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Institutional Adaptation to Saline-water Intrusion: A Case Study of The Gambia

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Abstract: Climate change is one of the environmental challenges that threatens any single aspect of development. Therefore, climate change poses both environmental and development problems. Salinization of freshwater and soil as a result of climate-induced sea-level rise in The Gambia is a growing concern for agriculture and ecosystems. This paper shed light on adaptation strategy response at the institutional level to saline-water intrusion in River Gambia and tributaries well-known for its ecological and livelihood delivery services such as rice cultivation in the lowlands. The study used stakeholder participation approach to gather data through a workshop in which 100 experts from four (04) different institutions intervening in saline-water intrusion adaptation were involved to discuss five themes relevant for institutional adaptation to saline-water intrusion in the country. Microsoft Excel 2013 was used to process and analyse the data at the end of the workshop. Results revealed that saline-water intrusion adaptation at the institutional level is poor performing in terms of capacity building, financial resources allocation for saline-water intrusion adaptation, available technology as well as collaboration among institutions. The study recommends an increase in budget allocation for saline-water intrusion adaptation in the targeted various institutions, capacity enhancement of staff in the monitoring of water salinity and provision of sophisticated equipment and technology to effectively address salinity in River Gambia and tributaries in the country.

Keywords: Institutional adaptation, River Gambia, saline-water intrusion, sea-level rise, stakeholder participation.

INTRODUCTION

Climate change is one of the environmental challenges that threatens any single aspect of development. This implies that climate change as an issue must come out of the environmental problems to take center stage as a major development problem [1]. The potential impacts of climate change on coastal regions include progressive inundation from sea-level rise, heightened storm damage, loss of wetlands, and increased salinity from saline-water intrusion [2]. It is estimated worldwide that about 600 million people currently inhabit low-elevation coastal zones and will be affected by progressive salinization [3]. The Intergovernmental Panel on Climate Change (IPCC) identified two strategies which are adaptation and mitigation in response to climate change [4] impacts. Adaptation is generally viewed as a key component of strategy or policy response to climate change besides mitigation. Adaptation is defined as the process of adjustment to actual or expected climate and its effects [5]. Furthermore, in human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities [4, 5]. Adaptation to climate impacts, in general, includes reactive or anticipatory actions by individuals or public institutions [6]. Subsequently, it is a way of reducing vulnerability, increasing resilience, moderating the risk of climate impacts on lives and livelihoods, and taking advantage of opportunities posed by actual or expected climate change [7] and its impacts.

Agriculture is extremely vulnerable to climate change [4] and importantly to its associated hazards, including saline-water intrusion. Saline-water intrusion is identified as a slow-onset hazard meaning it relates to incremental and cumulative environmental changes that emerge gradually over time, often based on a confluence of different events [8]. Saline-water intrusion is defined as the migration of saltwater into surface freshwater and aquifers [9].

Saline-water intrusion adversely affects agriculture by overall decrease in productivity, and loss of space (land, water, forest, etc.) for agricultural activities, which can drive out people who rely on it [10] and exacerbate food insecurity among poor rural communities in sub-Saharan Africa, one of the most vulnerable regions to climate change impacts [4, 11, 12]. The Gambia is one of those countries that are vulnerable to sea-level rise and its impacts of which

saline-water intrusion is no exception. In addition, the geographical position of The Gambia predisposes it to drought, windstorms, coastal erosion and sea-level rise [12-15].

Salinity is a major problem for rice production in The Gambia and it is affecting the farmers especially, those who are on lowland areas [16]. Therefore, formulating adaptation strategy is determinant in tackling the issue. In the quest of food security and building climate resilient communities [17], the country having rice as staple food [18] must create a robust adaptation policy aiming to effectively address salinity issue on rice-growing ecologies. Many strategies and policies in place in the country geared towards food security and poverty alleviation have poorly factored salinity issue in their conception and implementation. Therefore, with projected severe impacts of sea-level rise for The Gambia [13, 19, 20] policies focused particularly on agriculture salinity proofing are urgently needed to avoid loss and damage [21] which could easily undo previous enormous efforts for rice development in the country.

