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Determining Priority Strategies for Meteorological Drought Disaster Mitigation in Bima Regency, West Nusa Tenggara

Tanti Prasetya Prima Dewi[1], Yohana Noradika Maharani[1*], Johan Danu Prasetya[1], Eko Teguh Paripurno[1], Eko Murdiyanto[1]

[1] Master of Disaster Management Study Program,Universitas Pembangunan Nasional "Veteran" Yogyakarta, Indonesia
*Corresponding author. Email: yohananm@upnyk.ac.id

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Abstract

Drought is a recurring disaster with increasing frequency in Bima Regency, Indonesia. Budget efficiency measures have reduced the number of drought mitigation programs and beneficiaries, limiting the local government's ability to implement all proposed mitigation strategies simultaneously. This study aims to establish a priority-based decision-making framework for implementing meteorological drought mitigation strategies, thereby supporting more effective and targeted disaster risk reduction. The Analytic Hierarchy Process (AHP) was employed using Expert Choice 11 to evaluate mitigation priorities based on a hierarchical structure consisting of objectives, criteria, sub-criteria, and alternatives. Data were collected from 30 experts representing the Regional Disaster Management Agency (BPBD), the Meteorological, Climatological, and Geophysical Agency (BMKG), the Agriculture Office, the Public Works and Spatial Planning Office (PUPR), and drought-affected communities. The results indicate that technical feasibility and effectiveness are the most influential criteria in determining mitigation priorities. The final AHP synthesis ranks education and public awareness programs as the highest priority (17.8%), followed by groundwater well drilling and water pumping systems (16.9%), and rehabilitation and optimization of irrigation networks (16.7%). These findings provide a practical basis for integrating prioritized drought mitigation strategies into regional development planning, including the Regional Government Work Plan (RKPD), Strategic Plans (Renstra), the Regional Development Information System (SIPD), and the Disaster Contingency Plan (Renkon), ensuring more sustainable and effective meteorological drought risk management in Bima Regency.

Keywords: Analytic Hierarchy Process (AHP), meteorological drought, Drought mitigation, disaster risk reduction, priority analysis

1. Introduction

Drought is classified as a slow-onset natural disaster that develops gradually and produces widespread, multidimensional impacts across the economic, social, health, and education sectors (Sinambela, 2021). Disaster records from the Indonesian Disaster Data and Information (DIBI)-BNPB for the period 2008–2025 in West Nusa Tenggara Province (NTB) indicate that Pulau Sumbawa, particularly Bima Regency, has experienced drought more frequently than other areas. Over the past 18 years, Bima Regency has recorded up to 19 drought events, affecting approximately 760,868 people. Drought has become one of the most recurrent disasters in the region. According to official data published on the DIBI-BNPB website, the number of drought events increased to six occurrences in 2025. Droughts in Bima Regency generally occur during March, April, June, July, August, September, and October (dibi.bnpb.go.id, 2025).

The extent of drought impacts in Bima Regency has shown a significant upward trend. While previous drought events affected only seven villages, by November 2024 the number of affected villages had increased to 25, distributed across 15 of the 18 sub-districts in Bima Regency. The highest severity was recorded in Palibelo Regency, where eight villages experienced the most severe drought conditions (bimanews.id, 2024). Furthermore, the *Indonesia Climate and Air Quality Report 2024*, published by the Deputy for Climatology at BMKG, reported that the longest Consecutive Dry Days (CDD) during 2024 occurred in Sape District, Bima Regency, West Nusa Tenggara Province, reaching 214 consecutive days without rainfall.

The issuance of Presidential Instruction of the Republic of Indonesia Number 1 of 2025 concerning expenditure efficiency in the implementation of the State Budget (APBN) and Regional Budget (APBD) for Fiscal Year 2025, together with Decree of the Minister of Finance of the Republic of Indonesia Number 29 of 2025 regarding adjustments to the allocation of Transfer to Regions (TKD), indirectly resulted in changes to the regional transfer allocation for Bima Regency. These policy adjustments have consequently influenced disaster mitigation priorities. Interviews conducted with experts from BPBD and Dinas PUPR revealed that budget efficiency measures have reduced both the number of drought mitigation programs and the number of beneficiaries. Given these financial and resource constraints, the government of Bima Regency can no longer implement all proposed mitigation strategies simultaneously. Therefore, an objective and systematic decision-making mechanism is required to identify mitigation measures that are effective, efficient, and capable of delivering the greatest benefits to the community.

