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Skills Development for the Water-Energy Nexus: Bridging Gender Equality Gaps through Practical Projects like KDRP

- Fits under Sub-Theme: Social Equity and the WEFE Nexus - Gender and the Nexus

Title: Bridging the Gender Gap for the Water-Energy Nexus: Advancing Gender Equity through the Kariba Dam Rehabilitation Project **- ORAL**

While the Water-Energy-Food-Ecology (WEFE) nexus offers a framework for achieving sustainability, relying on it without fully addressing underlying inequalities such as gender disparities in access, participation, and decision-making can lead to outcomes that are technically achievable but ultimately fall short. Such an approach risks sidelining the Sustainable Development Goals (SDGs) for gender equality, undermining the transformative potential of holistic, inclusive development. The Kariba Dam Rehabilitation Project (KDRP), a flagship bi-national rehabilitation initiative between Zimbabwe and Zambia, historically reflected the broader trend of male-dominated energy sector where women made up only an estimated one in every six professionals on site.

Recognizing this imbalance, a bold intervention was made through the launch of a specialized Science, Technology, Engineering and Mathematics (STEM) Graduate Training Programme for young women. This initiative brought together 20 female graduates; 10 each from Zambia and Zimbabwe; offering them a rare opportunity to gain hands-on experience in dam rehabilitation, engineering, environmental monitoring, and energy infrastructure development. The program marked a significant shift in how large-scale infrastructure projects can be leveraged not only for technical outcomes, knowledge transfer and youth empowerment but also for social transformation.

This paper reflects on how gender-responsive programming within the KDRP is contributing to reshaping perceptions, building capacity, and promoting inclusive development in the water and energy sectors. It further examines how such initiatives can be scaled across the region to embed gender equity into the heart of sustainable resource management strategies.

Title: Bridging the Gender Gap for the Water-Energy Nexus: Advancing Gender Equity through the Kariba Dam Rehabilitation Project (KDRP)

1. Introduction

The Water-Energy-Food-Ecology (WEFE) nexus is widely recognized as a critical framework for sustainable development. However, its full potential cannot be realized without addressing underlying social inequalities, particularly gender disparities in technical sectors. Gender analysis reveals that women and men experience differing levels of access, participation, and opportunity; differences that are especially pronounced in technical fields such as energy and water infrastructure. Gender mainstreaming addresses these disparities by promoting equality, and because extensive evidence shows that women and girls remain more disadvantaged than their male counterparts, many interventions prioritize empowering women as a pathway to equity. [1] Gender equity remains a cornerstone of the Sustainable Development Goals (SDGs), particularly SDG 5, which emphasizes the need for inclusive participation in development processes. According to the World Economic Forum's 2023 Global Gender Gap Report, progress toward gender equality has been slow, with economic participation and political empowerment showing the least improvement globally since 2006. This data underscores the need for targeted interventions that not only mainstream gender but also intentionally strengthen women's participation in critical sectors. [2]

