Assessing Maladaptation in Urban Flood and Erosion Control Interventions: Lessons from The Idye Basin Erosion Control and Hydraulic Drainage Project, Makurdi, Nigeria

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Abstract
This study assessed maladaptation in urban flood and erosion control interventions, drawing lessons from the Idye Basin Erosion Control and Hydraulic Drainage Project in Makurdi, Benue State, Nigeria. A cross-sectional case study design integrating quantitative and qualitative methods was adopted. Data were collected through 400 structured questionnaires and 12 key informant interviews with residents in communities within the project's area of influence. A modified Multi-Criteria Index-Based Evaluation (MCIBE) framework, comprising five dimensions, namely: governance deficit, vulnerability creation, spatial risk transfer, sustainability and lock-in, and equity and distributional effects, was used to assess the extent of maladaptation. The results revealed an aggregate Maladaptation Index of 0.308, indicating a low overall level of maladaptation. However, the Governance Deficit Index (0.580) and Social Inequity and Livelihood Loss Index (0.355) fell within the moderate maladaptation category. Vulnerability creation, spatial risk transfer, and temporal maladaptation recorded low index values of 0.201, 0.191, and 0.214, respectively. Nearly half of the respondents (49.5%) reported that they were not consulted during project planning or implementation. Respondents also identified inadequate drainage capacity (17.0%), the need for drainage extension (14.5%), poor maintenance (15.5%), and refuse accumulation (11.3%) as major operational concerns. These findings demonstrate that a low aggregate maladaptation score can mask significant governance and equity shortcomings. The study recommends strengthening community participation, instituting routine drainage maintenance, improving waste management, and undertaking engineering reviews of drainage capacity and outlet connectivity.

Keywords: *Climate change adaptation, infrastructure resilience, maladaptation; flood and erosion control; hydraulic drainage; governance deficit; Nigeria.*

1. Introduction

Maladaptation refers to adaptation actions intended to reduce exposure or vulnerability to climate-related hazards but which produce unintended consequences that increase vulnerability, transfer risks, deepen inequality, or constrain future adaptation (Noble et al./IPCC, 2014; Barnett & O'Neill, 2010). Such outcomes may arise when interventions benefit one location or group at the expense of another, lock communities into inflexible development pathways, or create new

environmental and social pressures (Sarkar et al., 2024; Schipper, 2020). Consequently, the success of a climate change adaptation project should be judged not only by its stated purpose but also by its wider and longer-term effects on people, infrastructure, and the environment.

Climate change has increased the importance of adaptation planning as communities face risks associated with flooding, drought, changing rainfall patterns, and other climate-related stresses. However, adaptation interventions do not automatically produce positive outcomes. Poorly designed or implemented measures can shift hazards across locations and social groups, deepen existing inequalities, or create long-term dependence on infrastructure that is difficult to modify. These concerns make it necessary to assess climate change adaptation projects in relation to vulnerability, distributional effects, governance, and risk transfer (Intergovernmental Panel on Climate Change [IPCC], 2022; Magnan et al., 2016; Chi et al., 2021; Eriksen et al., 2021).

