

Integration of Decision-Making Frameworks for Prioritizing Water Projects in Sudan

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Abstract: *The Devastating repercussions of civil and military unrest in developing countries, led to governments facing complex challenges in delivering basic services to their nations effectively and equitably. Reconstruction can only be achieved through sustainable development and delivery of basic services to irreversibly empower and transform society which in the case of Sudan includes the massive rural to urban migration experienced during the years of conflicts.*

Recently, decision makers in Sudan are challenged to balance the strategic goals and make difficult choices when prioritizing water projects due to the prevalent economic crises, particularly since the country is burdened by years of mismanagement and sanctions. As a developing country, Sudan must enhance its progress towards reaching all Sustainable Development Goals (SDGs), in which water is the most powerful catalyst for the practical attainment of these goals.

The aim of this paper is to review the current institutions in Sudan that are responsible for developing strategies and regulations for water projects development. Furthermore the paper proposes guidelines for developing a prioritization framework that can be adopted in defining priorities for water sector development in Sudan. The framework is based on institutional multi-criteria decision support axes to assist decision makers in allocating limited financial resources. The prioritization process incorporates stakeholders' participation in-order to address their respective priorities. This framework also refers to the forms of institutional arrangements that will ensure its successful implementation, with a rolling out plan based on a national master plan for the development of the water sector in the country.

Keywords: *Institutional arrangement, MCDA, Prioritization process, Reconstruction, Decision-Making framework, Water Sector*

1. Introduction

Sudan suffered devastating floods in 2020, as the world fought the COVID-19 pandemic. Hundreds of thousands of people and thousands of homes were destroyed when the Nile reached its highest level in 100 years.

Every year, floods affect approximately 200,000 people: 99,000 in 2017, 222,300 in 2018, 426,300 in 2019, and 875,000 in 2020.

While droughts become more frequent in the country, greater strain is placed on the agricultural system, which is undermined by under-investment and insufficient water storage infrastructure. Climate change has exacerbated the country's agricultural challenges, with increased floods and droughts due to the country's changing climate. The irrigation schemes within Nile Basin which cover nearly 2 million hectares of land have deteriorated as a result of inefficiency and aging infrastructure, low yields, and poor management (Tayebi, 2021).

Most of Sudanese communities live in areas further from the Nile, where they rely almost exclusively on seasonal water sources, such as streams and underground sources of water. In the absence of control, inefficient and unplanned use of non-Nile resources can lead to either displacement of communities away from areas of depleted water or tension between competing communities, often leading to conflict over scarce resources. Consequently, the people of rural Sudan experience a negative cycle of degradation and relapse. A sustained and optimal use of water can be achieved, preventing instability and promoting peace, with the proper management of non-Nile water sources. Considering the strong institutional set-up which contributes to managing water resources in a long-lasting and cohesive way, the Government of Sudan (GOS) has recently recognized the importance of advocating for the intrinsic role water plays in economic development and prosperity. (United Nations Environment Program (UNEP), 2017). Nevertheless, it would be beneficial to expand the range of available tools for water projects selection in Sudan as a way to propose an alternative prioritization approach that is consistent and systematic, yet pragmatic and feasible within the government's current capacity. In order to support the decision-making process, the Infrastructure Prioritization Framework (IPF) is a decision support tool that views project outcomes from two perspectives: social and environmental. The IPF can be used to select projects when there are large numbers of small- to medium-sized projects, limited implementation resources, and basic project appraisal data (but not full SCBA data) are available. In these circumstances, IPF can combine social-environmental, financial, and economic selection criteria. Based on these indices, projects are plotted on a Cartesian plane, and the sector budget is applied to create a project map

that can be compared along each dimension (Marcelo, Cleland, Schuyler, & Z. Schwartz, 2016).

2. Scope of Research

The priority of water projects development becomes imperative due to economic repression. In order to achieve a balance, the Government of Sudan (GOS) must promote decision-making tools when selecting infrastructure projects for public investment.