To address this challenge, this study proposes the identification of priority mitigation strategies for drought disasters, with a particular focus on meteorological drought, as it serves as the primary indicator for determining drought emergency status in Indonesia. A region may be declared under drought emergency conditions once the meteorological drought indicator (meteorological drought early warning) has been met, even when agricultural or socio-economic drought indicators have not yet been observed. This highlights the critical role of meteorological drought as the initial trigger that subsequently affects agricultural production and socio-economic conditions. Consequently, appropriate mitigation measures are essential to prevent the escalation and spatial expansion of drought impacts. The proposed mitigation strategies include both structural and non-structural measures, evaluated based on relevant criteria, including technical feasibility and effectiveness; economic, social, institutional, and implementation; as well as environmental considerations.

To address these multi-criteria decision-making problem, this study adopts the Analytic Hierarchy Process (AHP). AHP enables complex decision problems to be decomposed into a hierarchical structure consisting of the overall objective, evaluation criteria, sub-criteria, and alternative strategies, thereby facilitating a systematic and transparent decision-making process. Furthermore, the comparative study conducted by Meiga and Purnama (2021) demonstrated that AHP provides more accurate and reliable results than other multi-criteria decision-making methods.

Several drought prevention and mitigation measures for disaster risk reduction have been outlined in the Disaster Risk Assessment (KRB) Bima Regency 2024–2029. However, no previous study has systematically prioritized these mitigation strategies using a multi-dimensional evaluation framework involving expert participation through a structured decision-making approach such as AHP. This study aims to address the gap between current recommendations for meteorological drought mitigation and the necessity for a systematic mechanism to prioritize implementation. The findings are expected to support more effective, evidence-based, and targeted risk reduction for meteorological drought disasters in Bima Regency.

2. Research Method

This study employed a quantitative descriptive-analytical research design. The quantitative approach was used to collect data based on expert judgments through pairwise comparison questionnaires using the Saaty scale within the Analytic Hierarchy Process (AHP) framework. The descriptive-analytical approach was applied to describe, classify, and analyze the relative importance of each criterion, sub-criterion, and alternative, as well as to determine the priority ranking of drought mitigation strategies based on the AHP-derived weights.

The study was conducted from September 2025 to April 2026 in Bima Regency, West Nusa Tenggara (NTB) Province, Indonesia. Data collection and analysis focused on sub-districts that have historically been classified as high drought-risk areas, namely Ambalawi, Bolo, Donggo, Lambitu, Palibelo, Sape, Soromandi, Wawo, and Woha subdistricts. The mitigation alternatives evaluated were limited to structural and non-structural measures identified in the Bima Regency Disaster Risk Study (KRB) 2024–2029, expert interviews, and an extensive literature review. The AHP method was used to determine the priority ranking of mitigation strategies based on assessments provided by key stakeholders, including BPBD, PUPR Service, Agriculture Service, BMKG, and representatives of drought-affected communities. The evaluation criteria encompass technical feasibility and effectiveness, economic, social, institutional and implementation, and environmental aspects.

The pairwise comparison judgments obtained from 30 respondents using the Saaty scale (Table 1) were aggregated using the geometric mean in Microsoft Excel 2021 to generate a group decision matrix. The aggregated matrix was subsequently analyzed using Expert Choice 11 to calculate the priority weights and the Consistency Ratio (CR). The consistency of respondents' judgments was considered acceptable when the CR value was ≤ 0.10, indicating that the pairwise comparisons were sufficiently consistent for decision-making.

