Adaptation to Water Stress and Climate Change in Nigeria: The Indigenous Knowledge and Socio-Cultural Nexus of Humanitarian Services and Crisis Management

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Abstract
Water stresses from climate change include but not limited to droughts, water shortage and quality degradation. The paper examines the influence of demeaning socio-cultural and tradition nexus on adaptation and responses in Nigeria. It underscores climate change and water stress management and humanitarian operations in the country.

Keywords: Climate change, water stress, adaptation mechanisms

Introduction
The demand for water is much greater than the available supply in many parts of the world. This is also affecting the developed world, where burgeoning demand simply cannot continue to be met and not only developing countries, where water infrastructure is poor and where many people do not have access to safe drinking water (The Royal Academy of Engineering 2010). The degree of vulnerability among different communities and households within the same country varies significantly from one to another. This should be seen from the viewpoint that vulnerability is closely linked with social characteristics such as ethnicity, religion, culture and norms amongst others (Pelser 2001). For example, in rural areas of Natal Midlands, the Venda region and the Eastern Cape, traditionally, common people are forbidden to go near sacred water sources, and only traditional healers associated with the water are allowed to approach such areas (Bernard 2000). Also, many communities restrict the distance to which cultivation can take place and where buildings can be erected near their surface water sources (Ayeni 2012). This is to honour the gods of their forefather through the spirit of the water in question. Nonetheless, the growing impacts of modernization and population pressure in many places are now reducing these traditional fears and restraints (Bernard 2000). To

many traditionalists, this has been the causes of environmental change and continually increases in wide anticipated water stress in most rural areas. For instance, most rural communities in Southwestern Nigeria have been experiencing climatic uncertainties and changes in responses to water stress and scarcity in the last three decades. These can be seen in their short-term responses to water-climate risks and changes, in some cases, leading to mal-adaptation or the adoption of measures that result to and/or create further health risk from hazard (Barnett and O'Neill 2010; Fazey et al. 2011).

Moreover, due to influence of cultural and traditional belief, adaptation in rural area has been oriented more towards short-term responses (rationing of surface water during the dry season) and less towards long-term planning (involving local stakeholder participation and high level community water management). Religious and traditional beliefs among rural communities play diverse roles and are important in water management and defining adaptation strategies. There are different societal roles and capacities to adapt to the impacts of climate change and climate change-induced water stress implications that are bound to have varying and significant effects on the livelihoods of rural communities. Adaptation is the means of reducing vulnerability to climate-induced changes and could occur either proactively via anticipated concrete planned activities of projected needs and changes, or reactively, using available resources in coping with the change (Hisali et al. 2011). It could as well occur on both individual and community levels (Jaglin 2002). Understanding these diverse societal cultures and beliefs as well as religious influence is essential for developing effective and proactive adaptation mechanisms.

There have been several studies/researches at both global and regional scales on how governments, societies as well as individuals will practically adapt to climate change. These include the works of Burton (1996); Smit and Pilifosova (2001); Adger et al. (2005); Schipper and Burton (2009). Adger et al. (2003) examines climate change adaptation in developing world. Ayeni et al. (2011) evaluates the basin optimization as effective adaptation strategy. The works of Barnett and O'Neill (2010); Fazey et al. (2011) assess the various climate change mal-adaptation while assessment of the effectiveness actions for ranking and developing normative criteria for successive adaption was the focus of Adger et al. (2005). Agrawala and Fankhauusal (2008) explored the adaptation scope and actions in various developed countries, Agrawal and Perrin, (2009) generate inventories of best practice and action in a change scenario. Their works were clearly silent on the influence of cultural and traditional belief on poor adaptation to climate change as well as water stress adaptation mechanism. This creates the lacuna that the study intends to fill.

As climate change progresses it is likely to have dramatic effects on the supply of water. In some areas it may increase, for example at higher latitudes, but water-stressed areas in the mid-latitudes are expected to face a reduction in available water. On a sub-continental scale, there are regional variations of temperature trends. For instance, warming is observed in southern and western Africa, and the tropical forests, while cooling is observed near lakes or coastal areas (Boko et al. 2007).

