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RIVER BASINS DEVELOPMENT IN NIGERIA: A REVIEW

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Abstract: Basin water development is vital in development of basin water resources. It involves the management, utilization, and conservation of water resources within a particular geographical area called basin. The basin water development involves different approaches for efficient and effective management of water resources within the basin. These approaches include; Integrated water management, Sustainable Resource Use, Conflict Resolution, Ecosystem Preservation, Flood Control and Mitigation, Climate Change Adaptation, Economic Development, Improved Water Quality. If these are approaches are implemented or the basin is developed to suit these approaches, there will be adequate, efficient and effective utilization of water resources in the basin among different users.

Keywords*: Water resources, River basin, development, management, Nigeria, policies*

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INTRODUCTION

Basin water development refers to the management, utilization, and conservation of water resources within a specific river basin or watershed. It involves various strategies, policies, and projects aimed at ensuring sustainable access to water for various purposes like agriculture, industry, urban consumption, and environmental conservation within that particular geographical area.

A river basin is defined as a portion of land drained by a river and its tributaries. It encompasses the entire land surface dissected and drained by mainly streams and creeks that flow downhill into one another. In this paper, a river basin is used to mean the portion(s) of land drained by a river, streams and creeks. The river basin development for water resources involves a set of rules in the form of programmed that takes special account of a particular region called basin and itemizes aims and objectives of water development in the basin for improving the levels of living of the people in that area. [1] attempted to enumerate those aspects of river basin water development, which in view of a programme for national, economic and social development, strive at a close integration with the structures, features and variables of the development process in Nigeria. These include: the regional population in relation to the area of land available and land water relationship, the demographic in relation to water demand and job opportunities as well as the growth of productive enterprises now and in the future, the structure of government in relation to administrative and political process in the region. And in developing river basin for effective and efficient management of water resources has some basic approach such as; Integrated water management, Sustainable Resource Use, Conflict Resolution, Ecosystem Preservation, Flood Control and Mitigation, Climate Change Adaptation, Economic Development, Improved Water Quality [2]. This writeup aims at reviewing basin water development; its scope considers social, economic, and environmental aspects of basin water development to ensure equitable and sustainable water management for current and future generations.

History of river basins development in Nigeria

The evolution of river basin development in Nigeria dates to the colonial era. The idea of harnessing Nigeria's rivers and their basins for agro-allied uses is very in Nigeria is traced to the era of British colonial administration in Nigeria. The British colonial government as at the late 1940s took special interest in the utilization and development of the river basins especially in northern Nigeria [3]. This was because of the acute shortage of rainfall in the northern part of the country, which hampered farming activities. The colonial development welfare fund made special provisions for this. For instance, during the colonial epoch, irrigation schemes were carried out at Yau on the Yobe River, at Ebiji, east of Maiduguri, Warno in Sokoto, in Kano and Smaller ones around Jos [3].

Njoku clearly observes that the British colonial authorities in Nigeria were inspired by the Tennessee Valley Authority in the United States of America which had prior to 1947 helped to revolutionized agricultural production in the United States through the use of river basins.

As a result of this, in 1947, the northern Nigeria colonial administrators through Colonial Development Welfare Fund (CDWF) voted special fund for commerce preliminary investigation into how best to develop the Sokoto-Rima basin for overall agricultural, techno-industrial development.

The economic gluts and the effects of war on the British economy and finances of the colonial economies caused further delay in the development of river basins in Nigeria.

In 1963, the Lake Chad Basin Commission as established. Works started on the Lake Chad Basin and the Sokoto River Basin during 1973-1974. The oil boom, which enhanced the revenue base of Nigeria, helped the federal government to create both legislative and institutional framework upon which the activities of RBDAs in Nigeria will be coordinated and developed for national growth and development [4].

In this perspective, [3] therefore, argued that this further led to the promulgation of decree No 73 in 1973 which extended the RBD project nationwide thus, following promulgation of the decree; eleven (11) RBDAs were established. There was additional creation of the Sokoto Rima Basin authority which brings the total number of RBDAs to twelve (12). Each authority was placed in charge of a designated area, though the demarcation sometimes followed geo- political rather than logical geomorphic profile.

