Value for Money Modeling for Scaling up Nature-Based Solutions for Improving Integrated Water Resources Management and Enhanced Water Security in Pakistan

Muhammad Sajjad[1], Saeed-ul-Islam[2], Nek Alam[3], Haidar Raza[4] and Muhammad Nazir[5]

https://doi.org/10.62345/jads.2024.13.3.2

Abstract

This paper is about the Value for Money (VfM) analysis conducted for the Water Resource Accountability (WRAP) Project, which comprehensively evaluates the project's economic efficiency, effectiveness, equity, and overall impact. The WRAP implements to undertake demonstrations of Nature-based Solutions (NbS), including Ecosystem-based Adaptation (EbA) interventions that will improve water security and governance, build resilience to climate change of communities at the target sites in Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa (KP), and enable the government and relevant stakeholders to implement and replicate NbS in Pakistan for building climate change resilience. The Paper is based on primary and secondary data collected using a well-structured interview schedule, focus group discussion, and other verified reports. The excel-based model was used for analysis, and a step-by-step and structured framework was used to conduct a VfM assessment. VFM estimates showed a favorable BCR across various interventions, with standout results like the Gabion check weirs and protection bunds (Gabion Bund) intervention achieving an impressive BCR of 3.50. These findings reaffirm the project's ability to deliver substantial benefits while efficiently utilizing resources, making it a prudent investment in water resource management and nature-based solutions. WRAP's equity analysis promotes inclusivity and fairness, particularly among vulnerable populations. While the project made significant strides in involving women in water-efficient practices, there is room for enhancing inclusiveness for lower-income and disabled populations. Recommendations emphasize setting specified targets for various populace categories to bolster the project's social impact further.

Keywords: Nature-Based Solutions (NBS); Ecosystem Services; VFM Analysis.

Introduction

Climate change has become a primary global concern over the past years, with the associated variations in temperatures, precipitation patterns, and the increasing frequency of extreme climatic events. Due to its particular location and geography, Pakistan is highly vulnerable to climate change impacts, particularly in the northern regions, which pose a significant threat to the country's water, food, and energy security (Hussain et al., 2022). Irregular and/or extreme temperatures, which have hastened the retreat of some glaciers in the north, compounded by increasingly irregular precipitation patterns, have considerably affected water flow in Pakistan's rivers (Amir & Habib, 2015; Hassan et al., 2017). Depleted water flows have several

[1]*Senior Economist, WRAP (Water Resource Accountability Pakistan), World Wide Fund for Nature. Corresponding Author Email: mdsajjad@wwf.org.pk*
[2]*Provincial Lead, WRAP, World Wide Fund for Nature.*
[3]*Team Lead, WRAP, World Wide Fund for Nature.*
[4]*Team Lead, WRAP, World Wide Fund for Nature.*
[5]*Lecturer, Institute of Business and Management Sciences, Agriculture University Peshawar.*

Compliance with ethical standards: There are no conflicts of interest (financial or non-financial). This study did not receive any funding.

interlinked consequences besides directly contributing to water security issues. These include impacts on the country's primarily agrarian economy, subsequently affecting food security, and hydroelectric power generation, Pakistan's second leading source of electricity, undermines energy security (Azeem et al., 2017). In addition, there has been a significant increase in natural disasters linked to climate change, e.g., landslides and floods, which have had massive negative repercussions on people's lives, livelihoods, and assets, particularly in poor rural communities (Sheikh et al., 2010; Caimotto, 2022). Climate change impacts thus aggravate the country's existing problems and hinder poverty alleviation measures.

To address the issue, the WRAP project was designed to protect the integrity and health of natural ecosystems by developing institutional capacities for better management of resources and engaging local stakeholders to build their climate resilience. The project has undertaken a diversified portfolio approach for Nature-based Solutions (NbS), which includes bioengineering for ecosystem-based adaptation, going beyond traditional complex infrastructure investments; local communities at target sites will be involved in ecosystem restoration and management that benefits their livelihoods and empowers them to build their resilience for climate adaptation. As a result, the proposed project will create multi-sectoral, long-term benefits for vulnerable communities in Pakistan.