This present study discusses adaptation challenging and rural water technologies for bridging loophole within the framework of SW Nigeria rural communities. It will therefore examine how demeaning socio-cultural and tradition nexus have influenced poor adaptation responses to water stress and what it might imply for policy formulation.

Methodology

The set of required data for this research work includes historical and documented records over time as well as relevant literature on the subject matter. Data were gleaned from existing literature and critical/guided personal observations during the first author's post-doctoral research field work around the derived Savanna of Southwestern Nigeria. The study targets rural dwellers and therefore, answers from interactive questions during the field activities were used to support authors existing literature and personal observations.

Factors Influencing the Usage of Surface Water

This section briefly discusses various significant factors that could be addressed in shaping future state of water availability in rural communities of the derived Savanna, Nigeria. The identified adaptation challenges include or not limited to population growth, human activities, land use change, and potential effect of climate change on the hydrologic cycle area as it has potential direct relation with water provision through surface waters (pond, stream, springs, lake and rivers). Addressing these factors carefully will give way forward to map an ideal situation that generates a balance between water demands and water supplies.

Population:

Surface waters are the main sources of water in most derived savanna rural communities. As a result, availability of these sources only last for about two months after raining season in October and by February water scarcity is already at its peaks. It is noted that increase in population resulting from augmented immigration and birth rate could trigger a rise in basic demands i.e. food, water and housing. Therefore, the consequence could eventually put an immense pressure on available limited water for domestic use. Subsequently, high demand of food could result to a situation where land use change converts natural recharge area for groundwater to agriculture and settlement areas. Intense water demand as a coherent consequence of increased population may intensify the problem, as water might be over-harnessed beyond its physical availability that is directly linked with recharge performance of the land. Population increase gives additional burden to natural resources particularly water in the water stress regions. As population growth rate rises, demand for water consumption becomes higher due to direct relationship that exists between population and water withdrawals (Gardner-Outlaw and Engelman 1997). The influx of migrant is also a contributing factor to an increase in population growth in the area and this situation is clearly noted in the rural communities where ponds are the only source. This has become a big obstacle for future sustainable water management and the problems have become even more severe, especially during the peak dry season.

Anthropogenic activities

Anthropogenic activities are yet other factors that have direct correlation with water balance/hydrologic parameters, i.e. rainfall, infiltration, run-off and evapotranspiration. A potential of hydrologic impact of global warming may contribute to the change in water balance as changes water balance parameters increase or reduce water recharge and storage capacity. As a result, the capacity of surface water to potential supply water for

the rural communities is degraded as rainfall reduces and ultimately, as water supply from surface water declines in the area water scarcity intensifies and ends in water insecurity in the communities.

Slight changes in soil-atmospheric behaviour may lead to environmental problems particularly removal of vegetal cover and subsequently prone to water loss due to run-off (Gillieson 1996). Soil capacity to infiltrate water decreases as vegetated areas anthropogenically transforms to impermeable features such as settlement, roads and buildings, land capacity to let water infiltrate decreases. This complicates water shortage in water stress region.

Global climate change

The change in climate condition, to some extent, may have significant impact on surface water availability. The increased temperature leads to an increase of evapotranspiration, thus reducing the recharge rate on a watershed scale and trigger more severe water depletion during dry season (IPCC 2007a and b).

Abandonment of local knowledge

Incorporation of indigenous knowledge on managing natural resources such as surface water is crucial for building a strong foundation that will serve as a basis for long-term water conservation. Finding shows that there is serious danger when policy makers fail to recognize and embrace the significant value of local water rights and knowledge access to water by all users (Cremers et al. 2005) as preservation of biodiversity requires a cultural control that shares its manifestation in the form of indigenous knowledge (Bridgewater and Arico, 2002). The indigenous socio-cultural dimension of resources management in the rural communities has been changing due to modern social factors. Traditional knowledge of managing water is important among rural communities because those who live with natural resources are the ones that are most capable for preserving them (Agrawal 2001). The failure to recognize the local wisdom by policy makers have created a gap between the society and achieving sustainable water use based on local knowledge, instead government demeaned the system that has been embraced for generations and therefore, has resulted to decline in conservation measures by indigenes around surface water sources.