Table 1. Value Scales Compared Saaty Pairs

Importance Scale	Definition	Description
1	Equal importance *(Equal)*	Two elements contribute equally to the objective.
2	Between equal and moderate importance *(Moderate)*	A condition where there is some compromise between two choices.
3	Moderate importance *(Moderate)*	Experience and judgment slightly favor one element over another.
4	Between moderate and strong importance *(Moderate to Strong)*	A condition where there is compromise between two choices.
5	Strong importance *(Strong)*	Experience and judgment strongly favor one element over another.
6	Between strong and very strong importance *(Strong to Very Strong)*	A condition where there is compromise between two choices.
7	Very strong importance *(Very Strong)*	One element is strongly favored and its dominance is demonstrated in practice.
8	Between very strong and extreme importance *(Very Strong to Extreme)*	A condition where there is compromise between two choices.
9	Extreme importance *(Extreme)*	The evidence favoring one element over another is of the highest possible order of affirmation.
Reciprocal	Reciprocal value	If element x has a value assigned over element y, then element y has the reciprocal value when compared with element x.

3. Results and Discussion

3.1 Analysis of Main Criteria Weights

The results of the weighting criteria show that technical and effectiveness are prioritized in determining meteorological drought disaster mitigation strategies in Bima Regency. Respondents' assessment of the priority weight of technical criteria and effectiveness reached 31.6% (Figure 1). The institutional and implementation priority weight is 29.2%, social criteria with a priority weight of 16.7%, economic criteria with a priority weight of 13.7% and environmental criteria with a priority weight of 8.7%.

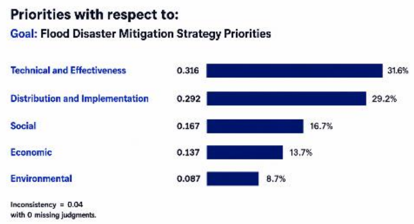

Figure 1. Priority Weight between Criteria in Expert Choice Software 11

3.2 Sub-Criteria Weight Analysis

The sub-criteria are details of each main criterion. The results of processing and analyzing data from each sub-criteria are as follows:

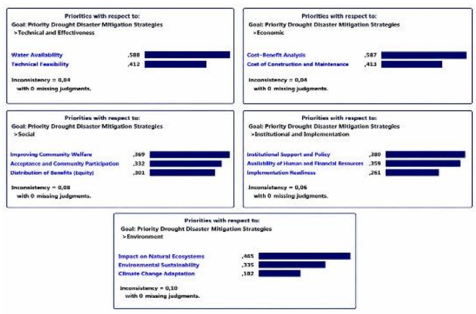

Figure 2. Priority Weight between Sub-Criteria in Expert Choice 1 Software

The weighting results for the technical and effectiveness sub-criteria indicate that respondents' primary concern was the mitigation strategy's ability to increase water availability in both the short and long term, with water security being a priority, with a weighting of 55.8%. In the economic sub-criteria, respondents focused on the costs required for the development, procurement, or initial implementation of the mitigation strategy, with an initial investment priority weighting of 58.7%. The mitigation strategy's ability to reduce the potential for social conflict over water resources was a primary focus for respondents in the social sub-criteria, with a priority weighting of 36.0%.

The weighting results for the institutional and implementation sub-criteria indicate that policy/regulatory support had a priority weighting of 38.0. This indicates that the level of involvement and synchronization between relevant agencies or institutions in efforts to mitigate the impact of drought is a primary focus for respondents. The environmental sub-criterion was primarily focused on adaptation to climate change, with a priority weighting of 46.5. This relates to the extent to which mitigation strategies remain effective during the longer-than-usual dry season in Bima Regency.

3.3 Main Criteria Weight Analysis

The consistency ratio value for all alternatives compared to the sub-criteria is <0.1. This means that the data provided by respondents is consistent and valid, so it can be used for subsequent data processing, namely weighting the importance of each alternative across all sub-criteria. The selected alternatives are shown in the hierarchical structure image below.