Building on the above-reported aspects, this paper aims to analyze the Value for Money (VfM) analysis for the Water Resource Accountability Pakistan Project (WRAP), which comprehensively evaluates the project's economic efficiency, effectiveness, equity, and overall impact.

VFM Conceptual Frameworks

UK aid strategy (2015) describes the methods for achieving VfM. It includes a pledge to reduce waste, promote higher transparency, give the public/beneficiaries the right to talk about aid spending, ensure independent evaluation and scrutiny, and encourage effective lesson learning and dissemination. VfM can be described as follows:

- Economy — minimizing the cost of inputs.
- Efficiency — achieving the best rate of conversion of inputs into outputs.
- Effectiveness — achieving the best possible result for the level of investment.
- Equity — the extent to which aid programs reach the poorest and most marginalized by following "leaving no one behind." A higher impact does not mean an intervention reaches the maximum number of people at the lowest cost. The critical point is whether we reach those most in need of support and whether the support is provided in the most economical, efficient, and effective way.
- Cost-effectiveness — achieving the ultimate impact of a program's overarching objective or the intended effects.

Materials and Methods

VfM is a systematic approach that considers economy, efficiency, and effectiveness and ensures benefits are distributed fairly and equitably during the project's implementation. Economic analysis often provides part of the mixed methods evidence (indicators and narrative) required to support a VfM assessment. The analysis of the WRAP project contained a structured and comprehensive framework for evaluating the project's VFM. This multifaceted analysis encompasses several critical dimensions, including data collection, total costs, total benefits, cost-benefit analysis, and a nuanced assessment of the economy, efficiency, effectiveness, and equity aspects of the VFM. The foundation of this methodology is built on meticulous data collection, integrating geographical, demographic, economic, and flood damage datasets from reputable sources. This robust data forms the basis for evaluating the project's financial viability, incorporating financial metrics such as Net Present Value

(NPV), Internal Rate of Return (IRR), and Benefit Cost Ratio (BCR). The subsequent sections delve into the intricacies of the methodology, addressing key facets such as the aggregation of project costs and an economic comparison with a benchmark project. Furthermore, the methodology scrutinizes the efficiency of resource allocation by assessing benefit-cost ratios for each intervention type, while the effectiveness analysis evaluates the project's ability to achieve predefined outcomes. Lastly, the equity assessment highlights the project's commitment to inclusivity, particularly emphasizing women's empowerment. The methodology section provides a comprehensive roadmap for evaluating the WRAP project's holistic performance, encompassing financial prudence, resource efficiency, and societal inclusivity. In sensitivity analysis, the quantitative model uses a discount rate of 9.12% for the base case scenario and 12% and 5%, respectively, for high and low discount rate scenarios. The analysis assumes upfront sustainability. The undiscounted costs are spread over a 25-year horizon with a linear flow in the benefits stream.

The analysis rightly identifies the economic benefits under different interventions - avoiding crop damages and infrastructure, carbon sequestration, avoiding health costs, and time-saving in water collection – alongside the financial benefits (high income earned from the use of improved vegetable seeds). This differentiates the analysis from financial cost-benefit analysis, which relies only on financial flows of costs and revenues. Economic theory suggests that the provision of services will be undersupplied (not supplied) by the market if the marginal private benefits are less than (none) the marginal social benefits. Hence, there is a case for investing in WRAP interventions.

Data Collection and Modeling for Value for Money Analysis

Data collection for the VFM Analysis was meticulously carried out by the Water Resource Accountability Pakistan (WRAP) project WWF–-Pakistan. The data collection and modeling of the project followed a two-pronged approach to analysis, where the limitations in the capacity of the data collection process were keenly observed. This also allowed us to navigate any potential challenges of data collection considering the social and community-based preferences in the reserved milieu of KP and GB. For instance, satellite-based imagery of GIS location data was used to map the areas of intervention and converge on detecting critical issues related to, and not limited to, clarity in population datasets and areas inundated by floods.