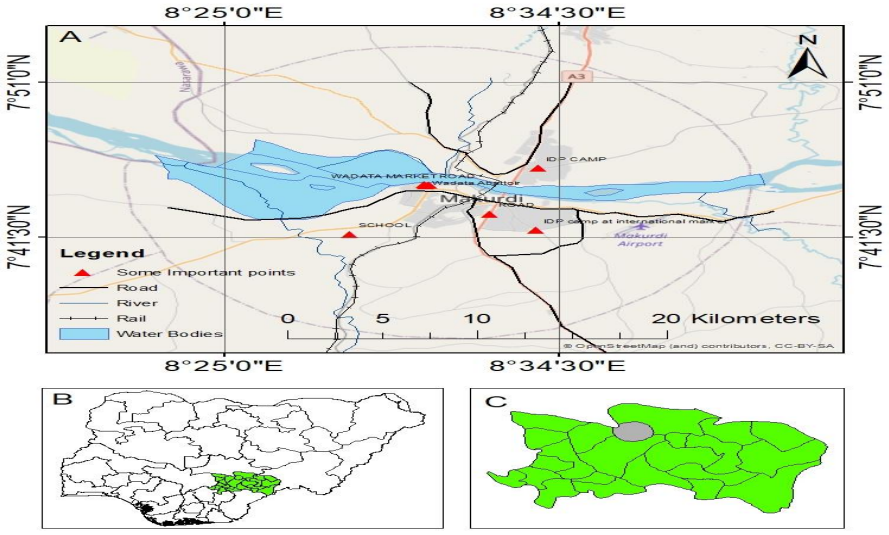
Across Africa, adaptation planning requires attention to local environmental conditions, institutional capacity, and the distribution of project costs and benefits. Where decisions are centralized and local knowledge is excluded, interventions may fail to reflect the experiences of the communities they are intended to protect (Niang et al., 2024; Bertana et al., 2022). In Nigeria, flood-control and drainage infrastructure are important responses to recurrent flooding, particularly in expanding urban areas. Inadequate planning, limited participation, and poor maintenance can nevertheless reduce the benefits of such interventions and create additional risks (Ekhuemelo & Adole, 2024; Mudege et al., 2021). Makurdi, the capital of Benue State, is situated along the River Benue and contains low-lying floodplain areas exposed to seasonal inundation. Previous studies have identified flood risk within the metropolis and linked urban growth with increasing pressure on the urban environment (Abah, 2013; Shabu et al., 2021). The Idye Basin Erosion Control and Hydraulic Drainage Project was implemented to reduce flooding and erosion and protect nearby communities, infrastructure, and livelihoods. However, residents have reported concerns about drainage overflow, inadequate channel capacity, interrupted drainage connections, waste accumulation, and maintenance. Such concerns raise questions about whether the intervention has reduced vulnerability equitably or produced unintended effects for some residents. Maladaptation research emphasizes that infrastructure may reduce one form of risk while transferring or reproducing vulnerability elsewhere (Okon et al., 2022; Schipper, 2020). This has been the experiences of communities located within and around the project area of influence. Despite this, existing research on climate change adaptation in Makurdi and other parts of Benue State has primarily examined maladaptation within the agri-food system, particularly rice value chains (see Terdoo, 2019, 2024), as well as flood risks (Ikyapa et al., 2020; Awopetu et al., 2013). However, limited attention has been paid to maladaptation associated with infrastructure designed to mitigate flooding and erosion. A key gap in the existing literature is the lack of robust, focused, and multidimensional assessments of maladaptation associated with ongoing and recently implemented climate change adaptation infrastructure projects, such as the Idye Basin project.

To address this gap, this study assesses the maladaptive outcomes of the Idye Basin Erosion Control and Hydraulic Drainage Project in Makurdi, Benue State, Nigeria, with the aim of drawing lessons for climate change adaptation planning and implementation. The project, a climate change adaptation intervention initiated and implemented by the Federal Government of Nigeria through the Ecological Project Office in 2018, initially covered approximately 3.5 km before being extended by about 1.2 km through N-HYPPADEC. It was commissioned in 2024 and was intended to reduce seasonal flooding and erosion while protecting communities around Idye, Nyiman, Achusa, Wadata, Wurukum, Gyado Villa, and Akpehe.

This study is expected to contribute to knowledge by providing a multidimensional assessment of the extent of maladaptation associated with climate change adaptation infrastructure interventions, with particular attention to governance, social equity, vulnerability creation, spatial risk transfer, and long-term sustainability. In doing so, it seeks to advance understanding of the unintended consequences of adaptation interventions in low-income settings such as Nigeria.