Humanitarian Services in Sustainable Water Management and Adaptation Mechanisms

Water insecurity in many places of the world has become a problem that without any urgent attention may result to problems such as health, sanitation, poverty and food insecurity problems. As about 25% of world population lives in regions with low or no access to freshwater (Gardner-Outlaw and Engleman 1997), rapid economic growth and increased population rate will intensify the situation in future if appropriate conservation mechanisms to the available fresh water are not well channeled.

The ability to manage water as a crucial natural resource entails a comprehensive set of concerns to administer water in a way that accommodates ecological, economical, technical and societal acceptance of a broader society (Bernhardi et al. 2000). Sustainable water management approaches vary spatially with respect to how it is being addressed by communities with different social backgrounds and diverse physical characteristics.

According to Smet and Wijk (2002) it is an answer to the large scale break down of water supply systems and government failure either to provide clean water or to devise a reliable and consistently system where other agencies would supply water. Since governments were not good at supplying infrastructure for their populations, communities should utilize their skills and motivations to meet their own domestic water needs through various humanitarian services. Water management option in some rural communities of Southwestern Nigeria is not only considered as local knowledge but also encourage physical characteristics into best conservation strategies through self-help services. Therefore, efficient water preservation strategy needs to be designed in order to combat societal problems (water issues and related conflicts) and the plausibility of the impact of global climate change.

Ponds and springs that are major water supply sources for most rural communities in Southwestern, Nigeria are at stake due to the factors that potentially contribute to the decline in water supply. Water insecurity remains the utmost problem as rural communities in the region depend on surface water (ponds, springs, stream) for domestic water supply. Therefore, it is important that conservation mechanisms are embarked on in order to overcome further future potential consequences. In acknowledging this, communities' effort based sustainable water management methods that are friendly to rural communities are drawn as humanitarian services framework for adaptation mechanisms in this study. The next sub-sections examine these.

Surface water catchment protection

Recharge process is mainly governed by physical characteristics of the surface and drainage system underneath. It is assumed that, with regard to the hydrologic cycle, the groundwater recharge process initially starts upstream where precipitation occurs. Water infiltrates and feeds the aquifer which retains and transports water to the adjacent outlets. This is crucial in determining the quantity and quality of groundwater that emerges downstream as spring. Therefore, any negative modification such as removal of vegetation, increase in built up size and waste disposal in this area could result in a decline of safe water supply. Therefore, the extent of vegetation in diffuse recharge area is very important to mainly act as buffer zone for water before it interacts with the earth surface and appropriately penetrates the soil. Reforestation can take place in the defined diffuse recharge area. The fundamental rationale that underlays reforestation measures are not limited to the physical concept of hydrologic cycle, but also the economic purposes. The selection of local vegetation needs to take into account that the improvement of inhabitants' livelihood is the most important long-term objective in efforts to enhance natural resources management in developing countries (Merrey et al. 2005). As a result, conservation of catchment surface waters (ponds, rivers, streams, springs, lakes) areas should be totally embraced by rural communities by cultivating plants/crops at diffuse recharge area (Afrasiabian 2007). This will accentuate infiltration by increasing the quantity of water percolating down to the water table (Allen and Chapman, 2001). Type of mini vegetation around sacred surface water catchment varies among different trees as observed in most part of Southwestern Nigeria e.g. around Osun Oshogbo river catchment, Arigiya spring at Ikare Akoko, and in most communities. These trees require to be protected due to their densely canopy and highly adaptation with tropical environment (Russell-Smith et al. 2007). In addition, they could as well

strengthen local's economy based on their economic value.

Public awareness campaign for adaptation mechanisms

Human and natural resources are exclusively interrelated. Man cannot survive to his utmost best without making use of the resources, therefore, the resources at the same time must be well conserved. Perceptions and attitude towards immediate environment and available natural resources (e.g. water source) determines life sustainability and fate of coming generation. Therefore, the recognition and understanding of resource conservation in the context of sustainable water management is crucial in rural domains. This could be achieved in rural areas through environmental education (promote water values, habits and skills through training, indigenous knowledge coach) using local dialect as a means of communication (Mogome-Ntsatsi and Adeola 1995). Awareness campaign is therefore, recommended and to be facilitated by both state and local governments.