Sudan's government (GOS) must inevitably establish priorities and decide how to allocate limited resources for public investment. This challenge is highlighted in particular by the huge financing gaps forecast for water projects development over the next decades. As such, GOS is faced with the challenge of systematically prioritizing and selecting proposed infrastructure projects while also extending their budget space through alternative sources of financing.

The challenge, then, is to identify alternative tools for use in different contexts, in ways that are most likely to be helpful to policy makers and governments to support investment decisions. To be effective and efficient at prioritizing projects, these frameworks need to pass tests for efficiency, effectiveness, and public legitimacy, and they should guarantee asset sustainability over the long term and, where possible, bankability (Marcelo, Mandri-Perrott, House, & Schwartz, 2015).

Prioritization of current projects is based on cost-benefit analysis (CBA), which is a method of comparing projects based on their monetized value. Among its strongest features is that it can be used intuitively by decision makers to compare and rank multiple alternatives based on a single metric. Water Projects Development (WPD) framework by definition is an approach that integrates financial, economic, social, institutional and environmental indicators and considers these indicators in addition to public budget constraints. This paper aims at introducing the best practices for developing (WPD) framework in Sudan.

The objectives of this paper include:

1. Analyze the current institutional aspects in Sudan regarding their responsibilities and potentials for water projects development.
2. Provide guidelines for developing a decision making framework that can be used to prioritize water projects in Sudan based on previous studies.

3. Related Work

In Moldova, access to safe water and sanitation services for all is weak. Insufficient capacity and weak sector institutions create the bottleneck for poor water governance. The government modernized the sector institutional framework which is reflected in key strategic documents: The Water Sector Strategy 2014-

2028 which includes a separate chapter on institutional development, and the National Environment Strategy 2014-2023 which aims at nationalizing the current set-up and improving inter-sectorial policy coherence. The project aims at improving the institutional foundations for better sector management and efficient investments in sustainable water and sanitation services. In the entry phase of this project, a study identified the main weaknesses and priorities in the sector to remedy the situation. A participatory planning process around these priorities led to considerable local ownership of the project (Schweizerische Eidgenossenschaft Confederation suisse., 2021).

In collaboration with UNESCO's Cairo office, the water research center at the University of Khartoum conducted a comprehensive study of institutional arrangements for water resource management in Sudan. It has been found that there is an urgent need for training and capacity building as nearly all institutions lack adequate technical and manpower capacities. From previous studies, major cross-cutting training areas comprise the planning, design, operation, and maintenance of water resources systems, hydro-informatics and data management, water, sanitation and hygiene, irrigation water use efficiency and productivity, assessment and management of surface and groundwater resources, watershed management, water governance and economics, and water diplomacy and cooperation. (Water Research Center and UNESCO Cairo Office, 2018)

4. Methodology

A comprehensive literature review was carried out on the previous studies and reports to identify institutional gaps and development needs in the water resources sector in Sudan. The results from literature review were used to identify the gaps that affect the decision making for (WPD) in Sudan. The guidance provided in the paper discusses how to develop a prioritization framework to maximize the success of water projects implementation and allocate limited financial resources based on good practices and lessons learned from several institutes and funding agencies throughout the world.

5. Results and Discussion

5.1 Institutional Analysis for Water Projects Development in Sudan

Institutional factors can relate to issues of policies and laws as well as the administrative processes for equitable allocations and water distribution to various sectors. The ability of institutions to provide for the access to water is another factor as well as the manner in which governance or decisions are made involving affected and influenced stakeholders.

In Sudan, various Ministries, Agencies, and Institutions are involved in the management and use of water

resources. Generally, there are three levels of government institutional authority; National or Federal level, State level and Locality level. At the Federal level the water resources institution responsible for water resources management is the Ministry of Water Resources and Irrigation. In Sudan, water projects development affairs are largely fragmented among several Ministries and Institutions, with limited coordination and conflicting interests. (Water Research Center and UNESCO Cairo Office, 2018).