2. Study Area

Makurdi, the capital city of Benue State, is located in the North Central geopolitical zone of Nigeria, within the Middle Belt region. It lies between latitudes 7°00'N and 7°45'N and longitudes 8°00'E and 8°32'E, encompassing an area of approximately 937.4 km² for the Makurdi Local Government Area (LGA) (Shabu *et al*., 2021). The LGA covers approximately 800 km² and lies within the Benue Plains. It is bounded by Nasarawa State to the north-west, Guma LGA to the north-east, and Gwer-East and Gwer-West LGAs to the south-east and south-west, respectively (Ministry of Lands, Survey and Solid Minerals, Benue State, 2026). Makurdi is underlain by sedimentary formations that include shale and sandstone. The area contains hydromorphic soils on recent alluvial deposits along the River Benue floodplain and tropical ferruginous soils farther from the floodplain (Abaa, 2004; Nyagba, 1995). The alluvial lowlands support activities such as market gardening but are also exposed to seasonal flooding. Urban expansion and the spread of impervious surfaces increase surface runoff and place additional pressure on natural drainage routes. The River Benue is the principal drainage channel and flows from east to west, dividing the metropolis into northern and southern sections. Other drainage channels and tributaries include Rivers Ake, Abum, Aso, Baa, and Kpege in the north, and Rivers Mu, Bar, and Uwurudu in the south. The Uwurudu marsh is also associated with seasonal flooding. Makurdi experiences a tropical wet-and-dry climate, with most rainfall occurring between April and October and a reported average annual rainfall of about 1,300 mm (Tyubee, 2006a). These hydrological and urban conditions make the performance of flood-control and drainage infrastructure important to residents and economic activities in the area. The local economy includes commerce, public and private services, small-scale farming, market gardening, and fishing (Tyubee, 2008).



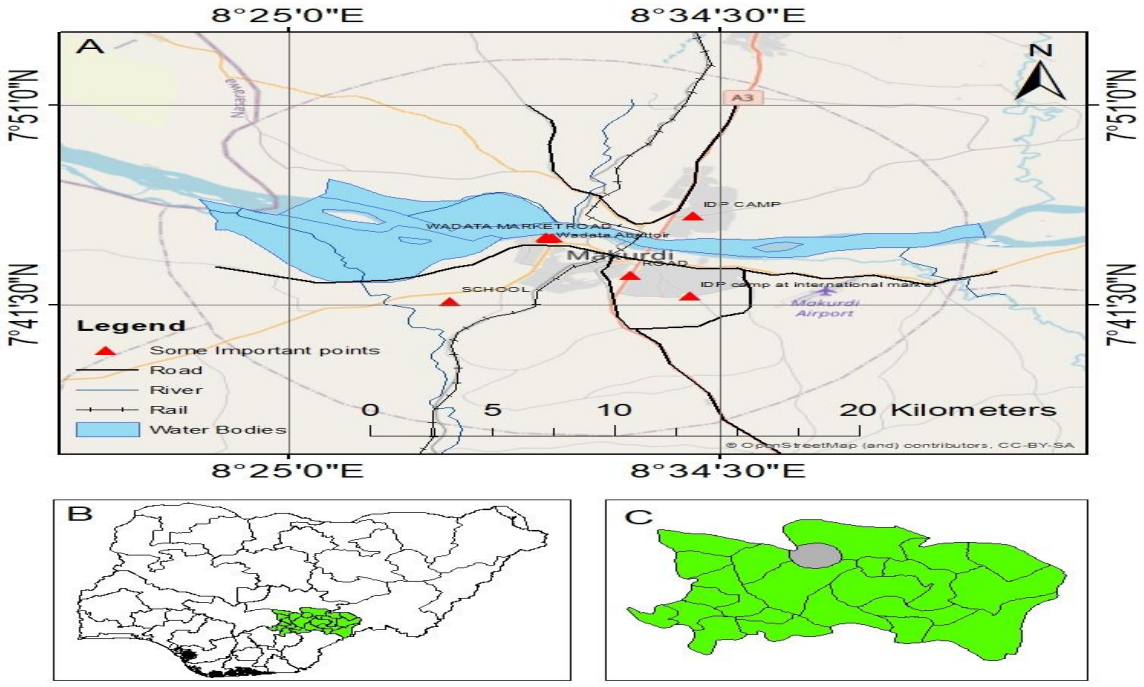


Figure 1: Makurdi showing study area
Source: Abasha Geospatial Technology (2025)