Strengthening communities' socio-cultural roles

In sub-Saharan Africa, the problem of resource scarcity prescribes that governments can no longer rely on conventional means to successfully address the basic needs of their populations. Most rural communities have historically developed adaptation mechanisms to deal with water-related stress and scarcity problems (Tompkins et al. 2010). Community participation has been advanced in some places, and strategically and potentially viable in complementing efforts to meet the needs (Njoh 2002; Fonchingong and Fonjong 2003). The community head, elders and Community Development Associations' (CDAs) function is to regulate and manage water sources immediate environment with various respected norms and customs. Ideally, this plays crucial role in ensuring equal water usage among inhabitants and conservation measures at spring site. In addition, in rural settings, community members meet at community square at certain day depending on elders' arrangements to discuss socio-economic, cultural values, technical issues and problems related to water sources management and conservation measures. According to Ayeni (2012), outcome of such meeting would be a significant input for regional authority to assess current policy concerning water and other socio-economic policies. Empowering such system is an option that promotes sustainable adaptation mechanisms. Government at all tiers should encourage and assist community heads and elders in coordinating and promoting such system by incorporating it in their water policy.

Participatory Approach allows the communities' stakeholders to collectively share their viewpoints and interest in a free and equal communication. It is expedient that there is no periodic discharge and water quality data but the trend of situation had been passing from one generation to another through historical discussion (past and recent of water situations physically, socially and culturally) with respect to functions and territories by communities, stakeholders - the heads, elders, and CDAs. This issue is suggested to be driven by existing local knowledge.

The Case Study: Akoko Northeast LGA, Nigeria

Akoko Northeast is a Local Government Area (LGA) in Ondo State, Nigeria with its headquarters is in the town of Ikare. The LGA lies between longitude $5^{o}38'$ & $6^{o}04'$East,

and latitude $7^{o}26'$ & $7^{o}42'$N. It has an area of about 372 km² and a population of 175,409 at the 2006 census. Other towns in the LGA include Akunnu, Iboropa, Ikakumo, Ise and Ugbe.

Access to potable water in this LGA has been in continuous decrease. Less than 20% of the inhabitants of the area currently have access to potable water (Ayeni 2012). Where public water exists, services are unreliable and unsustainable. This is because of the difficulties in management, operation, pricing and operational costs. In order to manage water crisis, various communities particularly the rural indigenes adopted friendly humanitarian services to cope with water stress and other environmental change nexus. The services include but not limited to searching, rationing, and storage amongst others.

The services are mainly small-scale water supply management of findings solution and improve problem to water stress. Searching strategy implies sourcing for water wherever is available, even outside one's community. It also requires long trek and/or walk to access available water sources, which at times require one to cover as long as 10kilometers returned trip.

Rationing means that each community or household is allowed to access and collect/fetch water by agreement and on an agreed time of the day or day of the week. This method is peculiar to wells and some community boreholes. Vendor/packaging water means the situation where a household buys water from truck vendors or buys sachet water. Some households store rain water in a big container, which sustained them for few weeks after the rains. Some abide with the queuing system where fetching containers are lined up based on first-come first-serve.

Access and time restriction in their custom simply means that they stay away completely from the water supply sources in question for a period of time (some hours) to allow the source yield appreciable quantity.

Springs protection techniques

Traditionally, the values placed on the springs make it protection and management unique. Historically, springs protection represented an ingeniously simple idea and first developed in the late 1940s while public water supply was under the control and supervision of native authority. In spite the inauguration of pipe borne water in parts of the LGA in the late 1950s, the communities still maintain their indigenous protection and services culture as if they foresee the future water stress and scarcity.

The spring's environment is cleared and made clean, then, mixture of stones between 15 to 30kg and cement will be used to mount a solid concrete wall around the spring so that dirty, debris and other solid will not contaminate the embarked water. Steer case or steps is made on one side for people to fetch water at their convenience (Fig. 1). Stones and fine sound particles are spread along the entrance and surroundings of others to prevent debris and dirt from entry the springs (Fig. 2 & 3). Spring is also housed (concrete material and roofed) with dispending outlet through which community members can fetch water (Fig. 4) and amongst other methods.