There is a significant gap between the federal and state levels in Sudan due to overlapping responsibilities, and the lack of coordination between them. At federal level allocations of funding for water projects competes with many other infrastructure demands such as roads, energy, agriculture, etc all competing for a very limited budget. External support from international agencies also channels funds through the federal level. With the limited coordination and integration of water demand between the various Ministries pose additional challenges for designing multipurpose infrastructure. Water projects demands are submitted separately by the various demanding sectors resulting in an uncoordinated, fragmented and hence unsustainable infrastructure.

Sudan's water resources management policies still have gaps and overlaps. Moreover, there are no adequate and coherent policies for natural resource management; there is no participation from affected groups in policy-making, which is the main reason for this problem. (The Government of Sudan and the UN Environment Programme (UNEP), 2020).

Laws governing the use of water in Sudan concern rivers, basins and catchments, as well as groundwater. Sudan's National Water Policy dates back to 1999, and it aims to consolidate all the legislation before 1992. According to the national policy, the federal government is responsible for planning, regulating, and implementing interstate waterways and national energy projects. Although each State exercises legislative, executive, and planning functions in regulating non-transit waters and electricity within its limits, policies should never be static, since economy and technology continue to advance, especially in countries that are subject to demographic change and climate change incidents like Sudan. (Ministry of Irrigation and Water Resources, 1999).

Invariably, the prioritization of water projects development becomes imperative due to economic repression. To achieve the necessary balance, GOS must promote the decision-making tools in selecting infrastructure projects for public investment and coordinated planning. It is worth mentioning that limited funding prevents the full implementation of the entire range of proposals.

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projects based on their monetized value. Among its strongest features is that it can be used intuitively by decision makers to compare and rank multiple alternatives based on a single metric.

The Water Projects Development (WPD) framework proposed is a quantitative multi-criteria prioritization approach that integrates financial, economic, social, environmental and technological indicators into two indices – social-environmental-technological and financial-economic – and considers these in addition to public and/or donor budget constraints.

Multi-Criteria Decision Analysis (MCDA) is an approach that explicitly addresses multiple factors in a decision-making environment; it refers to a set of procedures for resolving conflicts among multiple criteria that may require different standards in different contexts. In particular MCDA identifies the best ways to utilize the available information and reflect key criteria defined by the water sector. The selection of MCDA methods depends on many factors including the typology of the indicators, expected outcomes, type of decision making problem and the implementation procedure (Rosaria Guarini, Battisti, & Chiovitti, 2018).

Institutional Analysis and Development (IAD) is a set of variables defined by Ostrom that can be considered when assessing the role of institutions in the formation of social interactions and decision-making processes (Ostrom, Gardner, & Walker, 1994). IAD considers the formal and informal rules and decision-making processes in a territory, and assumes that the action scenarios are flexible (Oñate-Valdivieso, Massa-Sánchez, León, Oñate-Paladines, & Cisneros, 2021). The fact is that, despite the dynamic nature of water resources institutes in Sudan, affecting institutional change is not an easy endeavor, due to the complex nature of communities and stakeholders.

5.2 Process for Developing the Prioritization Framework for Water Projects Development (WPD)

The WPD prioritization process includes the following steps (figure 1):

1. Involving relevant stakeholders in the selection of decision criteria: Stakeholders from the relevant agencies are gathered at this step to identify potential project-level criteria. The minimum level of project information is maintained at this step so that the most effective key differentiators are carefully selected. All information should be gathered and consolidated to calculate the social-environmental-technological indicators (SETI) and financial-economic indicators (FEI) for each project.
2. Identification of indicators: Water projects aim at improving quality of life. A number of direct social and environmental benefits are associated with their implementation,

including improved access to public services; poverty alleviation, jobs and income opportunities created during the construction and execution of projects, continuity of supply and increasing existing safe water coverage. Financial profitability and economic value are also from the most common investment decision considerations.