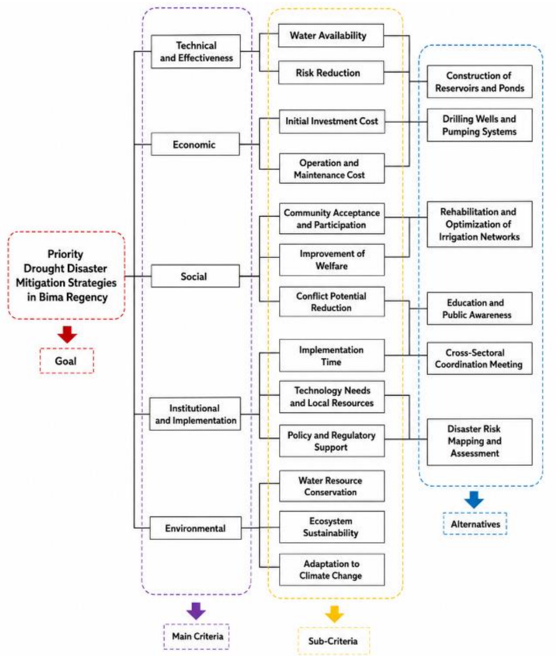

Figure 3. Hierarchy of determining priorities for drought disaster mitigation strategies

The priority weights of the global synthesis results for alternative strategies are evenly distributed, as shown in Figure 4. Education and outreach ranked first with a priority weight of 17.8%. The second-priority strategic alternative chosen by respondents was well drilling and pumping with a priority weight of 16.9%. Rehabilitation and optimization of irrigation networks ranked third with a weight of 16.7%. Cross-sectoral coordination meetings and disaster risk mapping had the same priority weight value, at 16.3%. Construction of reservoirs and dams had a priority weight value of 16.0%.

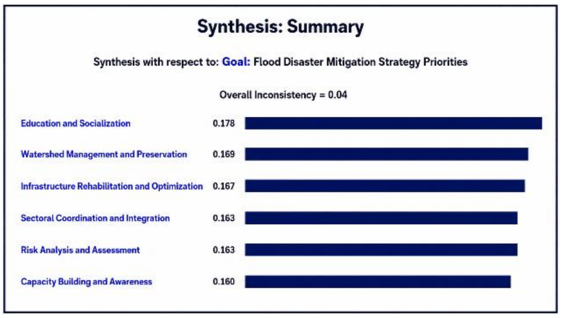

Figure 4. Global Synthesis Summary of Alternative Strategy Priority Order

In the context of Bima Regency, which faces budget efficiency pressures (Presidential Instruction No. 1 of 2025), expert respondents consciously prioritized responsive strategies with immediate short-term impact to maintain social stability and public health. Within the Sendai Framework, this approach is part of disaster risk management, integrating preparedness and response as a foundation before moving on to long-term structural investments. Therefore, mitigation in this study is operationalized as an umbrella risk reduction strategy encompassing anticipatory measures, emergency response, and ongoing prevention.

The policy recommendations in this study are comprehensively structured within the framework of four pillars of disaster governance to ensure the sustainability and effectiveness of meteorological drought mitigation in Bima Regency. These four pillars are:

1. **Regulatory Governance**

The results of this study indicate that the institutional and implementation criteria ranked second, with a weighting of 29.2%, and one non-structural alternative, cross-sectoral coordination meetings, ranked fourth with a weighting of 16.3%. This implies the need for strengthening regulatory governance specifically for meteorological drought risks through the development of Regent Regulations or specific Standard Operating Procedures (SOPs) that regulate measurable drought mitigation and preparedness mechanisms.

These regulations should include operational indicators based on Rainless Days (HTH) and BMKG early warning information as triggers for local government action.

Local governments should also adopt reward and punishment mechanisms, such as providing incentives to villages, farmer groups, or communities that actively implement water resource conservation, build Rainwater Reservoirs (PAH), rehabilitate water catchment areas, and implement water-saving practices. Conversely, actions that have the potential to accelerate water resource and environmental degradation need to be controlled through appropriate monitoring and sanctions. Thus, regulatory governance not only functions as a control instrument, but also as a means of encouraging behavioral change towards more sustainable water resource management.

