTS OF CLIMATE CHANGE ON WATER SOURCES IN IMO STATE, NIGERIA

***[1]Josephat Chudi Arthur, [2]Prof. Dr. Hüseyin Gökçekuş and [3]Assoc. Prof. Dr. Youssef Kassem, Ph.D.**

[1]Department of Environmental Science and Engineering, Faculty of Civil and Environmental Engineering, Near East University, Mersin 10 Turkey.

[2]Department of Civil Engineering, Civil and Environmental Engineering Faculty, Near East University, 99138 Nicosia (via Mersin 10, Turkey), Cyprus.

[3]Department of Mechanical Engineering, Engineering Faculty, Near East University, 99138 Nicosia (via Mersin 10, Turkey), Cyprus.

Article Received on 20/03/2022 **Article Revised on 10/04/2022** **Article Accepted on 30/04/2022**

***Corresponding Author**
Josephat Chudi Arthur
Department of Environmental Science and Engineering, Faculty of Civil and Environmental Engineering, Near East University, Mersin 10 Turkey.

ABSTRACT

Families are exposed to poor water quality because of climate change, which has a negative influence on children's chances of survival and serious health concerns. The main purpose of the research was to look into the consequences of climate change on Nigeria's Imo state's drinkable water sources. This research relied heavily on secondary data. The Nigerian Meteorological Agency (NIMET) provided the necessary rainfall data for this investigation. The Owerri synoptic station in Nigeria was used by the Nigerian Meteorological Department from 1999 to 2019 to collect monthly rainfall and air temperature (minimum and maximum) data (table 2). Data for the sources of water in Imo State was obtained from published article these articles used questionnaire and survey methods in adopting data on the drinking water sources in Imo State. Results showed that Borehole water is the most frequent source of potable water in Imo State. Water conservation and management should be the emphasis of climate change mitigation efforts in Imo State and any nation because climate change directly influences water resources. Imo State's water supplies have been shown to be affected by climate change, according to this research, which found variations in rainfall

patterns across the state during the study period. This has implications for both the quality and quantity of water available in Imo State.

KEYWORDS: Climate change, water sources, imo state.

1.1 INTRODUCTION

Scientists found that human activities such as the use of fossil fuels and land use change have resulted in a rise in the concentration of greenhouse gases in the atmosphere since the industrial revolution. These gases trap excess heat in the atmosphere, offsetting the earth's atmosphere-energy balance and causing rapid changes in the earth's system, which have been observed to be increasing at an increasing rate during the past two or three centuries.

Any change in climate over time, whether caused by natural variability or human activity, is referred to as climate change. It refers to a change in climate that is related to human actions directly or indirectly, changes the composition of the global atmosphere, and is in addition to natural variability observed over comparable time periods. It includes all types of climate inconsistencies (i.e., any variations between long-term meteorological element statistics obtained for various periods but belonging to the same place).

Climate change is now the most serious environmental threat facing humanity in the twenty-first century, manifesting itself in extreme weather events such as flooding, drought, heat waves, changes in rainfall intensity and pattern, sea level rise, and the drying up of rivers and streams, to name a few. Climate change's historic calamity now threatens to set already accomplished human growth into reverse, while also posing a significant obstacle to nations' achievement of the Millennium Development Goals (MDGs).

Climate change would modify the features of the components of hydroclimatogical systems in different ecological zones, with implications for the availability of water. Climate change, rising water demands, population increase, industrialization, and urbanization are already wreaking havoc on the world's water resources.

According to IPCC (2001a), precipitation has increased in the mid and high latitudes and the inner tropics over the twentieth century, while it has decreased in the majority of the northern subtropics. Projections for the 21st century indicate that this trend will continue. The central parts of the continents will experience above-average temperature rises, resulting in increased

evaporation that is often insufficiently compensated for by increased precipitation, causing soils to dry out and water availability to decline (IPCC, 2001a).

Observed temperatures in Africa have been warming since the 1960s, especially in the last few years. In Sub-Saharan Africa, long periods of drought are becoming more common and are predicted to become more widespread (WaterAid, 2007). Despite the fact that Africa is widely regarded as a continent with abundant water, both urban and rural residents on the continent lack access to adequate and safe drinking water, putting their food security at danger, as well as being exposed to preventable water-related diseases.