These river basins and their headquarters are listed below;

1. Anambra- Imo River Basin Development Authority- Owerri
2. Benin Owena River Basin Development Authority- Benin
3. Chad River Basin Development Authority – Maidugri
4. Cross River Basin Development Authority – Calabar
5. Hadeji-jama-are River Basin Development Authority – Kano
6. Lower Benue River Basin Development Authority-Makurdi
7. Lower Niger River Basin Development Authority– Ilorin
8. Niger delta River Basin Development Authority – Port Harcourt
9. Ogun-Osun River Basin Development Authority
10. Upper Benue River Basin Development Authority Yola
11. Upper Niger River Basin Development Authority –Abeokuta
12. Sokoto Rima River Basin Development Authority Sokoto

In order to facilitate rapid economic development of Nigeria through an integrated planning and management of Nigerian river basins, the authorities had the following mandate in their various operational areas;

1. Construction of dams and boreholes for irrigation and rural water supply
2. Large-scale mechanized clearing and cultivation of various land forms
3. Rural electrification and construction of feeder roads
4. Establishment of agro-service centres, with tractor hires services
5. Large scale multiplication of improved seeds for distribution to farmers
6. Large scale rearing of improved livestock and poultry for distribution to farmers
7. Establishment of grazing reserves for nomadic cattle breeders;
8. Establishment of large scale a forestation scheme and
9. Training of junior staff for oral development projects
10. Contribute to overall national security through food production and distribution governs for enhancing natural food self-sufficiency.

Nigeria is endowed with enormous water resource as is evident in the volume of rainfall, surface and underground water deposits [5.6] and yet, the gap between water needs and water supply appear to be widening [7].

Water resources development in Nigeria is threatened by both natural factors such as outcomes of climate change and hydrological extremes, and anthropogenic factors such as pollution of water bodies with industrial wastes, oil spillages, and salinization of surface and ground waters through irrigation and fertilizers [6].These natural and anthropogenic threats to water sources trigger variations in the physiochemical and biological characteristic of the water, ultimately impairing the quality of the water [7]. The dearth in the water management and supply system in Nigeria has led to many citizens resorting to self-help and exploiting the underground water resources in an unstructured and uncoordinated, and unsustainable manner [8]. As noted by [9], over 60% of Nigerians with access to drinking water now get it from underground sources.
He also noted that sustainable groundwater use in Nigeria is challenged by funding, weak institutions, poor data management system, poor implementation of groundwater exploitation regulation, in addition to hydrological factors. Many private business ventures have emerged from the decadence of water management and supply Nigeria.

For most poor and rural dwelling citizens, access to clean water supply has continued to be a challenge. As contended by [10], the dependence on private for-profit water ventures to meet the water needs of the population is unsustainable.

This further indicates the failure of policy. The uncoordinated exploitation of ground water may have other consequences, considering that geological and other anthropogenic conditions may affect the quality of the water. Some of the private individuals and business concern usually don't have the capacity to treat the water before making it available for human consumption. This is the case in most urban areas in Nigeria, where groundwater quality is affected by the geochemistry of the environment, rate of urbanization, industrialization, landfill and dumpsite leachates, and heavy metals [11,12]. Other fundamental challenges to water resources in Nigeria include wetland
degradation [13], climate change [14], scarcity, conflicting demands among others.

Frameworks and Approaches to Basin Water Development

In recent years, there have been substantial changes in water management approaches as a result of the emergence of new paradigms. Traditional approaches were essentially hydro-centric or single-sector (water) oriented. Consequently, the river basin or groundwater province was viewed as a complex physical system based on complex interrelationships between the hydrological and geomorphologic characteristics of the basin and its rivers and streams. Common in the 1930s to 1960s and favored by water engineers and water economists, this approach viewed the basin as a resource system whose waters were to be exploited for economic development. This approach emphasized the determination of maximum possible yield and the development of mechanisms for the most effective water allocation between users. It also served as the impetus for significant water resources development projects, such as the Hoover Dam—an icon of an era dedicated to dam building and irrigation expansion. Highly scientific methods and technological innovation were the driving forces behind this single-sector approach, which sought to maximize available yield from river basins and watersheds.

As evidenced in the work of the Tennessee Valley Authority and the U.S. Army Corps of Engineers in the US, the Nagarjuna Sagar Dam project in India, and the Snowy Mountains Scheme in Australia, more complex approaches promoted multi-objective development of water resources systems, including recreation, hydropower, navigation, and irrigation development.

The ecological and ecosystems approaches to water resources management, which were a product of the environmental movement of the 1970s, questioned the single (and multi-) objective approach and its strong development emphasis. The reality was that the traditional paradigm ignored the more diverse range of resource use features of river basins that interact to create the so-called "wicked" problems of environmental management and sustainable water resources management. The new paradigm recognized river basins as large, complex, integrated ecological systems.