3. Calculation of indices: SETI score and FEI are plotted and budget constraints are superimposed. The overall list of projects analyzed is presented, with their individual rankings on both the indices, as well as the expected costs of implementing the projects according to the feasibility reports.
4. Weighting Sensitivity Analysis: This analysis will evaluate how sensitive the results are to the different possible weighting schemes. Further calculations are carried out using alternative weights based on the subjective criteria (only for SETI) and equal weighting of criteria (for both, SETI and FEI).
5. Project Selection: This step is a crucial part of water projects development policy-making. MCDAs are designed to ensure that key policy objectives are considered and accountable decision-making is promoted.

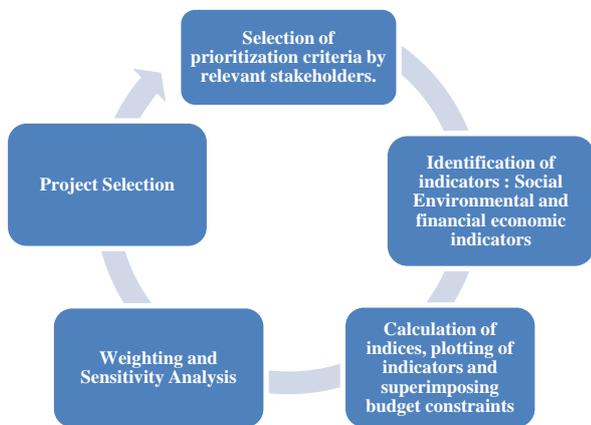


Figure 1: Steps for developing the prioritization framework for WPD (Compiled by the Authors)

5.3 The optimal regulatory, institutional and policy arrangement for WPD:

The structure of infrastructure projects must follow a defined process, from identifying needs by specialized organizations in the sector, to their execution through selection of the best bidder, to their long-term operation and maintenance. It is imperative that GOS defines its long-term development objectives and formulates a robust national development plan, determines the water projects to be built, and determines each project's priority in terms of gaining resources. The proposed prioritization plan should consider the budgetary status in terms of Cost Benefit

Analysis, to define the size of the proposed water projects. Coordination with the Ministry of Economy and Finance is crucial to undertake a preliminary screening of the projects to generate the most value for money (Suárez-Alemán, et al., 2021).

An institutionalized method for prioritizing investments is justified by the need for evidence, value, and legitimacy in infrastructure planning; the IPF affords infrastructure policy both kinds of legitimacy (input and output) by providing a transparent and objective decision-making process. In order to limit subjectivity, the IPF employs quantitative measures to the fullest extent possible. (Mandri-Perrott & Marcelo, 2016).

6. Conclusion and Recommendations

1. The WPD Framework proposed is structured to accommodate multiple policy objectives; attend to social, environmental and technological factors; provide an intuitive platform for displaying results; and take advantage of engaging stakeholders in defining, ranking and weighting criteria in the interest of transparency and consistency of an equitable approach that could be made publicly available. If implemented, this approach can also show the impact of enhanced resilience of infrastructure to climate change and possibly provide whole ecosystem green technologies options for much less cost than traditional expensive infrastructure.
2. The process for implementing this Framework is as important as the outcome itself since it can promote coordinated planning, transparency and hence cooperation.
3. It is important to note that this framework, although proposed for water projects can also be used for all infrastructures such as roads, power generation, agriculture, etc for planning and selection of national priority projects.
4. Water policies and strategies should never be static; they should be revised and validated based on the updated needs and interchangeable factors such as economic constraints and population growth.
5. A well-designed MCDA method requires asking the right questions first. Moreover, the outcomes should not be ambiguous and should be easily interpreted by non-experts.