Various climate change implications have been shown in the Nigerian context. According to estimates, the humid tropical zones of southern Nigeria, which are currently too hot and wet, would see an increase in precipitation (particularly during the rainy season) and temperature. Already, according to IPCC (2001a), temperature increases of 0.20C-0.30C per decade have been documented in the country's diverse biological zones, while droughts have plagued the Sudan-Sahel region, notably since the late 1960s.

1.2 Problem Statement

An estimated 2.2 billion people require access to safe drinking water, with 884 million currently lacking basic drinking water services. An estimated 4.2 billion people require safe sanitation management. Water stress conditions (for example, the disappearance of Lake Chad) are expected to worsen by 2025, increasing the burden on women and girls of collecting and transporting water over long distances (International Water and Sanitation Centre (IRC), 2004).

Because climate change is threatening the quality of water for many household uses, the family is exposed to low water quality, which poses major health concerns and has a detrimental impact on children's chances of survival (WaterAid, 2005).

Water, sanitation, and hygiene-related cases accounted for 70% of child mortality and morbidity in Nigeria, according to reports.

Climate change may limit men's ability to work for a living, resulting in unemployment and low self-esteem for men as well as greater family poverty.

The question now is: what are the sources of water for Imo State's households? What are the consequences of climate change on the area's water resources? What are the possible strategies for ameliorating the impacts of climate change on water resources in the area? Answers to these questions were the main thrust of this study.

1.3 Aims of the study

The study's ultimate goal was to investigate the effects of climate change on household water sources in Nigeria's Imo state. The study's objectives were to:

1. Identify the major sources of water for households in the area;
2. Determine the perceived effects of climate change on water resources;

1.4 Significance of the study

The outcomes of this study will highlight the consequences of climate change on the area's water resources, attracting residents', policymakers', and other stakeholders' attention to the threats that climate change poses to their environment and source of livelihood.

The findings of this study will be valuable to government and non-governmental organizations interested in improving the living conditions of the people in the area. The study will provide information on the role of gender in the provision of household water.

Policymakers can use the findings of this study to help achieve goals related to environmental sustainability and women empowerment as part of the UN's Millennium Development Goals.

The study's findings will also open up new avenues for scholars who are interested in climate change.

3.1 Study Area

Imo State has a land area of about 5,100 square kilometers and is located between latitudes 4°45'N and 7°15'N. It is found in the humid tropics and has a year-round high surface air temperature regime. The average minimum temperature is 23.5°C and the average maximum temperature is 32.1°C. There are two seasons in the year: rainy and dry. The rainy season begins in April and lasts until October.

There are 27 Local Government Councils in the state, as well as three major political zones: Okigwe, Orlu, and Owerri. Owerri, the state's administrative capital, is the most populous, commercialized, and industrialized city. The population of the state is estimated to be around

4.8 million people (Imo State - Wikipedia 2021). Natural resources in the state include zinc, lead, crude oil, natural gas, and some economic flora.

Figure 1: Map of Nigeria showing Imo State.

Figure 2: Map of Imo State.

3.2 METHODOLOGY

This study relied heavily on secondary sources. The Nigerian Meteorological Agency (NIMET) provided the rainfall data required for this study. The Nigerian Meteorological

Department collected monthly rainfall and monthly air temperature (minimum and maximum) data from the Owerri synoptic station between 1999 and 2019 (table 2).

Data for the sources of water in Imo State was obtained from published article; these articles used questionnaire and survey methods in adopting data on the Imo State's drinking water sources.

Table 1: Drinking water sources in Imo State.

Sources of drinking water	Percentage of users
Tap water	5.1
Borehole	65.4
Rain water	15.4
River	5.4
Hand dug well	2.5
Spring water	2.3
Stream	2.3
Lake	1.7
Total	**100**

Source of data: Iwuala et al, 2020

Table 2: Rainfall Data for Imo State, 1999-2019 (Owerri Synoptic Station).