2. **Information & Data Governance**

The success of drought mitigation depends heavily on the government's ability to manage information and data in an integrated manner. Therefore, strengthening information governance is necessary through the integration of meteorological data (real-time meteorological early warning data) from the Meteorology, Climatology, and Geophysics Agency (BMKG), disaster data and action matrices from the Regional Disaster Management Agency (BPBD), water resources infrastructure data from the Public Works and Public Housing Agency (PUPR), and agricultural data from the Agriculture Agency into a single, accessible and shared information system.

Meteorological drought early warning information issued by the BMKG must be translated into clear operational actions by relevant regional agencies so that the mitigation process can be implemented more quickly and in a coordinated manner.

Furthermore, the Geographic Information System (GIS)-based risk mapping compiled in the Disaster Risk Assessment (KRB) must be transformed into a dynamic database (spatial decision support system) that underpins tactical decision-making, from identifying priority intervention areas, determining water infrastructure development locations, mapping vulnerable community groups, coordinating water delivery routes to high-risk areas such as Palibelo District, and implementing climate-based land use management.

With good data governance, the decision-making process will be more evidence-based (evidence-based policy) and able to reduce uncertainty in facing the risk of drought which is increasingly influenced by climate change.

3. **Financial Governance**

Funding governance is a strategic pillar in ensuring the sustainable implementation of drought mitigation policies. Bima Regency's current primary challenges are regional fiscal constraints and pressures on central government budget efficiency, potentially leading to a lower priority for non-structural mitigation programs.

In this context, the results of the AHP analysis serve as scientific justification (evidence-based policy) in the regional budgeting process. The Bima Regency Government is recommended to integrate the results of these prioritized mitigation strategies into the Regional Development Information System (SIPD) as the basis for preparing the Regional Work Plan (RKPD), Regional Work Plan (Renja OPD), and other budgeting documents.

The research results indicate that the alternative mitigation strategy that ranked first with a priority weight of 17.8% is education and outreach. This empirically proves that non-structural strategies are the most effective and efficient mitigation measures under current conditions. Therefore, budget allocation for community capacity-building programs such as public education, preparedness training, strengthening disaster-resilient villages, disaster simulations, and early warning systems needs to be prioritized. The Regional Government should use the AHP results as the basis for developing risk-based budgeting policies to ensure more effective, targeted, and risk-reducing mitigation spending.

4. Community-Based Governance

Based on research findings, education and outreach strategies are the top priority for drought mitigation in Bima Regency, with a weighting of 17.8%. This confirms that community empowerment is key to reducing drought risk. Therefore, the paradigm of disaster governance must shift from an approach that positions communities as recipients of aid to one that positions them as the primary subjects of risk management.

The Bima Regency Government needs to encourage the formation and activation of communities, such as the Disaster Risk Reduction Forum (FPRB), down to the village level, to serve as hubs for local preparedness. These groups can play a role in monitoring water source conditions, educating residents about water conservation, encouraging the use of Rainwater Harvesters (PAH), overseeing water resource conservation, and acting as information liaisons between the local government and the community. Education programs should also be directed at long-term behavioral changes, including water-saving practices, climate adaptation, and protection of water catchment areas.

From a modern governance perspective, communities are not merely policy recipients but active partners of the government in building regional resilience. Therefore, strengthening community-based capacity is a key element in building resilience and increasing Bima Regency's resilience to the threat of drought in a sustainable manner.The results of the AHP priority sequence analysis in this study can be integrated into the regional development planning system of Bima Regency as in the following document:

1. Bima Regency's 2026 Regional Government Work Plan (RKPD). In the RKPD document, the results of the AHP analysis are translated into annual priority programs that can be funded through the Regional Budget (APBD). Each government agency is responsible for alternative mitigation strategies according to its duties and authorities. Thus, the 2026 RKPD is no longer solely oriented towards physical development but also serves as an instrument for increasing community adaptive capacity to drought.
2. The Strategic Plan (Renstra) of the Regional Disaster Management Agency (BPBD) and the Public Works and Housing Agency (PUPR) for 2026-2031. Strategic targets that BPBD, as the primary coordinator of drought mitigation, should include increasing community and institutional capacity through education programs, outreach, simulations, and the establishment of disaster-resilient villages. Furthermore, there is a need to strengthen the early warning system based on data from the Meteorology, Climatology, and Geophysics Agency (BMKG) and BPBD. The PUPR Renstra should prioritize water security as an infrastructure development initiative. Programs that should be included include the construction of village reservoirs and medium-scale reservoirs, rehabilitation of irrigation networks, conservation of springs, increasing water storage capacity, and development of rainwater harvesting infrastructure. The main focus is not only adding new infrastructure, but also improving the reliability of water services in areas with high levels of vulnerability, based on the regional risk map.
3. Regional Development Information System (SIPD). The results of the AHP analysis can be used as a basis for determining budget priorities and assigning weights to proposed programs. SIPD serves not only as a planning administration tool but also as an instrument for disaster risk-based decision-making. Programs with the greatest contribution to drought risk reduction receive higher funding priority than those with lesser impact.
4. Bima Regency BPBD Contingency Plan (Renkon). The Renkon document is the operational instrument that most directly utilizes the results of the AHP analysis. In this document, the strategic priorities derived from the AHP analysis are used to determine the sequence of action activations at each level of emergency status. Strategy activation is carried out based on an operational threshold system that refers to BMKG data and BPBD status. Under normal conditions with a Rainless Days (HTH) threshold of <21 days, mitigation strategies that can be implemented include education and outreach, as well as preparation for drought risk mapping. When the BMKG releases a rainfall forecast of >21 days and there is a chance of rainfall <20 mm/decade, this means the state has entered Pre-Alert (Waspada) status. At the alert stage, the government begins activating risk mapping activities, promoting water conservation, and intensive monitoring of water sources. When entering the Emergency Alert stage with a rainfall forecast of >31 days in ≥2 sub-districts, all priority strategies resulting from the AHP analysis are gradually activated or put into operation.

Through this integration, the AHP results serve not only as an academic analysis tool but also as a policy instrument capable of linking regional development planning, budgeting, infrastructure development, and disaster management mechanisms. This integrated model produces a framework that links BMKG early warning data, the BPBD status system, regional development priorities, and resource allocation in an integrated manner.

The expected outputs from integrating the AHP analysis results into the Bima Regency regional development planning system include:

a. Implementation of adaptive, data-driven drought risk management that aligns with the principles of sustainable regional development.

b. Reduction in the number of villages affected by clean water crises, crop failures, and economic losses due to drought.

c. Development of Contingency Plans and Operational Plans based on the operational thresholds of the Meteorology, Climatology, and Geophysics Agency (BMKG).

d. Development of the 2026 Regional Work Plan (RKPD), the Regional Disaster Management Agency (BPBD) Strategic Plan, and the 2026–2031 Public Works and Housing (PUPR) Strategic Plan that are responsive to drought risk and risk-based.

e. Integration of drought mitigation programs into the Regional Disaster Management Information

System (SIPD) to ensure adequate budgetary support.

4. Conclusion

The results indicate that technical feasibility and effectiveness are the most influential criteria in prioritizing meteorological drought mitigation strategies in Bima Regency, with a priority weight of 31.6%. This finding highlights that the success of drought mitigation largely depends on the technical capability to implement appropriate measures under local environmental and resource constraints. The global synthesis demonstrates that both structural and non-structural mitigation approaches have relatively balanced priorities (0.160–0.178), suggesting that an integrated and adaptive strategy is essential for improving drought resilience. The recommended priority strategies are education and public awareness programs (17.8%), groundwater well drilling and water pumping systems (16.9%), rehabilitation and optimization of irrigation networks (16.7%), cross-sectoral coordination (16.3%), disaster risk mapping (16.3%), and construction of reservoirs and retention ponds (16.0%). These findings provide an evidence-based framework for prioritizing meteorological drought mitigation under budget and resource constraints. The proposed priority ranking can support local governments in integrating mitigation strategies into regional development planning and disaster risk reduction policies, thereby enhancing the effectiveness, sustainability, and resilience of meteorological drought management in Bima Regency.

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