The term "ecosystem approach" served as a corollary for the integrated approach. Using this critical lens, the watershed was seen as an integrated ecological system in which human impacts were but one component of the functioning of ecosystems.

[15] recognized that the challenge of this integrated approach was its interpretation. He maintained that its advocates had for too long interpreted the ecosystem approach as synonymous with a comprehensive approach, in which attention is given to all components and linkages in a system. When a comprehensive approach is taken, there is a high probability that the period of time required to complete an analysis will be very long, thus resulting in a final plan that is no more than an obsolete historical document. Mitchell's interpretation of an integrated approach involves a more selective or focused perspective. Rather than focusing on all the components and connections in a system, it considers only those components that—on the basis of knowledge from all stakeholders (acquired through focus groups or other forums involving people, ranging from technical analysts to long-term residents)—are judged to be the key drivers of variability in the system [16]. Both a comprehensive and an integrated interpretation are consistent with an ecosystem approach, but the latter is more likely to produce a practical output.

Integrated Water Management

Basin water development focuses on an integrated approach to managing water resources within a particular geographic area. It considers the interconnectedness of surface water, groundwater, and their interactions within the basin. Integrated water resources management (IWRM) has been proposed and is now practiced as the new method of water management. It is an approach to land and water resources planning and management that encourages participants to consider a wide array of social and environmental interconnections. It extends beyond traditional, multi- purpose natural resources management to address societal goals and ecosystem functioning. The term IWRM implies the inclusion of a full array of physical, biological, and socioeconomic variables involved in managing a region for environmental values and human use. Many agency natural resource managers and academics have supported planning and managing water and related land resources on a watershed (catchment, river basin) basis and the approach is now being widely adopted [16-23].

IWRM extols the use of integrated, cross-sectoral, and coordinated approaches to water resources management across time and space as well as the river basin scale.

IWRM uses co-management but is fraught with the classic problems of commonly managed resources:
differing interpretations of property rights, conflicts over use, spatial and temporal variations in access to water, susceptibility to hazards of water surpluses or deficits, lack of ongoing financing when other spending (military, health, education) consumes public service delivery budgets, and others.

Despite these problems, IWRM provides mechanisms for meeting top-down with bottom-up management. In any geographical setting, "entry points" for success in IWRM need to be crafted, primarily through either improved human and organizational capacity; dedicated and sustained funding that employs cost-sharing; water visioning, not just ownership of the "commons" problem but also covenants of mutual responsibility and self-responsibility; or building leadership skills.

What works in one location may not work elsewhere. In practice, IWRM must bring together a diverse array of people who have a "stake" in a system if it is to collaboratively manage the activities and impacts. These stakeholders include government entities, community groups, business and industry organizations, and others with a particular concern or interest in water resources management. IWRM must also involve "the public" who also have an interest, albeit less well defined. This participatory approach produces strategies that are more coordinated, more cognizant of interconnections, and more inclusive of the diversity of goals. Furthermore, it increases support and commitment as well as the likelihood of implementation. The conceptual development of IWRM was extended recently by the Global Water Partnership [24]. Moreover, international endorsement of the concept has now been seen at the highest levels, including the 2003 Summit on Sustainable Development in Johannesburg, South Africa as well as the Second (2000) and Third (2003) World Water Forums in Kyoto, Japan. At the latter, "IWRM and the Basin Management Theme" was issued [25].

IWRM and River Basin Management

The nature of hydrological linkages suggests that a river basin forms a natural unit of management for river conservation or other purposes, especially in sub-humid, temperate, tropical, and equatorial hydrological regimes. Rivers are significant areas within watersheds. They are intimately linked to the land systems that surround them. They act as hydrological conduits, receiving excess water from precipitation, infiltration, and groundwater movement and transferring water across the landscape to watershed outlets, such as rivers, lakes, estuaries, and oceans. Thus, the ecological health of a river system reflects the ecological health of the land systems in the river basin and indicates the impact of upstream land management practices on ecological processes.

A recent statement on river basin governance captures the importance of rivers and river basin management. The expert group statement on Integrated River Basin Management for the Second World Water Forum and Ministerial Conference in the Hague, 2000, maintained that sustainable river basin management required proper study, understanding, and effective management within the context of social, economic and environmental resources. This study should recognize that water management at the basin scale must be understood systemically—recognizing conjunctive uses, aquatic ecosystem needs and upstream-downstream relationships.