Year	Total RF	Mean RF	Min Mean Temperature	Max Mean Temperature
1999	2515.4	209.6	23.65	31.84
2000	2337.2	195	23.63	32.18
2001	2304.3	192	23.81	32.34
2002	2053.7	171	23.73	32.29
2003	2327.8	194	24.13	32.37
2004	1762.3	147	28.89	32.38
2005	2236.6	186.4	24.1	32.8
2006	3209.1	267	24.3	32.9
2007	2361.6	197	22.15	31.72
2008	2470.2	205.9	23.71	32.68
2009	2092.8	174.4	22.65	31.53
2010	2106	175.5	22.94	32. 13
2011	2812.3	234.4	22.27	31.76
2012	2030.4	169.2	22.18	31.54
2013	2445	203.7	22.25	31.19
2014	2014.4	167.8	22.52	31.66
2015	2247.2	187.3	22.37	31.92
2016	2163.9	180.3	22.97	32.61
2017	2128.8	177.4	23.16	32.0
2018	2007.6	167.3	20.91	31.27
2019	2895.6	241.3	21.47	32.14

Source of Data: NIMET, Nigeria

4.0 RESULTS AND DISCUSSION

Sources of water in Imo State

Borehole water (65.4 %), Rainwater (15.4 %), River water (5.4 %), Tap water (5.1 %), Dug-Well water (2.5 %), Springwater (2.3 %), and Streamwater (2.3%) were the most commonly available potable water sources in Imo State, according to Table 1. The findings are consistent with UNEP (1999), which stated that due to inter-annual variability in rainfall in Africa, many people are becoming reliant on groundwater. According to Okereke (2009), the high percentage of borehole water usage can be attributed to its relative potability, developmental consciousness, and the commitment of local, state, and federal governments in recent times, as well as some well-to-do individuals who sink boreholes for both private and commercial use.

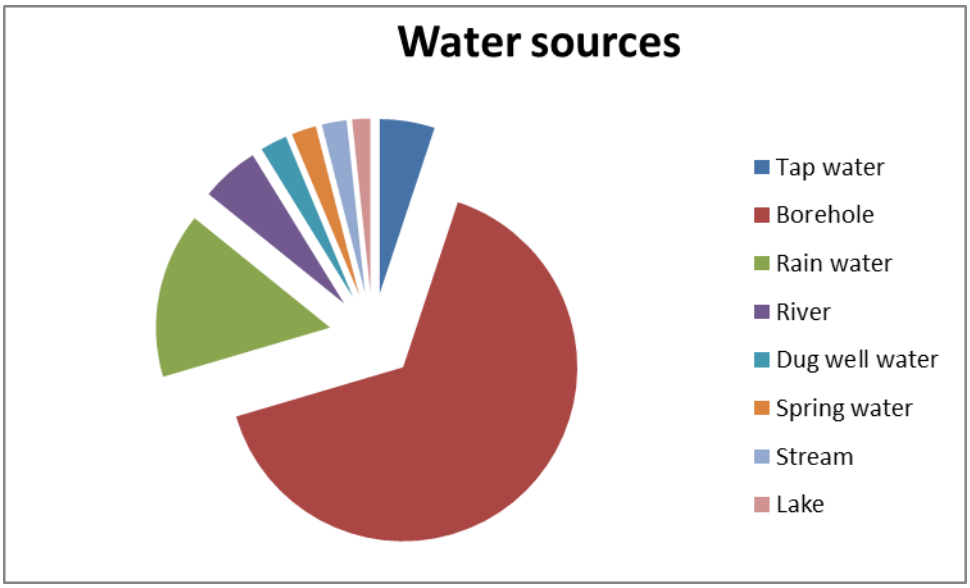

Figure 3: Chart of the sources of water in Imo State.

Variability in Rainfall

Changes in the climatic period (1999-2019) show changes in rainfall across the state since 1999. In 1999, the total annual rainfall across the state was approximately 2515.4mm. This figure fell to 2053.7mm in 2002 before rising slightly to 2327.8mm in 2003. The total rainfall amount over the state has increased in recent years, with 2019 receiving 2895.6mm. It is important to note, however, that these increases are associated with flooding in some areas. These changes in the spatial distribution of rainfall amount, as well as the resulting impacts on agriculture, water resources, and human settlements, among other things, are indicators of the state's vulnerability to climate change and the socioeconomic implications associated with

such changes (Olorunfemi, 2011).