3. Methods

3.1 Research Design and Project Selection

A cross-sectional research design was combined with a case-study approach using quantitative and qualitative methods. The cross-sectional component enabled the collection of household information from residents in communities within the influence area of the Idye project, while the case-study approach supported an examination of the project's implementation, perceived effects, and maladaptive outcomes. A reconnaissance survey was conducted on 7 March 2026 to identify the project location, observe its condition, consult relevant stakeholders, review available project information, and determine the data required for the assessment.

The Idye Basin Erosion Control and Hydraulic Drainage Project was selected because it was designed as a flood- and erosion-risk reduction intervention and had been implemented for more than two years. Information available to the study indicated that the project was awarded by the Federal Executive Council on 4 May 2018, with an initial statutory completion period of 48 weeks. The first phase covered approximately 3.5 km and was subsequently extended by about 1.2 km through N-HYPPADEC. The project was commissioned in 2024. Its stated purposes were to reduce recurrent flooding, stabilize areas affected by erosion, and protect the assets and livelihoods of nearby communities. The project's area of influence includes Idye, Nyiman, Achusa, Wadata, Wurukum, Gyado Villa, and Akpehe.

3.2 Population, Sample Size and Sampling

The study population comprised adult residents in communities within the project's area of influence and key informants with relevant knowledge of the project. The 2006 national population

census recorded 300,377 residents in Makurdi LGA (National Population Commission, 2006). For sample-size estimation, this figure was projected to 2026 using an annual growth rate of 2.3%, giving an estimated LGA population of approximately 473,346. A separate population count for the project's immediate influence area was not available; therefore, the projected LGA population was used as the population base for the sample-size calculation. Yamane's (1967) formula was applied at a 5% margin of error:

$$n = N / [1 + N(e^2)]$$

where n = sample size; N = projected population (473,346); and e = margin of error (0.05). Substituting these values gives $n = 473,346 / [1 + 473,346(0.05^2)] \approx 399.66$. The sample was therefore rounded to 400 respondents.

A multi-stage sampling procedure was used. Makurdi LGA was purposively selected because of its exposure to flooding and the presence of the Idye intervention. Communities within the project's area of influence were selected for the household survey, and households were selected systematically to distribute respondents across the study area. Key informants, including community leaders, long-term residents, relevant government personnel, and individuals with direct knowledge of the project, were selected purposively. Twelve key informant interviews were conducted.

3.3 Data Collection

Primary data were collected through a structured household questionnaire, semi-structured key informant interviews, and direct field observation. The questionnaire captured respondents' socio-demographic characteristics, experience of project-related effects, community consultation, incorporation of local knowledge, perceived transparency, asset and livelihood impacts, and views on the causes of project underperformance. Questionnaires were administered face-to-face by trained research assistants using Google Forms. The instrument was reviewed by an expert for content validity and pilot-tested in a non-sampled ward. Cronbach's alpha was used to assess the internal consistency of the scale items, with a value above 0.70 adopted as the acceptable threshold. The 12 semi-structured interviews captured the views of community leaders, long-term residents, and project officials. Interviews were recorded, transcribed, and used to explain and contextualize the quantitative findings. Secondary information was obtained from relevant project and administrative documents, published research, and institutional materials. Field observations focused on the condition of drainage channels, their continuity and outlet connections, blockage by refuse or sediment, and evidence of overflow or localized flooding.