In view of regional differences, a blueprint for river basin management was not given in this report, but they provided recommendations and guidelines for sustainable river basin management, focusing on:

1. Basin-wide planning: Basin-wide planning should balance all user needs for water resources, in the present and the long-term, and it should incorporate spatial developments. Vital human and ecosystem needs have to be given special attention.
2. Participation in decision-making: Local empowerment as well as public and stakeholder participation in decision-making will strengthen river basin management.
3. Demand management: Demand management has to be part of sustainable water management. Managing the demand for water is more likely to achieve sustainable use than is continual expansion of water supplies.
4. Compliance: Compliance monitoring and assessment of commitments under river basin

Sustainable Resource Use and Sustainable Development:

Sustainable Resource Use emphasizes sustainable utilization of water, ensuring that current needs are met without compromising the ability of future generations to meet their own needs. This involves balancing water extraction for various purposes while maintaining ecological balance and minimizing environmental impacts.

Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [26]. As the world continues to explore economic prosperity, sustainable development goals seek to mainstream the environmental interest of future generations in the economic activities of the present generation. Sustainable development debates have largely centered around the effect of economic activities and industrialization on the environment [27-28]. The goal six of United Nations 2030 agenda for sustainable development, aims at ensuring availability and sustainability of water and sanitation for all.

Scholars like [29-30], have variously explored issues of water management and security for sustainable development. The significance of water resources in developing countries, more so in sub-Sahara Africa cannot be overstated. The depletion of water bases like rivers and lakes calls for an efficient management and exploitation of the resource. Thus [29], held that sustainable development requires integrated multi-sector approach which should incorporate hydrological and non-hydrological components such as the environment, base of the economy, character of socio-cultural and institutional subsystems. [30] noted that transboundary nature of water basins, variability of climate and rainfall, water scarcity, water pollution, environmental degradation and increasing demand are some of the features necessitating efficient water resources management in Africa. The role of water in sustainable development policies is fundamental. Thus, water security issue is a global one that affects all, requiring an interconnected response framework that should be global in design, embodying within it, a variety of national and regional responses [31].

Climate Change Adaptations

The effects of climate change and variability such as rising temperature and changes in rainfall are undeniably clear, with impacts already affecting ecosystems, biodiversity,

and people [32]. Africa is among the most vulnerable regions in terms of the impacts of climate variability and change (Intergovernmental Panel on Climate Change [33-34]. The high vulnerability of Africa to the impacts of climate variability and change is also attributed to its low adaptive capacity [36].
The projected climate change will have far-reaching, negative impacts on the availability of water resources, food and agricultural security, human health, tourism, coastal development, and biodiversity [37].

Stakeholders and Governance

Effective water management and governance within a basin require collaboration, coordination, and mutual understanding among these diverse stakeholders to address challenges like water scarcity, pollution, equitable access, and climate change impacts. These stakeholders include the following;

1. Governments: They play a crucial role in water management through policy creation, regulation, and enforcement. National and local governments develop water laws, allocate water rights, and establish frameworks for water resource management. They often provide funding for infrastructure projects such as dams, irrigation systems, and water treatment facilities. Government agencies also monitor water quality, set standards, and address issues related to water scarcity, pollution, and equitable distribution. Poor governance exacerbates water stress and amplifies the negative impacts of extreme events like flooding and drought. Lack of investment in water allocation and infrastructure, insufficient institutional and human capacity, or lack of political will to satisfy the range of demands for available water, can lead to economic water scarcity, where there are an inefficient and inequitable distribution of water resources, even if there is physical abundance of water. If mounting physical and governance-related pressures on freshwater resources are not addressed, some regions across the world could see their economic growth rates decline by around six percent of their gross domestic product by 2050 [37]. With implications for national and regional security. Improving water resource governance through WRM is therefore critical for building the resilience of systems and people reliant on water supplies who will see dramatic climate-related shifts over the next few decades.
2. Communities: Local communities are directly impacted by water management decisions. They use water for various purposes like agriculture, drinking, sanitation, and industry. Involving communities in decision-making processes ensures that their needs and concerns are considered. Community participation often occurs through public consultations, community-based initiatives for water conservation, and education programs to promote responsible water usage.
3. Non-Governmental Organizations (NGOs): NGOs play a vital role in water management by supplementing government efforts. They often work on the ground, implementing projects related to water conservation, education, and advocacy. NGOs collaborate with communities, governments, and other stakeholders to address specific water-related issues such as access to clean water, sanitation, watershed management, and climate change adaptation.