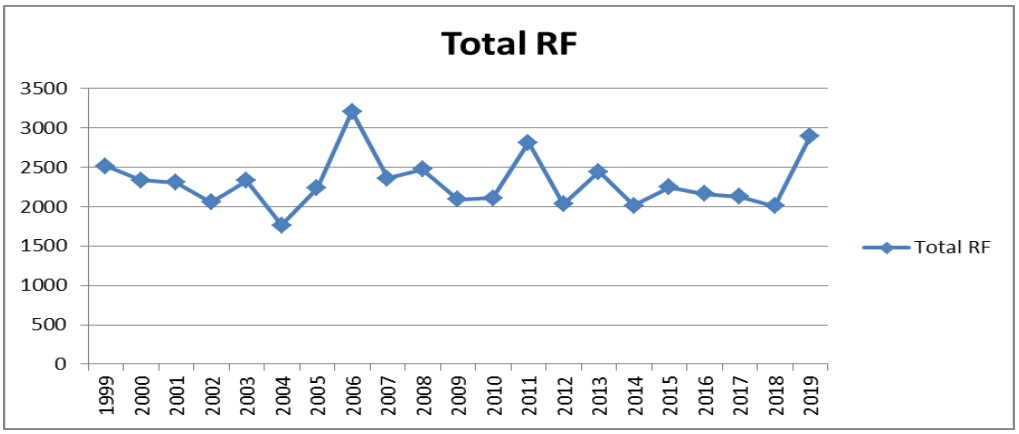

Figure 4: Graph of annual rainfall in Imo State (1999-2019).

Flooding

Humans have settled in floodplains to cultivate fertile soils, establish towns on flat ground, get easy and safe access to water, and utilize rivers for transportation (Pavel, 2003). Humans have become more vulnerable to flood danger in recent years as development into flood plains and a lack of flood response plans enhance the potential for devastation. Imo has been affected by flood disasters/events during the wet season due to a variety of non-climate-related or manmade reasons/factors (Olayemi, 2007). Duru (2014) reported that Imo has seen three flooding episodes in less than a decade, resulting in untold hardships and property loss.

Drought

Drought can be meteorological (low precipitation and low water levels in rivers, lakes, and groundwater), agricultural (low soil moisture), or environmental (a combination of the above) (Bates et al., 2008). Droughts affect human livelihoods in both direct and indirect ways (Pavel, 2003). Crop loss is a direct result, which might result in famine if alternate food sources are unavailable. Indirectly, water scarcity contributes to disease spread by depriving people of water for basic hygiene. Imo state has been fortunate to avoid severe droughts; however there have been reports of water shortages in several areas of the state.

Surface and Groundwater Systems

At the global scale, there is evidence of a broadly coherent pattern of change in annual runoff, with some regions, particularly those at high altitudes, experiencing an increase (Tao et al., 2003a, b; Hyvarinen, 2003; Walter et al., 2004), while others, for example, in parts of Africa, experience a decrease (Milly et al., 2005). While lake levels have increased in other regions

of the world (e.g., Mongolia and China) as a result of increasing snow and ice melt, lake levels have decreased in Africa as a result of the combined effects of drought, global warming, and human activity (Kevin, 2010).

For example, the open water surface of Oguta Lake in Imo State has decreased significantly, impairing economic activity and food security in the Basin. The Lake has shrunk as a result of both global and local factors. Climate change and substantially increased competition for the Lake's and adjacent land's resources have hastened the Lake's decline in recent years (Maher and Alex 2009). As a result of insufficient recharge, surface water depletion results in decreased groundwater quantity.

Water Quality

Changes in the timing of river flows and rising air temperatures can have a variety of effects on water quality and water consumption. Flood peaks, on the other hand, may result in increased erosion, turbidity, and concentrated pulses of pollutants. This will make it more difficult for water treatment plants to generate safe drinking water.

At the other end of the spectrum, declines in flow, warming, and eutrophication slow the propagation of floods and occasionally result in virtual standstill of water in some locations in Imo State. Floating weeds restrict fishing, navigation, irrigation scheme operation, and hydroelectric development. Additionally, they foster the growth of vectors of water-borne diseases such as malaria. Untreated wastewater discharged into rivers from urban areas and increased use of agricultural input both contribute dangerously to water quality degradation and the spread of waterborne illnesses.

The majority of climate change's effects on a nation's water resources result in secondary effects such as food scarcity, hunger, economic decline, and other social consequences such as conflict and migration. To avoid the chain of consequences outlined above, it is critical to address climate change's impact on water use, conservation, and management in a given region by adjusting water use, conservation, and management to climate change.