Fig. 1: Surface water protection

Fig. 2: Surface water protection

Fig. 3: Surface water protection

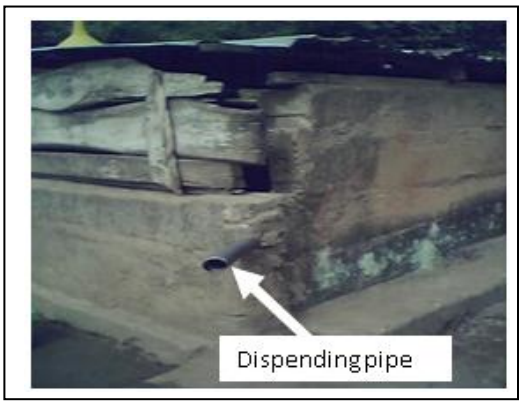

Fig. 4: Surface water protection

Concluding Remark

To complement government effort in reducing the impacts of climate change and water stress in the rural area, protection of surface water is important for the rural communities as it continuously provides water for domestic uses. If exclusively managed in line with knowledge that suits local tradition, it will meet the primary functions (basic life support and economic roles in the community) and secondary functions (administrative, social and ecological). This is because the local knowledge by which the communities manage their surface water and its ecosystem has a well-designed organizational arrangement. Stakeholders' roles and community water rules should therefore be encouraged by community members, and emphasizing the importance of humanitarian services and indigenous water management to younger generations for the system sustainability. It is, therefore, concluded that the inhabitants will keep on supporting and promoting their village system if exclusively supported by policy and their indigenous knowledge into cognizance in planning.

References

Adger, W. N., N. W. Arnell, E. L. Tompkins. 2005. Successful adaptation to climate change across scales. *Global Environmental Change **15**: 77–86.*

Adger, W.N., S. Huq, K. Brown, D. Conway and M. Hulme. 2003. Adaptation to climate change in the developing world. *Progress in Development Studies **3**: 179–195.*

Afrasiabian, A. 2007. The importance of protection and management of Karst water as

drinking water resources in Iran. *Environmental Geology **52**(4): 673-677*

Agrawal, A. 2001. Common property institutions and sustainable governance of resources. *World Development **29**(10): 1649–1672*.

Agrawal, A., N. Perrin. 2009. Climate adaptation, local institutions and rural livelihoods.

Adger, W. N., I. Lorenzoni, K. L. O'Brien, eds. *Adapting to Climate Change: Thresholds, Values, Governance*. Cambridge University Press, Cambridge, pp. 350–367

Agrawala, S., S. Fankhauser. 2008. *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*. OECD, Paris, 133 pp.

Allen, A., D. Chapman. 2001. Impacts of afforestation on groundwater resources and quality. *Hydrogeology Journal **9**(4): 390-400.*

Ayeni, A. O. 2012. *Spatial Access to Domestic Water Sources in Southwestern – Nigeria.* LAMBERT Academic Publishing & Co. KG, Germany, 177pg

Ayeni, A.O., A.S.O. Soneye, O.O. Fasunwon, R.T. Miteku, L.A. Djiotang-Tchotchou. 2011. Water Resources Development Optimization in a Climate Change Scenario: Case Study of Benin-Owena Basin, Nigeria. *Res. J. Environ. Sciences. **5**(1):56-64*

Barnett, J., S. O'Neill. 2010. Maladaptation, Global Environmental Change. *Human and Policy Dimensions **20**: 211–213*

Bernard, P. 2000. Mermaids, snakes and the spirits of the water in Southern Africa: Implications for river health. Paper read at a Workshop for the National Aquatic Biomonitoring Programme, Grahamstown, February 2000.

Bernhardi, L., G. E. G. Beroggi, M. R. Moens. 2000. Sustainable Water Management through Flexible Method Management. *Water Resources Management **14**(6): 473–495.*

Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R.