They also raise awareness, conduct research, and provide technical expertise to support sustainable water management practices.

4. Private Sector: Businesses and industries are significant water users. They have a role in sustainable water management by adopting efficient water use practices, investing in technologies for water conservation, and adhering to regulations on water pollution. Some private entities also engage in partnerships with governments and NGOs for community-based projects that aim to improve water access and quality.
5. Academic and Research Institutions: These entities contribute to water management through research, innovation, and knowledge dissemination. They conduct studies on water-related issues, develop technologies for water treatment and conservation, and train professionals in the field of water resource management.
6. International Organizations: Bodies like the United Nations, World Bank, and regional organizations often facilitate cooperation among countries that share transboundary water resources. They provide technical assistance, facilitate negotiations, and support the development of agreements and treaties for equitable and sustainable water use among different nations within a basin.

Conflict Resolution

As water resources are shared among various stakeholders including communities, industries, and agriculture, conflicts over water allocation and usage can arise. Basin water development provides a framework for equitable distribution and effective conflict resolution mechanisms among these stakeholders. The continued water insecurity has been generally attributed to water governance crises partly manifested in the form of increased water-related conflicts; failure to incorporate peacebuilding into the development and implementation of water projects; lack of conflict resolution mechanisms especially at a local level; and poor operation and maintenance of the water infrastructure [38-40]. Cognizant of the widely documented vicious circle of water governance challenges, local water conflicts and lack of conflict resolution mechanisms have in recent years been highlighted as key governance aspects, challenging efforts to achieve water users' cooperation towards sustainable water security by most governments in developing countries [41-43].

More still, there is fear that increased competition will escalate water-related conflicts among users and actors within as well as among different sectors. Hence, greater efforts are needed to promote water-related conflict transformation and peace building in water development endeavors as a means of preventing and mitigating conflicts at all levels of governance. As a result, tensions may subside, and a renewed sense of communal dignity and cooperation may reign [45].

The term "water-related conflicts" as used in this article, refers to conflicts arising between two or more parties holding competing claims over water resources allocation or their use [46]. I use the term conflict to include a range of patterns of interaction among stakeholder groups at different levels of water governance such as national, district, community, and village levels.

This extends from short-term confrontations among competing resource users where violence is implicit, to sustained and explicit violent clashes involving diverse actors in the water sector such as local end users; private, civil society, donors, and state actors. Therefore, in the context of this article, a water event is considered conflictual if one or more parties are discontented with service provision including water quality, quantity, management, location, and distance to the water source or if one's access rights are challenged, for example, denied water or non-existence or non- functionality of the water infrastructure [47-48].

Ecosystem Preservation

Healthy river basins are crucial for supporting diverse ecosystems. Effective basin water development aims to protect and restore natural habitats, preserving biodiversity and ensuring the sustainability of ecosystems that rely on these water sources. Ecosystem services play a crucial role in the management of river basins, which are vital for sustainable development. Such roles are, Water Provision, Water Purification, Flood Regulation, and Bio-diversity Conservation.

Flood Control and Mitigation

Proper management of water resources in a basin includes measures to control and mitigate the impacts of floods. This might involve constructing dams, reservoirs, and implementing land-use planning strategies to reduce the vulnerability of communities to flooding.

Economic Development

Sustainable water management is essential for economic development. It supports agriculture, industry, and urban growth by ensuring reliable water supply for various purposes. Additionally, it can promote eco-tourism and recreational activities associated with well-maintained water bodies.

Improved Water Quality

Managing water resources at a basin level involves monitoring and improving water quality. Controlling pollution sources, implementing wastewater treatment, and maintaining healthy aquatic ecosystems contribute to better water quality for consumption and ecosystem health.

SOLUTIONS AND RECOMMENDATIONS

Some policy interventions and changes that could help improve basin water management in Nigeria include:

1. **Integrated Water Resource Management (IWRM):** there should be Implementation of policies that adopt an integrated approach to managing water resources.

This involves considering the various uses of water (agriculture, industry, domestic), environmental conservation, and the needs of different stakeholders within the basin.