5.1 CONCLUSION

As climate change impact directly on water resources, it is important that adaptive strategies geared towards mitigating climate change impacts should be focused on efficient conservation and management of water resources in Imo State and any Nation. However, this

study concludes that, based on the findings, changes in rainfall patterns across Imo State over the study period suggested some evidence of climate change in the State's water sources, as issues of quality and quantity of water is directly caused by this change in climate.

5.2 RECOMMENDATION

In order to help people adapt to the effects of climate change on water supply, development organizations need to employ an integrated water resource management approach. By ensuring that water provision intervention takes into account the development, use, and protection of water resources as well as all sectors and institutions that affect and use them.

REFERENCES

1. Abou-Hadid A. F., R. Muogou, A. Mokssit and A. Iglesias Assessment of impacts, adaptation and vulnerability to climate change in Northern Africa: food production and water resources. AIACCAF90 Semi-Annual Progress Report, 2003; 37.
2. African Development Bank (AfDB) Poverty and climate change: Reducing the vulnerability of the poor through adaptation.
3. Aguila L., A. Araujo. and A. Quesadar-Aguilar *Gender and Climate Change*. World Conservation Union (IUCN), 2008.
4. Agwu J., and A. Okhimamhe, Gender and climate change in Nigeria. Available at: www.boeunigeria.org . Retrieved on 14/06/2011, 2009.
5. Alabi O. O., J. A. Ndastu, M. A. Ojo, S. Omodona and A.F Lawal. Food Crisis: The role of women farmers in sorghum production in Zaria Local Government Area, Kaduna State Nigeria. Proceedings of the 14th Annual Conference of Agricultural Extension Society of Nigeria (AESON), 2009; 21-24 April.
6. AquacultureAfrica Fisheries and aquaculture: Multiple risks from climate change. In: Okwu B. I. (ed). Promoting Fish farming and aquaculture for sustainable development. *AquacultureAfrica*, 2011; 2: 1-3.
7. Bates, B.C., Kundzewicz, Z.W., Wu, S., and Palutikof, J.P. (eds) Climate Change and Water.Technical Paper of the Intergovernmental Panel on Climate Change. IPCCSecretariat, Geneva, 2008; 210.
8. Bathge, S. Climate Change and Gender: Economic Empowerment of Women through Climate Change Mitigation and Adaptation. Available at www.gtz.de/gender.Retrieved on, 29/02/2012.

9. Building Nigeria‟s Response to Climate Change (BNRCC) *Gender and Climate Change Adaptation: Tool for Community-level Action in Nigeria.* Ibadan, Nigeria Environment Study/Action Team (NEST), 2011.
10. Burkett V., D.Wilcox , R. Stottlemeyer ,W. Barrow D. Fagre, J. Baron, J. Price, J. Nielsen, C. Allen, D. Peterson, G. Ruggerone, and T. Doyle Nonlinear dynamic in ecosystem responses to climate change: case studies and policy implications. *Ecological complexity*, 2005; 2: 357-394.
11. Chen Z., S. Grasby and K. Osadetz Relationship between climate variability and groundwater levels in the upper carbonate acquifer, Southern Manitoba, Canada *Journal of Hydrology*, 2004; 290(1-2): 43-62.
12. Cleaver K. M. and G. A. Shrieber Reversing the spiral: *The Population, agriculture and environment nexus in Sub-Saharan Africa*.IBRD, Washington D.C., 1994.
13. Christensen,J. H., B. Hewitson, A. Businoc and A.Chin Rgional Climate Projections. In: Solomon D. (ed.). *Climate Change 2007: The Physical Science Basis.* Contribution of working Group I of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, 2007; 847-8.
14. Ciasis P., M. Reichstein, N. Viovy, A. Granier, J. Ogee, V. Allar, M. Aubinet , and N. Buchmann Europe-wide reduction in primary productivity caused by the heat and drought in 2003. *Nature*, 2005; 437: 529-533.
15. Cury P. and L.Shannon Regime shifts in upwelling ecosystems: observed changes and possible mechanisms in the Northern and Southern Benguela, 2004.
16. Dai, A., P. J. K. E. Lamb, M.Trembert, P.Hulme, D. Jones and P. Xie The resent Sahel drought is real. *International Journal of Climatology*, 2004; 24: 1323-1331.
17. Dai A., K. Trenberth and T Qian. A global data set of palmer drought severity index for (1870-2002): Relationship with soil moisture and effects of surface warming. *Journal of Hydrometeorology*, 2004; 5: 1117-1130.
18. De Wit M. and J.Stankiewicz Changes in surface water supply across Africa with predicted climate change. In: Davis J. R. (Ed). *Managing Algal Blooms. Outcomes from CSIRO's multi-divisional blue-green algae program. CSIRO land and water,* Available at:Doi:10.1126/science.1119929. http://www.sciecneexprss.org . Retrieved on 5/3/2011, 2006.
19. De Wit, M. The perception of and adaptation to climate change in Africa. CEEPA Discussion Paper No.10. University of Pretoria, 2006.