Critical data decisions are listed below, forming the backbone of the analysis.

1. Determining village areas was facilitated by utilizing shapefiles generously provided by WWF, ensuring accurate geographical representation.
2. Population counts are a critical dataset sourced from Facebook's META and their collaboration with Columbia University's dataset Center for International Earth Science Information Network (CIESIN), ensuring the reliability and comprehensiveness of demographic information.
3. Land areas were determined with precision, leveraging datasets such as 'globcover' and esri land use/land cover, which enabled a comprehensive understanding of land use patterns.
4. Flood damage factors, essential for assessing the impact of natural disasters, were derived from various sources and published reports from relevant agencies within Pakistan. This encompassed district-level information on cropped areas, production, population demographics, houses, and infrastructure. These sources included agricultural statistics and population census reports.
5. The estimation of flood damage to standing crops during inundation was conducted meticulously, considering various factors such as flood depth, duration, susceptibility of each crop, farm costs, and farm-gate prices. Monthly economic values of potential yield loss were determined based on expected economic farm-gate gross revenue minus on-farm costs incurred post-dated to the flood event. Total crop losses per hectare of Culturable

Command Area (CCA) were calculated by combining crop effects with monthly probabilities of flood occurrence.

6. Estimations of non-crop direct damages resulting from inundation and erosion were calculated by analyzing the concentration of housing, road infrastructure, and railway infrastructure within the project's protected area on a unit area basis. Flood damage factors for houses and infrastructure were determined by considering each location's composition, density, and unit replacement costs.
7. Economic data, including discount rates, GDP deflator, and inflation rates, crucial for financial assessments, were meticulously extracted from the World Bank database, guaranteeing the use of up-to-date and credible information. 8. Currency exchange rates, a fundamental element in financial calculations, were sourced from the official website of the State Bank of Pakistan, ensuring accurate conversions between Pakistani rupees, Great Britain pounds, and US dollars. This comprehensive data collection process ensured that the WRAP project's analysis and assessments were grounded in accurate, up-to-date, and reliable information, forming a robust foundation for subsequent analyses and decision-making processes.

VFM Analysis-Excel Based Model

The Excel-based model was used for VFM Analysis. This model is a step-by-step and structured framework for conducting a VfM assessment. This toolkit promotes a wholesome approach and takes advantage of the full spectrum of VfM criteria, ToC, and evaluation methods.

Results

Table 1: Performance Summary

	Base Line	Low	High
Net Present Value	66,709	26,594	123,519
BCR	3.50	2.00	5.59
Internal Rate of Return	14.18%	8.33%	18.65%

Economic Analysis in Value for Money

The Economy section of the VFM analysis serves as a vital component in the assessment of the WRAP project's VFM analysis. This section is dedicated to the aggregation, structural classification, and thorough assessment of the project's total costs, with a critical evaluation of its economic value in comparison to two different closely related benchmark projects namely: 'Recharge Pakistan: Building Pakistan's resilience to climate change through Ecosystem-based Adaptation (EbA) and green infrastructure for integrated flood risk management' and 'Scaling-up of Glacial Lake Outburst Flood (GLOF) risk reduction in northern Pakistan'. Additionally, this analysis extends to encompass the number of beneficiaries, facilitating a per capita evaluation of the entire WRAP project. When considering the number of beneficiaries, the per capita cost equates to a mere £17. A comparative analysis with both the benchmark projects reveals compelling insights. The Recharge Pakistan project, despite its similarity in terms of interventions, incurred a significantly higher cost of £63,134,700. Not too dissimilar to the WRAP project the global lake outburst flood initiative, as used as the second benchmark, cost about a staggering £30,431,250. Both the project's grand total costs seem gargantuan in comparison to WRAP interventions. This discrepancy is also evident at the per beneficiary level of analysis, with £83 and £68 more being allocated to each beneficiary in the benchmark projects, respectively, as shown in table 2 below.