3.4 Data Analysis

Quantitative data were analysed using frequencies, percentages, means, and standard deviations. The extent of maladaptation was assessed using a modified Multi-Criteria Index-Based Evaluation (MCIBE) framework informed by multi-criteria assessment and maladaptation literature (Haque, 2016; Bagdanavičiūtė et al., 2018; Juhola et al., 2016; Juhola & Käyhkö, 2023; Bajdor & Korpysa, 2025). The framework assessed five dimensions: (i) governance deficit, measured through community consultation, incorporation of local knowledge, and transparency; (ii) vulnerability creation or introduction of new risks; (iii) spatial risk transfer; (iv) sustainability and temporal lock-in; and (v) equity and distributional effects, including social inequity and livelihood loss. The dimensions and example indicators are presented in Table 1.

Table 1. Maladaptation dimensions and assessment indicators

Governance deficit	Community consultation; incorporation of local needs and knowledge; transparency of implementation	0–3
Vulnerability creation	Changes in exposure to flooding and introduction of new risks	0–3
Spatial risk transfer	Evidence that flood or erosion risks are shifted to other locations or groups	0–3
Sustainability and lock-in	Persistence or reversibility of negative effects and constraints on future adaptation	0–3
Equity and distributional effects	Distribution of project benefits and burdens; livelihood disruption or loss	0–3

Source: Adapted from Juhola et al. (2016), Haque (2016), and the study's questionnaire framework.

Questionnaire responses for maladaptation indicators were coded on a four-point ordinal scale: 0 = no/never, 1 = low/rarely, 2 = moderate/sometimes, and 3 = high/frequently. Higher values indicated greater maladaptation, except for positively worded governance items, for which higher values indicated better governance and were reverse-scored. The mean score for each indicator was calculated as $\bar{x} = \Sigma x_i/N$, where x_i is an individual response score and N is the number of valid responses for that indicator. Direct maladaptation indicators were normalized as $MI_i = \bar{x}_i/3$, while the governance deficit score was calculated as $MI^g = (3 - \bar{x}^g)/3$. The reported social inequity and livelihood-loss score was treated as a composite indicator and normalized to the same 0–1 range. The overall index was calculated as the arithmetic mean of the five-dimension scores: Aggregate $MI = \Sigma MI_i/5$. The normalized scores were interpreted using the study's thresholds: 0.00–0.32 = low maladaptation; 0.33–0.65 = moderate maladaptation; and 0.66–1.00 = high maladaptation. Qualitative information from interviews and field observations was analysed using thematic content analysis. Interview transcripts and field notes were coded around recurring issues relating to project design, drainage capacity, outlet connectivity, maintenance, waste accumulation, community participation, and unintended social and environmental effects. Quantitative and qualitative findings were triangulated to provide an integrated interpretation of the project's maladaptive outcomes.

4. Results and Discussion

4.1 Extent of Maladaptation Associated with the Idye Basin Project

The extent of maladaptation associated with the Idye Basin Erosion Control and Hydraulic Drainage Project was assessed using five dimensions derived from the household questionnaire. The mean scores and normalized Maladaptation Index (MI) values are presented in Table 2. The Governance Deficit Index recorded the highest maladaptation score (MI = 0.580), followed by the Social Inequity and Livelihood Loss Index (MI = 0.355). Both dimensions fell within the moderate maladaptation category. Vulnerability creation (MI = 0.201), spatial risk transfer (MI = 0.191), and sustainability and lock-in/temporal maladaptation (MI = 0.214) fell within the low maladaptation category.

Table 2. Mean scores and maladaptation indices for the Idye Basin project

Governance Deficit Index	1.261	0.580	Moderate
Vulnerability Creation / New Risk Introduction	0.602	0.201	Low
Spatial Risk Transfer	0.574	0.191	Low
Sustainability and Lock-in / Temporal Maladaptation	0.642	0.214	Low
Equity and Distributional Effects / Social Inequity and Livelihood Loss	1.065	0.355	Moderate

Source: Fieldwork (2026). MI = Maladaptation Index.