20. Denton, F. Climate change vulnerability, impacts, and adaptation: Why does gender matter? *Gender & Development,* 2002; 10(2): 10-20.
21. Department for International Development (DFID) Addressing Water Crisis: Healthier and more Producrive Lives for Poor people. Available at: www.dfid.gov.uk. Retrieved on 16/09/10, 2001.
22. Development Partnership in Higher Education (DelPHI) A Framework for Agricultural Adaptation to Climate Change in Southern Nigeria. AResearch report of DelPHI Project, 2010; 326.
23. D ll, P. Impact of climate change and variability on irrigation requirements: a global perspective. *Climate change*, 2002; 54: 269-293.
24. Ekong *Introduction to Rural Sociology.* Uyo: Dove Educational Publishers, 2003.
25. Environmental Protection Agency (EPA), Greenhouse gas overview. Available at http://www.epa.gov/climate change/emission/index.htm#ggo. retrieved on 13/11/07, 2007.
26. Falconer I. R. Blue-green algae in lakes and rivers: their harmful effects on human health. *Australian Biologist,* 1997; 10(2): 107-110.
27. Fischer G., F.Tubiello, H.Van Velthuizen and D. Wiberg Climate change impacts on irrigation water requirements: global and regional effects of Mitigation, 1990-2080. A paper presented to the Technical Forecasting Society on 21st May, 2006.
28. Hyvarinen,V. Trend and characteristics of hydrological time series in Finland. Nordic Hydrol, 2003; 34: 71-91.
29. Iwuala, Chimezie & Amadi, Agwu & Udujih, Obinna & Udujih, Helen & Okereke, S. A Study on Sources, Availability and Accessibility of Potable Water in Imo State, Nigeria. World Journal of Social Science Research, 2020; 7: 1. 10.22158/wjssr.v7n1p1.
30. Milly, P.C.D., Dunne, K.A. and Vecchia, A.V. Global pattern of trends in stream flow and water availability in a changing climate. Nature, 2005; 438(7066): 347-350.
31. Maher S. and Alex B.M., Adaptive Water Management in the Lake Chad Basin. FAO WATER Seminar Proceedings; World Water Week, Stockholm, 2009; 16-22.
32. Pavel Kabat Climate changes the water rules: How water managers can cope with today's climate variability and tomorrow's climate change. Published in The Netherlands by the Dialogue on Water and Climate; Nature, 2003; 106.
33. United Nations Framework Convention on Climate Change, United Nations, 1992; 3.
34. Olayemi, A. B. Crisis of the commons: Global water challenges, The Eighty first Inaugural lecture, (University of Ilorin, Ilorin Nigeria,), 2007; 5-10.

35. Olorunfemi, F.B. Managing Flood Disasters Under a Changing Climate: Lessons from Nigeria and South Africa. Nigerian Institute of Social and Economic Research (NISER), Ibadan, Nigeria, 2011.
36. Mitchell, T. and Tanner, T. Adapting to Climate Change: Challenges and Opportunities for the Developing Community. A Publication of Tearfund, UK, 2006.
37. Tao, F., Yokozawa, M., Hayashi, Y. and Lin, E. Changes in agricultural water demands and soil moisture in China over the last half-century and their effects on agricultural production. Agri. Forest Meteorol, 2003; 118: 251-261.
38. Tao, F., Yokozawa, M., Hayashi Y. and Lin, E. Future climate change, the agricultural water cycle, and agricultural production in China. Agri. Eco. Environ, 2003b; 95: 203-215.