Tabo, P. Yanda. 2007. Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge UK, 433-467.,

Bridgewater, P. B., S. Arico. 2002. Conserving and managing biodiversity sustainably: The roles of science and society. *Natural Resources Forum **26**(3): 245-248.*

Burton, I., 1996. The growth of adaptation capacity: practice and policy. Smith J., N. Bhatti, G. Menzhulin, eds. *Adapting to Climate Change: An International Perspective.* Springer, New York, pp. 55–67.

Carter, R., A. Parker. 2009. Climate Change, population Trends and Groundwater in Africa. *Hydrological Sciences Journal, **54**(4): 676-689.*

Cremers, L., M. Ooijevaar, R. Boelens. 2005. Institutional reform in the Andean irrigation sector: Enabling policies for strengthening local rights and water management. *Natural Resources Forum, **29**(1): 37-50.*

Fazey, I., N. Pettorelli, J. Kenter, D. Wagatora, D. Schuett. 2011. Maladaptive trajectories of change in Makira, Solomon Islands. *Global Environmental Change **21**:1275–1289*

Fonchingong, C. C., L. N. Fonjong. 2003. The Concept of Self-Reliance in Community Development Initiatives in the Cameroon Grassfields. *Nordic Journal of African Studies **12**(2): 196–219*

Gillieson, D. S. 1996. *Caves: processes, development, and management*. Oxford:

Blackwell Publishers.
Hisali, E., P. Birungi, F. Buyinza. 2011. Adaptation to climate change in Uganda: Evidence from micro level data. *Global Environmental Change **21**: 1245–1261*
IPCC (2007a): Climate Change 2007: Synthesis Report. Contribution of Working Group to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) at IPCC Plenary XXVII (Valencia, Spain, 12-17 November 2007). Cambridge, UK.: Cambridge University Press.
IPCC (2007b): Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK.: Cambridge University Press.
Jaglin, S. 2002. The right to water versus cost recovery: participation, urban water supply and the poor in sub-Saharan Africa. *Environment & Urbanization **14** (1): 231-245*
Merrey, D. J., P. Drechsel, F. W. T. Penning de Vries, H. Sally. 2005. Integrating ''livelihoods'' into integrated water resources management: taking the integration paradigm to its logical next step for developing countries. *Reg. Environ Change **5**: 197–204*
Mogome-Ntsatsi, K., O. A. Adeola. 1995. Promoting environmental awareness in Botswana: the role of community education. *The Environmentalist **15**(4), 281-292.*
Njoh, A. 2002. Barriers to Community Participation in Development Planning: Lessons from the Mutengene (Cameroon) Self-help Water Project. *Community Development Journal **37**(3): 233–248.*
Pelser, A. J. 2001. Socio-Cultural Strategies in Mitigating Drought Impacts and Water Scarcity in Developing Nations. *S. Afr. J. Agric. Ext./S. Afr. Tydskr. Landbouvoorl **30**: 52 - 74*
Russell-Smith, J., S. Djoeroemana, J. Maan, P. Pandanga. 2007. Rural Livelihoods and Burning Practices in Savanna Landscapes of Nusa Tenggara Timur, Eastern Indonesia. *Human Ecology **35**(3): 345–359.*
Schipper, E. L. F., I. Burton. 2009. *The Earthscan Reader on Adaptation to Climate Change*. Earthscan, London, 480 pp.
Smet, J., C. V. Wijk. 2002. IRC Technical Paper Series 40, chap. 1, pp. 16 -24
Smit, B., O. Pilifosova. 2001. Adaptation to climate change in the context of sustainable development and equity. McCarthy J. J., O. Canziani, N. A. Leary, D. J. Dokken, K. S. White eds. *Climate Change 2001: Impacts, Adaptation, Vulnerability*. Contribution of Working Group II. Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 877–912 (chapter 18).
The Royal Academy of Engineering. 2010. Global Water Security –an engineering perspective, published by The Royal Academy of Engineering, 3 Carlton House Terrace, London SW1Y 5DG
Tompkins, E. L, W. N. Adger, E. Boyd, S. Nicholson-Cole, K. Weatherhead, N. Arnell 2010. Observed adaptation to climate change: UK evidence of transition to a well-adapting society. Global Environmental Change **20**: 627–635