The aggregate index was calculated as (0.580 + 0.201 + 0.191 + 0.214 + 0.355)/5 = 0.308. Based on the adopted classification, the aggregate score indicates a low overall level of maladaptation. However, the aggregate value should not obscure the moderate scores recorded for governance deficit and social inequity. The result suggests that the project's overall maladaptation score is relatively low, while important institutional and distributional weaknesses remain. This finding is consistent with the argument that adaptation interventions may address a physical hazard while still producing uneven outcomes through governance failures or unequal exposure to costs and benefits (Magnan et al., 2016; Schipper, 2020; Bertana et al., 2022). It also illustrates why maladaptation assessment should examine individual dimensions rather than relying only on an aggregate score (Juhola & Käyhkö, 2023).

4.2 Community Consultation and Integration of Local Knowledge

The results show a pronounced gap in community consultation. As presented in Table 3, 198 respondents (49.5%) reported that there had been no consultation during project conceptualization or implementation. A further 131 respondents (32.8%) reported a low level of consultation, while 60 (15.0%) indicated a moderate level. Only 11 respondents (2.8%) reported a high level of consultation. These responses suggest that a substantial proportion of residents had limited opportunities to contribute to decisions about the project.

Table 3. Community consultation and incorporation of local needs

0	198	49.50	135	33.75
1	131	32.80	189	47.40
2	60	15.00	70	17.50
3	11	2.80	6	1.50
Total	400	100.00	400	100.00

Source: Fieldwork (2026). Percentages may not total exactly because of rounding.

The integration of local needs also appears limited. A total of 135 respondents (33.75%) reported that local needs were not incorporated, while 189 (47.40%) reported a low level of incorporation. Only 6 respondents (1.50%) reported a high level. Taken together, the direct consultation and local-needs responses indicate that meaningful participation was limited for many residents. This is important because local knowledge can help identify seasonal flow paths, recurrent flood locations, and community-specific needs that may not be fully captured in engineering assessments. The finding supports the argument that spatial analysis and stakeholder knowledge are important in avoiding maladaptation (Chi et al., 2021), while institutional barriers and unequal participation can weaken adaptation outcomes (Bertana et al., 2022).

4.3 Perceived Transparency of Project Implementation

Respondents' ratings of project transparency are summarized in Table 4. A total of 282 respondents (70.5%) rated implementation as very or fully transparent, while 96 (24.0%) described it as moderately transparent. Fifteen respondents (3.8%) rated it as slightly transparent, and 7 (1.8%) considered it not transparent at all.

Table 4. Respondents' ratings of project implementation transparency

0	Not transparent at all	7	1.8
1	Slightly transparent	15	3.8
2	Moderately transparent	96	24.0
3	Very/fully transparent	282	70.5
Total		400	100.0

Source: Fieldwork (2026).

The high proportion of positive transparency ratings contrasts with the substantial proportion of respondents who reported no consultation. This suggests that perceived transparency and participation were not necessarily experienced in the same way: residents may have considered some aspects of implementation visible while having little influence over project decisions. Transparency in project delivery should therefore be accompanied by meaningful opportunities for participation and accountability. The distinction is relevant to maladaptation because

institutional arrangements can shape who influences decisions and how project benefits and burdens are distributed (Barnett & O'Neill, 2010; Bertana et al., 2022).

4.4 Perceived Operational and Structural Drivers of Project Underperformance

Respondents identified several structural and operational concerns affecting the performance of the drainage infrastructure. The most frequently reported concern was inadequate channel size or width (17.0%), followed by poor or insufficient maintenance (15.5%) and the need for expansion or extension of the drainage network (14.5%). Refuse dumping and waste blockage accounted for 11.3%. Other reported concerns included low channel height (9.8%), poor construction quality (7.0%), lack of community consultation (5.5%), overflow associated with insufficient capacity (4.5%), and inadequate desilting or cleaning (3.8%). Miscellaneous responses accounted for 11.3%. These responses indicate that perceived underperformance involves both infrastructure design and post-construction maintenance.