To cope with and to adapt to changes people at grassroots' level usually establish coping/adaptation strategies that are ways in which local individuals, households, and communities have changed their mix of productive activities, and modified their communities [22]. It is noted that individual adaptation is different from government adaptation; however they are not independent of each other – they are embedded in governance processes that reflect the relationship between individuals, their capabilities and social capital, and the government [23]. That is why many authors conclude that an effective adaptation process would focus on the entire system rather than simply those components of the system but involves many aspects (physical, social, cultural, economic, and political environments) instead of single one [24]. Adaptation to climate change can be subdivided into three levels: global, regional or national or institutional and community levels [4]. Societies, organizations, and individuals have adjusted their behaviour in response to past climatic changes, and many are now contemplating and adapting to altered future climatic conditions [25]. Much of this adaptation is reactive, in the sense that it is triggered by past or current events, but it is also anticipatory in the sense that it is based on some assessment of conditions in the future [25]. These levels of actions take home within hierarchical structures such that the levels intermingle with each other. The hierarchical structure extends beyond the nation-state: Article 3 of the United Nations Framework Convention on Climate Change encourages governments to adapt to climate change, the Delhi Ministerial Declaration on Climate Change and Sustainable Development, issued at the Eighth Conference of the Parties of the Framework Convention on Climate Change in 2002 [25] and the Paris Agreement in 2015 stated that adaptation 'is of high priority for all countries' and that 'adaptation requires urgent attention and action on the part of all countries'. The scales of appropriate adaptation also extend to lower elements of the political and jurisdictional scale. Municipalities, cities, firms, and markets are all adapting within the bounds of available technologies, regulatory systems and knowledge of future climate risks [24-26]. This central role of institutions in determining environmental outcomes is an emerging theme in the examination of society-environment interactions at various scales [27]. But since institutions coevolve with the physical system and risk parameters [28], it is important to examine the adaptation processes themselves [29]. Hence, the changing institutions of the state, as well as underlying cultural perceptions of risk, are determinants of social vulnerability to environmental risks [30] of which saline-water intrusion in The Gambia is of no exception.

The focus of this paper is on the institutional or governmental adaptation to saline-water intrusion, a climatic hazard in The Gambia. There is more global focused adaptation dimension to climate policy integration at the international level with little concern over saline-water intrusion among academicians and policymakers in the country (at national or institutional or governmental level). It is against this drawback that this paper adopts top-down perspective to explore at the national level how far different government institutions in The Gambia have gone in adopting new policies, strategies, and technologies in adapting to saline-water intrusion in the country. The paper has the significance to illuminate the importance of institutional research in the study of hazards in general and saline-water intrusion in particular for The Gambia.

In so doing, this paper attempts to elicit the current position of adaptation at the policy and decision making levels so as to support decisions by suggesting better ways of addressing salinity issue in the country at governmental or institutional level.

MATERIALS AND METHODS

To evaluate the current national adaptive response of the country towards saline-water intrusion, stakeholder participation approach was used. There is a wide range of methods to involve stakeholders, namely expert judgement brainstorming or checklists, cognitive mapping, surveys and interviews [31]. It is overall agreed that in case of unavailability of quantitative data, expert views of key stakeholders can provide alternate sources of relevant information [32]. Purposive expert sampling technique was employed in selecting respondents for the study. 25 experts were selected from four (04) key institutions which intervention areas cover saline-water intrusion in the country. Hence a total of 100 experts were involved in the workshop. The documents used for the workshop were officially communicated to the heads of these institutions which

later were relayed to staff for 3 weeks, to ensure familiarization with the questions embedded in the documents. The heads of the institutions selected the experts based on their level of expertise on saline-water intrusion as well as their willingness to participate in the workshop. The institutions consulted were National Agriculture Research Institute (NARI), Soil and Water Management Services (SWMS) of the Department of Agriculture (DoA), Department of Water Resources (DWR), and the Coastal and Marine Environment Unit (CMEU) of the National Environment Agency (NEA)

Five themes were at the menu of discussions during the workshop. These are 1. Manpower and specialisation on saline-water intrusion, 2. Saline-water intrusion Financing, 3. Collaboration and Networking on saline-water intrusion, 4. Current Adaptation actions in place to deal with saline-water intrusion, and 5. Major barriers in adapting to saline-water intrusion.