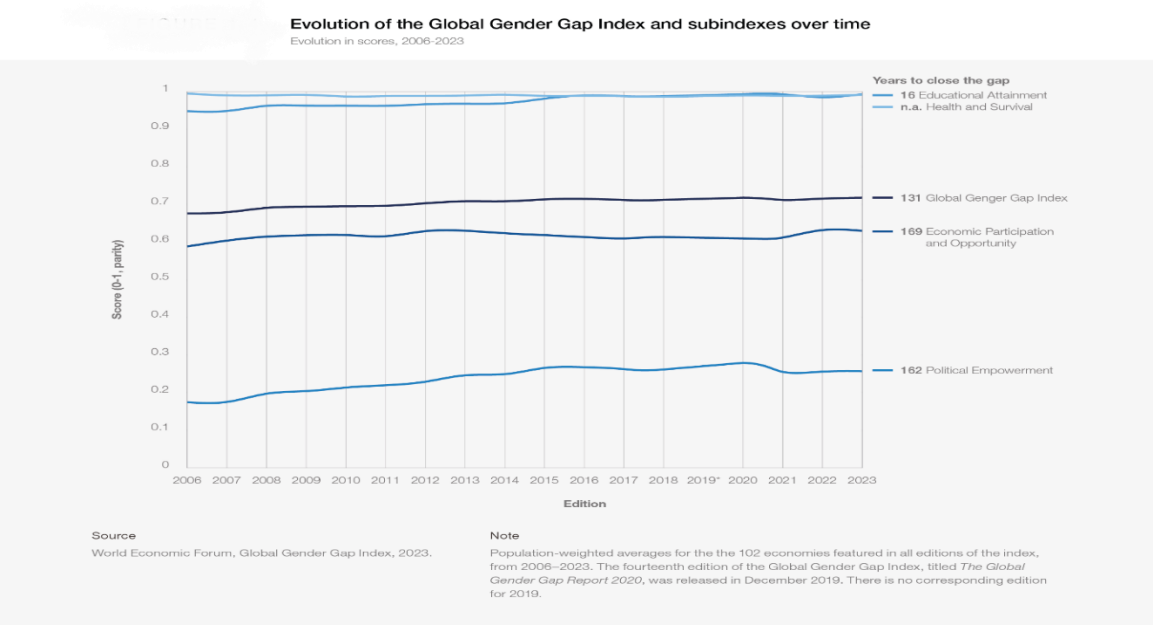

Figure 1: Global Gender Gap Index [2]

This paper highlights gender-responsive programming implemented under the Kariba Dam Rehabilitation Project (KDRP), a bi-national infrastructure initiative managed by the Zambezi River Authority (ZRA). Specifically, it focuses on the integration of a specialized STEM Graduate Training Programme designed to empower young women in the energy sector, an effort that reflects a deliberate shift toward inclusivity within the WEFE nexus.

2. Gender Disparity in the Hydropower Sector

Historically, the energy sector; particularly infrastructure [3] and hydropower [4]; has exhibited pronounced gender imbalances. Prior to targeted interventions under the KDRP, the Kariba Dam project site reflected this pattern, with an estimated ratio of 1 woman to every 6 men across technical and engineering roles. This disparity limited women's access to training, decision-making, and long-term professional advancement in infrastructure development. Yet, studies highlight that women possess valuable, often overlooked knowledge about climate patterns, ecosystems, and resource management, insights that are essential for shaping resilient and equitable energy solutions in the face of climate change challenges [5].

Table 1: Statistics from ZRA reports

	DEC 2022 – *Pre- STEM*		**SEPT 2024 - *STEM***	
	FEMALE	**MALE**	**FEMALE**	**MALE**
Project Supervision	5	22	33	23
Plunge Pool	43	196	37	142
Spillway	21	180	22	227
SUB-TOTAL	**69**	**398**	**92**	**392**
	1: 6		**1: 4**	

Such gender exclusion presents a risk to sustainable development, as it restricts the diversity of perspectives and capacities required to address complex water and energy

challenges. The Kariba Dam, a vital asset in the Southern African Power Pool (SAPP), exemplified these challenges prior to deliberate intervention under the KDRP.

3. STEM Graduate Training Programme for Women

In response to the pronounced gender gap, the Zambezi River Authority launched a structured Science, Technology, Engineering and Mathematics (STEM) Graduate Training Programme, targeting female graduates from Zambia and Zimbabwe. The program enrolled 20 young women (10 from each country), placing them directly within the core components of the KDRP to receive hands-on technical training and mentorship.