Table 5. Respondents' perceptions of operational and structural problems

Drainage too small or not wide enough	17.0
Poor or inadequate maintenance	15.5
Drainage expansion or extension required	14.5
Refuse dumping or waste blocking drainage	11.3
Drainage height too low	9.8
Poor construction or low quality	7.0
Lack of community consultation	5.5
Overflow due to insufficient capacity	4.5
No proper desilting or cleaning	3.8
Other responses	11.3

Source: Fieldwork (2026). Percentages are reported as supplied in the study material and may vary slightly from 100% because of rounding.

The concerns about channel dimensions and extension point to the need to assess whether the infrastructure can convey runoff under the conditions experienced in the catchment. The study's survey results represent respondents' perceptions and do not, on their own, establish the hydraulic capacity of the channels; a technical assessment would be required to confirm their adequacy. Similarly, the reported maintenance and waste problems indicate that the benefits of drainage infrastructure depend not only on initial construction but also on regular operation and upkeep. This interpretation is consistent with the wider maladaptation literature, which cautions that an

intervention may fail to reduce vulnerability where its design and implementation do not account for changing environmental conditions and the needs of affected groups (Barnett & O'Neill, 2010; Eriksen et al., 2021; Schipper, 2020).

4.5 Qualitative Evidence on Maladaptive Outcomes

The key informant interviews and field observations provided further explanation of the quantitative findings. Four recurring themes emerged: inadequate drainage capacity, incomplete connection to a downstream outlet, maintenance and solid-waste problems, and limited community consultation.

4.5.1 Inadequate Drainage Size and Capacity

Residents repeatedly described the channels as too narrow or shallow to accommodate runoff during periods of heavy rainfall. They associated insufficient channel dimensions with localized overflow and the movement of floodwater into nearby properties. One resident explained:

"The concrete gutters they built are simply too shallow and narrow for the volume of water that comes down during heavy rains. Every August, the water overflows the edges within twenty minutes of rainfall because the channel is too small to contain the flow."

This account reinforces the survey finding that channel size was the most frequently mentioned structural concern. While residents' observations provide important evidence of experienced performance, the actual conveyance capacity would need to be established through engineering measurements and hydrological analysis. The distinction between intended protection and experienced outcomes reflects the concern that adaptation infrastructure may not reduce vulnerability when it is poorly matched to local conditions (Eriksen et al., 2021; Schipper, 2020).

4.5.2 Incomplete Drainage Connection and Downstream Discharge

Some residents viewed the drainage network as incomplete because sections were perceived to terminate without a functional connection to a safe receiving channel. This concern was expressed by a farmer living near the reported terminal point of the construction:

"They built a drain that stops abruptly. The engineering design makes no sense because it does not empty into any natural river. You must extend the drainage beyond Mobile Barrack Junction and link it directly to the main River Benue bank, otherwise, you are just collecting water from one neighbourhood and dumping it into another."

The interview indicates a community perception that the drainage system may not provide a continuous and safe outlet. This concern is relevant to spatial risk transfer, one of the dimensions of maladaptation, because drainage interventions can move water-related risks from one location to another if downstream effects are not considered. However, the interview evidence alone does not verify the technical condition of the terminal outlet. A detailed assessment of channel continuity, gradients, outfall condition, and downstream effects is therefore necessary. This interpretation is consistent with studies emphasizing the need to assess the spatial consequences of adaptation interventions (Magnan et al., 2016; Chi et al., 2021).