Table 2: Economic Measures

Sr. No	Metric	Projected Value	Bench Mark Value 1	Bench Mark Value 2	Difference Bench Mark Value 1	Difference Bench Mark Value 2
1	Total cost	5,000,000	63,134,700	30,431,250	(58,134,700)	(25,431,250)
2	Total discount rate adjusted cost	4,544,000	57,376,815	47,178,352	(52,832,815)	(42,634,352)
3	Discount adjusted cost per beneficiary	17	83	68	(67)	(51)
4	Qualitative assessment score	Exceed				
Benchmark 1: https://www.greenclimate.fund/sites/default/files/document/fp207-wwf-pakistan-rev.pdf						
Benchmark 2: Scaling up of glacial lake outburst Flood (GLOF) (2017); https://www.greenclimate.fund/project/fp018.						

The higher costs of these benchmark projects are due the reason of involvement of human resources of international organizations (i.e. UNDP and WWF-US), whereas WRAP is being implemented with the national (human) resources which are highly cost-effective.

Efficiency Analysis in Value for Money

The Efficiency section of the VFM analysis serves as a crucial dimension for evaluating the effectiveness of the WRAP project. This section primarily focuses on assessing the benefit-cost ratio (BCR) of the entire project. The fundamental unit of analysis revolves around the conversion of inputs into outputs, emphasizing the cost-efficiency and value generation embedded in the project's interventions. Imbued in the notion of understanding per input benefits received, Efficiency in VfM work in a modular function for each intervention and provides a systematic analysis of the whole project. To calculate the efficiency ratio for each intervention type, we consolidate the discounted costs and benefits per intervention. This calculation provides a quantitative measure of the benefits achieved per unit of cost incurred, offering unique insights into resource allocation efficiency. Furthermore, this analysis extends to encompass a list of beneficiaries, an integral component of the finalized summary within the value for money analysis framework. This comprehensive assessment not only quantifies per project efficiency but also incorporates per capita perspectives, enhancing the depth of the project's evaluation.

Table 3: Efficiency Measure

Sr. No	Output	Discounted Cost (£)	Discounted Benefit (£)	B/C (Discounted Benefit/Discounted Cost)
1	Gabion Bund	26,735	93,444	3.50
2	Natural Drainage Path Restoration	16,136	73,402	4.55
3	Slope Stabilization	1,734	26,643	15.37
4	Enhancement of traditional irrigation structures/micro-irrigation	27,702	119,842	4.33
5	Afforestation of indigenous species	2,991	22,873	7.65
6	Protection of critical natural forests and watershed services (Ha)	3,073	12,735	4.14
7	Improvised piped network	17,951	271,808	15.14
8	Construction of off-seasonal tunnel farming	36,163	58,343	1.61
9	Water filtration units	20,906	229,550	10.98
10	Improved vegetable seeds kits for Women	48,267	421,452	8.73
	Total	**201,658.14**	**1,330,091.30**	**7.60**

In above tables, the Gabion Bund intervention yielded an impressive BCR of 3.50, signifying that every £1 invested as a cost generated £3.50 in benefits. Notably, the 'protection of critical natural forests and watershed services' intervention achieved an outstanding BCR of 4.14, a testament to its remarkable success in safeguarding and rejuvenating the natural ecosystem landscape, in the form of carbon sequestration. More notably so, 'improvised piped network' produced an aggregated benefit of £15.14 per £1 put in, in the form of time saved in accessing water and health costs avoided due to cleanliness of that water. These compelling findings underscore the economic viability and effectiveness of the WRAP project. The favorable BCRs across various interventions validate the project's ability to deliver substantial benefits while prudently managing costs. Moreover, the emphasis on preserving and restoring the ecosystem's natural landscape exemplifies the project's holistic approach to sustainable water resource management.

Effectiveness Analysis in Value for Money

The effectiveness section of the Value for Money analysis is a critical dimension for evaluating the WRAP project. This section assesses the project's ability to achieve predefined outcomes in relation to the costs incurred to attain these outcomes. Leveraging the logical framework provided by WWF, the analysis entails a comprehensive cost-benefit assessment of these outcomes. It is imperative to emphasize that the finalization of outcomes hinges on the project's capacity to measure the benefits accrued and align them with the intended outcomes. Akin to that limitation, and the pre-established outcome indicators taken from logical framework by WWF, interventions were treated as exclusive outcomes. The first breakdown of the analysis reveals the attainment rate for the outcome titled 'Nature-based Solutions (NbS) introduced for integrated water resource management, river basin management, and watershed management protection' is shown in table 4.