Participants were integrated into activities across the three main rehabilitation components and other projects:

- **Plunge Pool Reshaping**: Geotechnical strengthening to address foundation scouring risks.
- **Spillway Rehabilitation Phase 1**: Replacement of deteriorated concrete affected by Alkali-Aggregate Reaction (AAR), installation of emergency gates, and structural reinforcement.
- **Spillway Rehabilitation Phase 2**: Modernization of outdated hoist motors, programmable logic controllers (PLCs), and Motor Control Centres (MCC).
- **Floating Solar Hydro- Electric Project:** A phased solar power installation on Lake Kariba, targeting 150 MW initially and scaling up to 1,000 MW.
- **Batoka Gorge:** A 2,400 MW joint hydroelectric venture between Zambia and Zimbabwe, located downstream of Victoria Falls. The project features a 181 m high dam and twin power stations at its feasibility study stage.
- **Devil's Gorge Hydro- Electric Project:** A proposed 1,200 MW downstream development forming part of the Zambezi hydropower cascade. Currently at pre-feasibility stage, the project is being explored as a complementary or sequential build-out to Batoka Gorge.

This initiative marked a significant step in incorporating gender equity into engineering operations while building a pipeline of skilled professionals for future infrastructure projects.

4. Technical Exposure and Capacity Building

Through direct involvement in engineering design reviews, site inspections, project monitoring, and safety compliance, participants acquired practical knowledge in dam safety, hydropower systems, and project management. The program also facilitated professional development in:

- Project management, from planning all the way to closure
- Project monitoring, supervision and contract management
- Quality management, Safety, Health and Environmental monitoring techniques and protocols
- Electrical and mechanical systems operation
- Contract management and claims handling
- Water resource management
- Dam safety and monitoring
- Technical documentation and stakeholder reporting
- Dispute Avoidance and adjudication

This multi-disciplinary training addressed critical gaps in the representation and involvement of women in technical operations. Beyond skill acquisition, the program contributed to organizational transformation, fostering a more inclusive culture within the ZRA and its partner institutions.

5. Advancing the WEFE Nexus through Gender Equity

Gender equity is not only a moral imperative but a strategic necessity in advancing the goals of the WEFE nexus. Academic research linking energy infrastructure and the need for inclusive access states that women are not just beneficiaries of energy policies, but they are active agents whose roles must be recognized and supported [6]. By strengthening human capital through inclusive training programs, KDRP contributes to:

- Strengthening human capital in water and energy systems
- Promoting social equity and inclusive governance

- Enhancing institutional resilience to climate-related infrastructure challenges

The inclusion of women in engineering teams enhances diversity of thought and ensures that infrastructure solutions better reflect the needs and realities of all resource users by fostering diverse leadership, cross-disciplinary competencies, and community-centred engineering practices.

6. Challenges and Implementation Insights

Despite the program's success thus far, several challenges have been encountered:

- Initial gaps in field experience among participants required intensive orientation.
- Cultural perceptions within male-dominated technical environments necessitated ongoing advocacy and sensitization.
- Ensuring the long-term retention of women in engineering roles beyond the program remains a key consideration.

Mitigating these challenges requires close mentorship, cross-departmental collaboration, and proactive performance tracking.

7. Opportunities for Scaling and Regional Adoption

The success of the STEM program under KDRP thus far, offers a scalable model for similar infrastructure projects in the region. Key recommendations include:

- Institutionalize gender-focused technical training in national infrastructure policies
- Strengthen public-private partnerships to fund inclusive capacity-building programs
- Establishing scholarship or internship pathways in partnership with universities
- Establish regional mentorship networks to support knowledge exchange across the SADC region

These strategies can be adapted across sectors and borders to strengthen the role of women in sustainable water and energy development.

8. Conclusion

The Kariba Dam Rehabilitation Project has demonstrated that large-scale infrastructure can serve not only technical and environmental objectives but also as platforms for social transformation. The STEM Graduate Training Programme for Women serves as a model for embedding gender equity into complex engineering systems and advancing the objectives of the WEFE nexus.

As Zambia and Zimbabwe work toward their SDG and Agenda 2063 targets [7], the lessons from KDRP underscore the value of gender-responsive infrastructure development. Projects that invest in women's technical capacity not only bridge historical gaps but build more inclusive, equitable, and resilient systems thus benefiting entire communities and strengthening regional cooperation.

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