4.5.3 Maintenance Deficits and Solid-Waste Accumulation

Interview responses linked poor maintenance with the accumulation of sediment, vegetation, and solid waste in drainage channels and culverts. Residents reported that a lack of regular desilting

and waste collection reduced the capacity of the infrastructure. A trader operating near the drainage system stated:

"The government abandoned the project immediately after the contractor left. There is no proper desilting or cleaning scheduled. Now, because there are no trash bins provided, people use the drainage as a dumpsite. The waste blocks the culverts completely, and when the floods come, the water has nowhere to go but into our shops."

This account is consistent with the survey findings on maintenance and refuse blockage. It suggests that the long-term performance of the project depends on clearly assigned maintenance responsibilities and supporting municipal waste-management services. The result also demonstrates that flood-control infrastructure cannot be considered independently of the social and institutional systems required to operate and maintain it (Eriksen et al., 2021; Schipper, 2020).

4.5.4 Limited Community Consultation and Participatory Governance

The interviews also revealed that some residents felt excluded from the planning and design stages. Respondents argued that local knowledge of terrain, seasonal flow paths, and locations that repeatedly experience flooding could have improved project planning. A community leader summarized this concern as follows:

"The community was not consulted at any stage of this project. The engineers just turned up with equipment and began digging based on a drawing they made in an office. If they had asked us, we would have shown them the actual environmental terrain and the seasonal flood tracks that water has followed for thirty years."

This account provides qualitative context for the high proportion of respondents who reported no consultation and the moderate governance deficit index. It also illustrates how excluding local knowledge can create a mismatch between project design and the lived experience of residents. The finding supports the view that adaptation planning should address power relations and institutional barriers, not only the technical dimensions of infrastructure (Bertana et al., 2022; Juhola & Käyhkö, 2023). Taken together, the qualitative findings suggest that residents' concerns are not limited to the existence of drainage infrastructure. They relate to channel dimensions, network continuity, maintenance after construction, solid-waste accumulation, and the extent to which local knowledge informed project decisions. These conditions provide context for the moderate governance and social-equity scores in the MCIBE assessment. They also show how infrastructure designed to reduce flood risk may sustain localized vulnerability when its design, operation, and governance are not adequately aligned with community needs. This reflects the central concern in maladaptation research that an intervention can pursue a legitimate adaptation objective while still generating unintended social or environmental consequences (Barnett & O'Neill, 2010; Magnan et al., 2016; Schipper, 2020).

5. Conclusion

This study assessed the extent of maladaptation associated with the Idye Basin Erosion Control and Hydraulic Drainage Project in Makurdi, Benue State. The aggregate Maladaptation Index of 0.308 falls within the low maladaptation category. However, this aggregate score masks moderate levels of maladaptation in governance and social equity, with index values of 0.580 and 0.355, respectively. The findings further reveal that limited community consultation, inadequate consideration of local needs, concerns about drainage capacity, incomplete drainage connections, poor maintenance, and waste accumulation are among the major challenges reported by residents.

Although the project represents a significant structural response to recurrent flooding and erosion, its long-term effectiveness depends on more than physical infrastructure development. It also requires inclusive governance, reliable maintenance, and drainage infrastructure that adequately responds to local hydrological conditions. The study therefore concludes that, despite its low overall maladaptation score, the project exhibits notable governance and distributional weaknesses that require urgent attention. The study recommends that relevant stakeholders incorporate maladaptation screening into the appraisal, implementation, and monitoring of flood-control projects while strengthening governance arrangements to enhance the climate resilience and long-term sustainability of infrastructure interventions. The MCIBE framework applied in this study can complement relevant national screening instruments by providing a systematic approach to identifying potential vulnerability creation, spatial and temporal risk transfer, social inequity, and governance deficiencies both before and after project implementation.

Authors' Contributions

Auwal Aliyu Dandare, Fanen Terdoo, Johnson Ofega Mage, and Alphonsus Nyajo conducted this study. Auwal Aliyu Dandare carried out the fieldwork and data analysis, while Fanen Terdoo, Johnson Ofega Mage and Alphonsus Nyajo designed and supervised the study. Both authors read and approved the final manuscript.

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