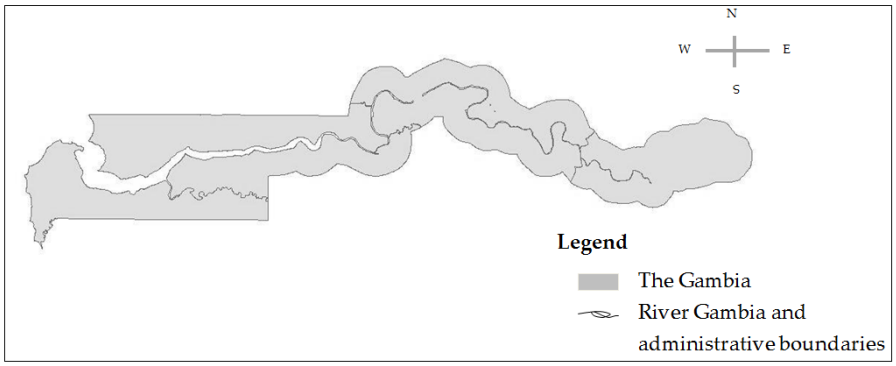

Fig-1: Map of The Gambia

RESULTS AND DISCUSSION

Manpower and specialisation on saline-water intrusion adaptation

To the information related to "Manpower and specialisation on saline-water intrusion adaptation" most of the institutions (75%) affirmed not having the required manpower specialised on saline-water intrusion adaptation against 25%. Moreover, experts declared not having any specialised on-job training on saline-water intrusion. However, few among them especially at the Soil and Water Management Services got trained on general Soil Survey and Land Use Planning. This could be explained by the fact that there is little or no training opportunity and lack of national competent manpower in the country on salinity technologies.

Saline-water intrusion Financing

Institutions staff members all affirmed (100%) that little finances are made available for saline-water intrusion monitoring as well as response strategies. All declared a decreasing resource allocation of finances to saline-water intrusion mitigation and adaptation for the Department of Water Resources in particular. Nonetheless, few projects financed by international organisations such as UNEP contribute largely to the use of few sophisticated equipment of salinity measurements along River Gambia and the saline-front monitoring in the River [33].

Collaboration and Networking on saline-water intrusion

In terms of existence and intensity of collaboration between selected institutions and other institutions, the rating ranged from weak, average to very strong. SWMS-NARI: weak; DWR-NARI: average; DWR-AGHRYMET: very strong; SWMS-Farmers' Association: very strong. The Department of Agriculture which oversees SWMS collaborates with Action Aid basically through joint implementation projects and activities on land reclamation and anti-salt dikes construction to limit saline-water intrusion on rice-growing fields. Moreover, these collaborations between institutions in the overall have declined over the last 5 years.

Adaptation actions to saline-water intrusion

Regarding past and current adaptation actions in place within each and across the institutions, the Department of Water Resources deals with monitoring of the saline-water front in River Gambia and inform other institutions, particularly the Department of Agriculture on the suitable period and location for agricultural activities to be held along River Gambia (especially on rice-growing ecologies). The Department of Water Resources regulates the frequency, period and location of freshwater abstraction activities from underground as well as within the River. Moreover, the DWR through the Water Quality Laboratory Unit conducts monitoring of River Gambia's water quality but with irregular visits on sites which could be explained by constraints of inadequate equipment and finances.

Soil and Water Management Services activities entail reversing the environmental degradation by reclaiming degraded lands and the construction of embankments such as anti-salt dikes to prevent the intrusion of saline-water on the rice-growing fields in the country and construction of bridges. SWMS has

been active in addressing the problems of soil degradation in The Gambia [35]. Beside governmental actions through SWMS, farmers provide the required labour force for soil conservation activities while SWMS offers materials and technical know-how (anti-salt dikes construction and application of chemicals: lime, gypsum, urea, etc.). The drawbacks registered were generally the smallness of dikes and spillways which do not last long [35]. Other projects came in to construct bigger dikes and spillways without any labour contribution of the beneficiary communities. These projects include: Soil and Water Management Project (SWMP) - Sponsored by USAID and The Gambia Government, Soil and Water Conservation Project (SWCP) - Sponsored by GTZ and The Gambia Government, Lowland Agricultural Development Programme (LADEP) - Sponsored by AfDB, IFAD and The Gambia Government, Participatory Integrated Watershed Management Project (PIWAMP) as a follow-up to LADEP - Sponsored by AfDB, IFAD and The Gambia Government, The Gambia Lowland Development Project (GALDEP) [35]. GALDEP constructed a series of water retention and anti-saline-water intrusion dikes to retain fresh rainwater and prevent saline-water intrusion in the rice-growing areas. Also, sluices are constructed to regulate water volumes in the areas where dikes are constructed. Liming is practiced to counter excessive soil acidity in the rice-growing fields. Recent projects like NEMA and FASDEP aiming at preventing saline-water into lowland rice-growing ecologies are currently on-going in many of the agricultural regions of the country. These projects in the regions have continued with anti-salt dikes and spillways construction for rural rice farmers. Moreover, they provided alternative sources of livelihoods to the farmers by establishing generally vegetable gardens for many villages in the country. This helped in adapting to saline-water intrusion issue. However, the projects intervention sites did not reach every part of the country and increasingly these infrastructures with time, became old and poor performing vis-à-vis of the unceasing saline-water intrusion which is causing losses and damages to the poor rural farmers [22]. Moreover, the old dikes constructed at that time did not have sluice gates which play the role of control of excess of water thus to prevent and remove saline-water during high tide from the fields [36].