Table 4: Effective Analysis

Sr. No	Outcome	Total discounted costs (£)	Total discounted benefits (£)	Effectiveness ratio
1	Outcome 1: Nature-based Solutions (NbS) introduced for integrated water resource management, river basin management, and watershed management protection	78,370	348,938	4.45
2	Outcome 2: Adaptive capacity of communities vulnerable to climate change induced risks is strengthened	75,021	559,701	7.46
3	Outcome 3: Community-based natural resource management (CBNRM) approach mainstreamed to implement and maintain NbS	48,267	421,452	8.73
				6.88

Equity Analysis in Value for Money

The Equity section of the Value for Money analysis plays a pivotal role in ensuring inclusivity and fairness within the Water Resource Accountability Pakistan Project (WRAP). This section is dedicated to upholding the principles of non-discrimination and equality, ensuring that the project extends its benefits to all vulnerable populations without any form of bias. Through a comprehensive assessment, the Equity analysis strives to promote equitable access to project interventions, see table 5 below:

Table 5: Equity Analysis

Criterion weighting	Indicator projected value	Indicator goal	Indicator percentage achieved	Weighted equity metric
For an overall metric, assign a weight to each criterion category.	55677	75000	74%	74%

According to the disaggregated intervention data, the project achieved 74% of its planned milestone, which aimed to reach 75,000 women. Specific interventions were designed to promote the involvement of women in the project, such as 'use of kitchen wastewater to promote kitchen gardening' and 'Improved vegetable seeds kits for women.

Discussion

The core execution of the CBA involved assessing the financial viability of each intervention within the project (Joseph et al., 2020). Individual calculations were performed for NPV, IRR, and BCR for every intervention, enabling a granular evaluation of their respective cost-benefit profiles. The results of the CBA present a compelling outlook for the entire project. The benefits consistently outpace the costs at both the aggregate and intervention-specific levels. For instance, considering the case of the Gabion Bund—the initial programme cost intervention—it demonstrates a substantial NPV of over £66,709 and a swift IRR of 14.18%. These figures signifies the monetary value of benefits accrued, which surpass the costs of intervention. The NPV shows the amount of returns/benefits from making the intervention, which makes the project's viability extremely potent, and the IRR shows the rate at which those returns are expected to be received in terms of cash flow, being positive are also a sign of high yield from the investment made. To further gauge the project's robustness, sensitivity testing was carried out. Under the high sensitivity test scenario, the NPV significantly increased to £123,519, accompanied by a favorable IRR of 18.65%. Conversely, the low sensitivity test showed an NPV of £26594 and an IRR of 8%. These sensitivity tests reveal the project's resilience in response to potential variations in political and economic conditions. They demonstrate the project's capacity to deliver maximum benefits while also weathering adverse scenarios. Remarkably, the positive outlook extends across all interventions individually, underscoring the exceptional viability of the project's components. Notably, the nature of intervention here shows great promise and needs to be studied for its specific mitigating qualities to be analyzed for best practices as shown in the table 1. Performance summary of Gabion Bund intervention showing NPV, IRR and BCR and the sensitivity testing of 'high' and 'low' discount rate testing. The high percentage used is 15%, while low sensitivity ratio is considered to be 5% (World Bank, 2023).

Conclusion and Recommendations

Results revealed that the Value for Money analysis of WRAP demonstrates its commendable financial efficiency and effectiveness in achieving the defined objectives. With economic expenditure, cost-effective interventions, and inclusive practices, WRAP stands as a model for sustainable water resource management and climate resilience. To ensure continued success, ongoing monitoring and inclusivity enhancements are crucial, reinforcing WRAP's position as a prudent investment in Pakistan's water governance and environmental sustainability. Efforts should be made to keep future intervention of the WRAP project limited to achieved social, economic, environmental and policy level impacts of the project at all appropriate scales. WRAP's equity analysis focuses on promoting inclusivity and fairness, particularly among vulnerable populations. While the project made significant strides in involving women in

water-efficient practices, there is room for enhancing inclusiveness for lower-income and disabled populations. Recommendations emphasize setting specified targets for various populace categories to further bolster the project's social impact.