2. **Water Conservation Initiatives:** there is need to encourage and incentivize water conservation practices among industries, agriculture, and households. This might involve promoting efficient irrigation techniques, fixing leaks in water supply systems, and implementing water-saving technologies.
3. **Stakeholder Engagement and Participation:** there is need to ensure the active involvement of all stakeholders—local communities, industries, agricultural sectors, and government bodies—in decision-making processes regarding water management. This could be done through public consultations, community meetings, and participatory forums.
4. **Ecosystem Protection and Restoration:** the development and enforcement of policies aimed at protecting and restoring ecosystems within the basin is very essential. Healthy ecosystems contribute to water quality and quantity, and measures such as afforestation, wetland restoration, and erosion control can significantly impact water resources positively.
5. **Water Pricing and Economic Instruments:** Policies that reflect the true value of water should be implemented. This could involve setting up pricing structures that encourage responsible water use, especially in sectors that are heavy water consumers, while ensuring access to water for basic needs.
6. **Climate Change Adaptation Strategies:** Developing strategies to address the impacts of climate change on water resources within the basin needs not be overemphasized. This might involve investing in resilient infrastructure, water storage solutions, and drought/flood management plans.
7. **Transboundary Cooperation:** If the basin spans across multiple regions or countries, there is need to foster cooperation and agreements among these entities to manage water resources sustainably. This could involve treaties, joint management plans, and shared data for better decision-making.
8. **Technology and Innovation:** The adoption of innovative technologies for water purification, desalination, wastewater treatment and reused, green infrastructure, blockchain technology and efficient water use is very essential. This might involve providing incentives for research and development in water-saving technologies.
9. **Education and Awareness Programs:** there should be Implementation of educational programs to raise awareness about the importance of water conservation and sustainable management practices among the population. This could be done through schools, media campaigns, and community outreach programs.
10. **Monitoring and Regulation:** there is need to strengthen monitoring mechanisms to track water usage, quality, and environmental impacts as well as develop and enforce regulations that ensure compliance with water management policies, including penalties for non-compliance.

CONCLUSION

This paper assessed water basin development and management in Nigeria. It relates overall challenges of basin water resources development globally. Framework and approaches related to water basin development, where the traditional approach was essentially hydro-centric or single-sector (water) oriented. This approach emphasized the determination of maximum possible yield and the development of mechanisms for the most effective water allocation between users. The ecological and ecosystems approaches to water resources management, which were a product of the environmental movement. "Ecosystem approach" served as a corollary for the integrated approach, the watershed was seen as an integrated ecological system in which human impacts were but one component of the functioning of ecosystems. Basin water development has significance in managing water resources, and is been discuss using various approach such as integrated water management, Sustainable Resource Use, climate change adaptation, Stakeholders and Governance, Conflict Resolution, Ecosystem Preservation, Flood Control and Mitigation, Economic Development, and Improved Water Quality.

It also offers policy interventions and changes that could help improve basin water development and management.

REFERENCES

[1] Olayide, S.O.1980. Perspective in Bennin-Owenna River Basin Development. Ibadan: Ibadan university press.

[2] Onuh, P. A & Bassey, U. I. 2021. Water Resource Management and Sustainable Development in Nigeria: Lessons from Israel. University of Nigeria J. of Political Economy: Vol. 11, pp.48-68.

[3] Onwuka N. Njok, 2001. Economic History of Nigeria, 19th & 20th Centuries, Magnet Business Enterprises in English, pp.1-271.

[4] Adeoti, O. 2010. The Development of River Basin Organizations in Nigeria, Research Journal of Social and Water Management 1 (3-4). pp. 91-100.

[5] Ezeabasili, A.C.C., Okoro B. U., Ezeabasili, A.I. 2014. Water resources: management and strategies in Nigeria. An International Journal of Science and Technology, 3(1), pp.35-54.

[6] Idu, A.J. 2015. Threats to water resources development in Nigeria. Journal of Geology and Geophysics, 4(3), pp.1-10. doi:10.4172/2329-6755.1000205.

[7] Chukwu, K.E. 2017. Pollution of surface water resources in Nigeria. International Journal of Academic Research in Environment and Geography, 4(1), 77–92.

[8] Akpor, O.B., Muchie, M. 2011. Challenges in meeting the MDGs: The Nigerian drinking water supply and distribution sector. Journal of Env. Science and Technology, 4 (5). pp.480-489.

[9] Omole,D. O. 2013) Sustainable groundwater exploitation in Nigeria. Journal of Water, 43(1): pp.5-21.

[10] Obeta, M. C. 2019. Private for-profit rural water supply in Nigeria: policy constraints and options for improved performance, Journal of Water and Land development. No41, pp.101-110.

[11] Ocheri, M. I, Odoma L.A., Umar, N.D. 2014. Groundwater quality in Nigerian urban areas: A Review. Global Journal of Science Frontier Research: h. Environment & Earth Science, Vol.14, Issue 3. pp.34-45.