7. References

- [1] Mandri-Perrott, C., & Marcelo, D. (2016, 08 30). *Prioritizing infrastructure investments: Framework and forward momentum*. Retrieved 06 28, 2022, from World Bank Blogs:

- <https://blogs.worldbank.org/ppps/prioritizing-infrastructure-investments-framework-and-forward-momentum>
- [2] Marcelo, D., Mandri-Perrott, C., House, S., & Schwartz, J. (2015, 08 27). Prioritization of Infrastructure Projects: A Decision Support Framework. World Bank PPP Group.
- [3] Marcelo, D., C. M.-P., S. H., & Z. Schwartz, J. (2016, 04 15). *An Alternative Approach to Project Selection: The Infrastructure Prioritization Framework*. World Bank PPP Group.
- [4] Ministry of Irrigation and Water Resources. (1999). *Sudan National Water Policy*. Retrieved from <https://www.ircwash.org/sites/default/files/824-SD99-18175.pdf>
- [5] Oñate-Valdivieso, F., Massa-Sánchez, P., León, P., Oñate-Paladines, A., & Cisneros, M. (2021). Application of Ostrom's Institutional Analysis and Development Framework in RiverWater Conservation in Southern Ecuador. Case Study—The Zamora River. *Water*, 13, 3536. <https://doi.org/10.3390/w13243536>.
- [6] Ostrom, E., Gardner, R., & Walker, J. (1994). *Rules, Games, and Common-Pool Resources*. MI: University of Michigan Press: Ann Arbor.
- [7] Rosaria Guarini, M., Battisti, F., & Chiovitti, A. (2018). A Methodology for the Selection of Multi-Criteria Decision Analysis Methods in Real Estate and Land Management Processes. *Sustainability* 10, no. 2: 507. <https://doi.org/10.3390/su10020507>.
- [8] Schweizerische Eidgenossenschaft Confederation suisse. (2021, 05 31). *Strengthening the Institutional Framework in the Water and Sanitation Sector in Moldova*. Retrieved 06 22, 2022, from Schweizerische Eidgenossenschaft Confederation suisse.: <https://www.dfae.admin.ch/deza/en/home/countries/moldova.html/content/dezaprojects/SDC/en/2014/7F08870/phase1>
- [9] Suárez-Alemán, A., Castrosin, M. P., Fioravanti, R., Bonifaz, J. L., Chackie, J. E., Debaeke, P., et al. (2021, 06). *Planning and Prioritization in Infrastructure Development, and the Role of Public-Private-Partnerships*. Retrieved 06 28, 2022, from Inter-American Development Bank: <https://publications.iadb.org/publications/english/document/Planning-and-Prioritization-in-Infrastructure-Development-and-the-Role-of-Public-Private-Partnerships-Seeking-an-Efficient-Coordination-of-Investment-Budgeting-and-Financing-Cycles-in-Latin-Ameri>
- [10] Tayebi, N. (2021, 09 29). *On the road to recovery: How Sudan is saving its water sector*. Retrieved 06 22, 2022, from World Bank Blog: <https://blogs.worldbank.org/water/road-recovery-how-sudan-saving-its-water-sector>
- [11] The Government of Sudan and the UN Environment Programme (UNEP) . (2020). *The first State of the Environment and Outlook Report 2020: Environment for Peace and Sustainable Development*. Khartoum: United Nations Environment Programme.
- [12] United Nations Environment Program (UNEP). (2017, 11). *Aiming for Sudan's integrated & sustainable water management*. Retrieved 06 23, 2022, from United Nations Environment Program (UNEP): <https://www.unep.org/news-and-stories/story/aiming-sudans-integrated-sustainable-water-management>
- [13] Water Research Center and UNESCO Cairo Office. (2018). *AU-NEPAD Networks of Centre of Excellence in Water Sciences and Technology: Human Capacity Development (HCD) Component*. Khartoum: AU-NEPAD.

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