References

- Amir, P., & Habib, Z. (2015). Estimating the impacts of climate change on sectoral water demand in Pakistan. Mehran University Research. *Journal of Engineering and Technology, 2,* 398-406.
- Azeem, K., Hashmi, B., Nisar, A., Jawed, G., Sadiq, M., & Anwar, T. (2017). Hydropower Issues in Pakistan. *Journal of Energy Technologies and Policy, 7,* 225-0573.
- Caimotto, M. C. (2022). *Climate change and sustainability.* In Lifestyle Politics in Translation Report. 1-15.
- Center for International Earth Science Information Network. (2023). *Pakistan and India High Resolution Population Density Maps.* Columbia, University.
- Department for International Development. (2015). *DFID's approach to Value for Money* (VfM).
- Federal Food Commission. (2017). *Development of National Flood Protection Plan-IV (NFPP-IV) and Related Studies to Enhance Capacity Building of Federal Flood Commission-FFC.* 76-99.
- Foreign, Commonwealth and Development Office. (2023). *Annual Review for WRAP program of WWF*. Annual Report. 1-21.
- *Glacial Lake Outburst Flood*. (2023). *Scaling-up of Glacial Lake Outburst Flood risk reduction in Northern Pakistan.* Available online with updates at https://usda.mannlib.comell. edu/data-sets/crops/9X100.
- Green Climate Fund. (2023). *Building Pakistan's resilience to climate change through Ecosystem-based Adaptation (EbA) and Green Infrastructure for integrated flood risk management.* Available online with updates at https://usda.mannlib.comell. edu/data-sets/crops/9X100.
- Hassan, I., Ghumman, A. R., Ghazaw, Y., Abdel-Maguid, R. H. & Samreen, B. (2017). Climate Change Impact on Precipitation in Arid Areas of Pakistan. *International Journal of Water Resources and Arid Environments*, *6*, 80-88.
- Hussain, Z., Mujahid, F., & Anwar, U. (2022). Climate Change in Pakistan: Impacts, Strategies, and the Way Forward. *Pakistan Languages and Humanities Review*, *6*, 181-192.
- Jakupec, V., & Kelly, M. (2016). *Assessing the impact of foreign aid: Value for Money and Aid for Trade.* Elsevier Inc., UK. 16-25.
- Joseph, C., Gunton, T., Knowler, D., & Broadbent, S. (2020). *The Role of Cost-benefit Analysis and Economic Impact Analysis in Environmental Assessment: The Case from Reform.* 491-501.
- King, J. (2018). *OPM's approach to assessing VfM: A guide.* Oxford: Oxford Policy Management Ltd. Available online with updates at https://usda.mannlib.comell. edu/data-sets/crops/9X100.
- Sheikh, M., Manzoor. N., & Adnan, M. (2010). *Precipitation Related Disasters in Pakistan, Linkage to Climate Change, Risk Reduction and Possible Adaptation Measures. Proceedings of Second International Disaster Management Conference* (IDMC-2010) Publisher: University of Peshawar, Pakistan. 4-45.
- State Bank of Pakistan. (2023). *State Bank of Pakistan. Economic Data 2023-24.* Available online with updates at httrps://usda.mannlib.comell. edu/data-sets/crops/9X100.
- World Bank. (2023). *The World Bank. World Development Index Data*. Available online with updates at https://usda.mannlib.comell. edu/data-sets/crops/9X100.
- World Wide Fund. (2022). World Wide Fund for Nature. The Logical Framework – WRAP. 1-10.
- World Wide Fund. (2023). *World Wide Fund for Nature*. Value for Money Strategy, submitted to FCDO. 1-1-23.