[12] Olorunfemi, D., Efechuku, U., Esuana, J. 2015. Toxicological Evaluation of Drinking Water Sources in Some Rural Communities in Southern Nigeria after Mycofiltration Treatment. Polish Journal of Environment Studies, Vol. 24(3): pp.1205-1212.

[13] Uluocha, N.O., Okeke, I.C. 2004. Implications of wetlands degradation for water resources management: Lessons from Nigeria. GeoJournal Vol.61, pp.151-154.
[14] Coulibaly N., Coulibaly, T.J.H., Mpakama, Z., Savané, I. 2018. The impact of climate change on water resource availability in a trans-boundary basin in West Africa: The Case of Sassandra. Journal of Hydrology. Vol.5., Issue 1, pp.1-13.
[15] Mitchell, B. 1991. "BEATting" Conflict and Uncertainty in Resource Management and Development. In Mitchell, B. (ed.) Resource Management and Development. Oxford University Press, Toronto.
[16] Hooper, B.P., G. McDonald and B. Mitchell. 1999. Facilitating Integrated Resource and Environ. Management. Journal of Environmental Management and Planning 42 (5), pp.747-766.
[17] Batchelor, C. 1999. Improving water use efficiency as part of integrated catchment management. Agricultural Water Management 40: pp.249-263.
[18] Bellamy, J. A., McDonald, G. T., Syme, G. J. and Butterworth, J. E. 1999. Evaluating Integrated Resource Management. Society and Natural Resources 12: pp.337-353.
[19] Born, S. M. and Sonzogni, W.C. 1995. Integrated environmental management: strengthening the conceptualization. Environmental Management 19: pp. 167-181.
[20] Environmental Protection Agency. 1993. Watershed Protection: Catalog of Federal Programs. EPA, Washington, DC. pp.1-120.
[21] Gonzalez, A. C., Arias, C. 2001. The incorporation of integrated management in European water policy. IAHS Publication. pp. 69-74.
[22] Jonch-Clausen, T. and Fugl, J. 2001. Firming up the Conceptual Basis of Integrated Water Resources Management. 2001. International Journal of Water Resources Development. Vol.17. Issue 4., pp.501-510
[23] Margerum, R., Born, S.M. 2000. A Co-ordination Diagnostic for improving Integrated Environmental Management. Journal of Env. Planning and Management. Vol.43(1). pp.5-21.
[24] Food and Agricultural Organization FAO. 2008. Nigeria. Retrieved from: http://www.fao.org/nr/water/aquastat/countries_regions/nga/printfra1.st
[25] World Water Council, 2003. Integrated Water Resources Management and the Basin Management Theme. Final Statement. Report of the Session: IWRM and River Basin Governance.
[26] United Nations General Assembly. 1987. Report of the world commission on environment and development: Our common future. Oslo, Norway: United Nations General Assembly, Development and International Co-operation: Environment.
[27] Polasky, S., Kling, C. L., Levin, S. A., Carpenter, S. R., Daily, G. C., Ehrlich, P. R., Heal, G. M., Lubchenco, J. 2019. Role of economics in analyzing the environment and sustainable development. PNAS, Vol. 116 (12). pp. 5233-5238. https://doi.org/10.1073/pnas.1901616116.
[28] Bartniczak, B., Raszkowski, A. 2018. Sustainable Development in African Countries: An Indicator-Based Approach and Recommendations for the Future. Sustainability, 11(22), pp.1-23
[29] Kundzewicz, Z.W. 1997. Water resources for sustainable development. Hydrological Sciences Journal, 42(4), pp.467–480. doi:10.1080/02626669709492047.
[30] Mwanza, D.D. 200). Water for sustainable development in Africa. Environment, Development and Sustainability, 5(1/2), pp.95–115.doi:10.1023/a:1025380217316
[31] Biswas, A. K. (1991). Water for sustainable development in the 21st century. International Journal of Water Resources doi:10.1080/07900629108722516 Development, 7(4), pp.219–224.
[32] Vera, C., Barange, M., Dube, O. P, Goddard, L., Griggs, D., Kobysheva, N., Odada, E., Parey, S., Polovina, J., Poveda, G., Seguin, B. and Trenberth, K. 2010. Needs Assessment for Climate Information on Decadal Timescales and Longer. Procedia Environmental Sciences 1: pp.275 - 286.
[33] IPCC (2007). Climate change 2007: the scientific basis. The Fourth Assessment Report of the Intergovernmental Panel of Climate Change. Cambridge University Press, New York. p. 940.
[34] Fischer, G., Shah, M., Tubiello, F.N. and van Velhuizen, H. 2005. Socio-economic and climate change impacts on agriculture: an integrated assessment 1990 – 2080. Philosophical Transactions of the Royal Society 360. Issue 1463. https://doi.org/10.1098/rstb.2005.1744.