It is worthy to highlight that the interventions of SWMS especially during 1970-1980s comprised of the use of lime and gypsum to neutralize salinity on the soils. It is evidenced that gypsum helps improve soil structural stability by providing a mildly saline soil solution which is not strong enough to adversely affects water uptake by most crops, but which restricts the movement of water molecules into the space between clay particles. Gypsum also contains calcium, which displaces sodium and magnesium from the exchange sites between clay particles thus impoverishes the soil [37]. Recent studies by [38] pointed out the economically and environmentally unsustainable character of gypsum and urea application among other adaptive strategies employed in four villages from two unions in Asasuni upazila of Satkhira district in Bangladesh.

Coastal and Marine Environment Unit of the National Environment Agency does not carry out any salinity activity because of lack of adequate materials to monitor salinity in the river

On an irregular rhythm, NARI collects some soil samples to evaluate soil salinity on rice-growing fields across the country. This could lead to sparse and inconsistency in the dataset on soil salinity for the country.

Major barriers in adapting to saline-water intrusion

The major barriers faced at the institutional level of adaptation to saline-water intrusion in The Gambia revealed by staff members of top institutions dealing with salinity in the country included mainly:

No clear delimitation of the institutional role of each institution

The nature of collaboration is not well spelled out in the yearly work plan of many institutions which could slow down in the execution of specific activities by each institution. For SWMS for instance, companies contracted for soil and water structures or anti-salinization edifices such bridges, spillways, anti-salt dikes etc. implement their activities without prior consultation with SWMS on sustainable land use practices that recommend the use of heavy machinery with little environmental damages.

Poor allocation of finances for regular monitoring of salinity

Budget constraints have been highlighted by all the institution's staff members (100%) to constitute one of the bottlenecks faced by their institutions in dealing with saline-water intrusion-related matters. For instance, since the first State of Environment Report (SOER) for The Gambia in 1997 conducted by the National Environment Agency (NEA) under the auspices of the World Bank support in the implementation of the Gambia Environmental Action Plan (GEAP) (1995-200), there have been no further reports due to financial constraints [33]. The SOER is the ever comprehensive data collection document which is the product of a collaboration of a number of cooperating departments and Non-Governmental Organisations and which provided environment-related data [39].

Poor specialised human resources on saline-water intrusion matters

Most of the institutions encounter problems of poor and to some extent lack of qualified and trained personnel on saline-water intrusion adaptation.

Non-availability of technologies and adequate equipment

The non-availability of technologies and adequate equipment are at the heart of issues that hinder environmental protection in the country. The SOER reported technology gaps on responses of the country towards adaptation to natural disasters including saline-water intrusion in the country which is qualified by [10] as at the origin of humanitarian crises across the globe [22, 34, 35].

CONCLUSION AND RECOMMENDATIONS

Strengthening adaptation capacity to saline-water intrusion requires institutional supports for salinity control. Different institutions' adaptation is mostly dependent upon institutional response for promotional activities and to managing observed risks in The Gambia. Social, ecological, and institutional capacities are significantly important to the coastal communities to adapt to an adverse situation [36]. It requires strengthening the existing collaboration among all the stakeholders. Government personnel and other stakeholders (non-government organisations, international or national groups, researchers, etc.) have to integrate so as to be able to implement any of the government policies related to salinity collectively.

More resources (human and financial) have to be allocated to the different institutions for capacity enhancement of personnel, technology development and intensification of saline-water monitoring and adaptation activities.

Agricultural practice is increasingly constrained with a high level of salinity. Given the impacts of salinity on land and lack of irrigation in dry seasons, climate resilient and saline tolerant rice varieties could be a vital need for agricultural production in the country rice-growing ecologies.

Harvesting of freshwater from rain and River Gambia could be explored and provides a solution for freshwater irrigation for crop production and human uses.

Moreover, numerous human activities such as untimely water use, unplanned shrimp culture, insufficient or poorly maintained infrastructure, and inadequate management systems have to be surrendered to strict regulations.

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Glossary

FASDEP: Food and Agriculture Development Project.

NEMA: Water and Lowland Development Project.