[35] Global Water Partnership, 2000. Integrated Water Resources Management. Technical Advisory Committee Background Paper No.4. pp.1-68. Global Water Partnership: Stockholm
[36] United Republic of Tanzania (URT). 2003. Initial Communication under the United Nations Framework Convention on Climate Change (UNFCCC). Vice President's Office, Dar es Salaam, Tanzania, [ttp:// unfccc.int/resource/docs/natc/tannc1.pdf].
[37] Mugabe, F. T., Chitata, T., Kashaigili, J., Chagonda, I., and Nyagumbo, I. 2010. Modelling the effect of rainfall variability, land use change and increased reservoir abstraction on surface water resources in semi-arid southern Zimbabwe. In: Proceeding of 11th WaterNet WARFSA GWP - SA symposium. (Edited by WARFSA), 27 – 29 October 2010, Victoria Falls, Zimbabwe. pp. 313 - 334.
[38] World Bank Group. 2016. High and Dry: Climate Change, Water and the Economy. Book Water Global Practice. pp.1-55.
[39] Naiga, R. 2020a. Determinants of user satisfaction and the implications on collective-action indemand-driven water governance in rural Uganda. International Journal of Rural Management, pp.1-27. https://doi.org/10.1177/0973005220968957.
[40] Eberhard, R. R., Margerum, K., Vella, S., Mayere, S., B. Taylor, B. 2017. The practice of water policy governance networks: An International comparative case study analysis. Society and Natural Resources, 30(4), pp.453–470.
[41] Global Water Partnership. 2002. Dialogue on Effective water Governance. Global Water Partnership. pp.1-23.
[42] Naiga, R. 2018. Conditions for successful community-based water management: Perspectives from rural Uganda. International Journal of Rural Management, 14(2), pp.1-26.
[43] Taylor, P.L., Sonnenfeld, D.A. 2017. Water crises and institutions: Inventing and reinventing governance in an era of uncertainty. Society and Natural Resources, 30(4), pp. 395–403.
[44] Naiga, R., Penker, M. Hogl, K. 2015. Challenging Pathways to Safe Water Access in Rural Uganda: From Supply to Demand-Driven Water Governance. International Journal of the Commons, 9. pp.237-260. https://doi.org/10.18352/ijc.480.
[45] Gehrig, J., Rogers, M.M. 2009. Water and conflict: Incorporating peace building into water
[46] Organization for Economic Co-operation and Development/Development Assistance Committee (OECD/DAC). 2005. Main streaming conflict prevention: Water and violent conflicts.
[47] Swain, A. 2016. Water and post-conflict peacebuilding, Hydrological Sciences Journal, 61(7), pp.1313-1322
[48] Van Laerhoven, F., Andersson, K.P. 2013. The virtue of conflict: An institutional approach to the study of conflict in community forest governance. International Forestry Review, 15(1), pp.122–135. https://doi.org/10.1505/146554813805927219

FORMIRANJE REČNIH SLIVOVA U NIGERIJI: PREGLED

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Apstrakt: Razvoj i formiranje voda u basenu je od vitalnog značaja za stanje vodnih resursa sliva reka. To uključuje upravljanje, korišćenje i očuvanje vodnih resursa unutar određene geografske oblasti koja se naziva sliv reke.
Razvoj slivnih voda uključuje različite pristupe za efikasno i efektivno upravljanje vodnim resursima unutar sliva. Ovi pristupi uključuju: Integrisano upravljanje vodama, održivo korišćenje resursa, rešavanje konflikata kod upotreb, očuvanje ekosistema, kontrola i ublažavanje poplava, prilagođavanje klimatskim promenama, ekonomski razvoj, poboljšanje kvaliteta vode.
Ako se ovi pristupi implementiraju ili se sliv razvije tako da odgovara ovim pristupima, postojaće adekvatno, efikasno i efektivno korišćenje vodnih resursa u slivu između različitih korisnika reke.

Ključne reči: *vodni resursi, rečni sliv, razvoj, upravljanje, Nigerija, politike*

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