



EFFECTIVENESS OF THE CLIMATE CHANGE ADAPTATION INTERVENTIONS OF NIA LAGUNA-RIZAL IRRIGATION MANAGEMENT OFFICE

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ABSTRACT

The National Irrigation Administration (NIA) has implemented climate change adaptation interventions such as dam strengthening and rehabilitation, canal system repair and rehabilitation, and the establishment of solar-powered irrigation pumps to address such issues. These measures aim to improve the resilience of irrigation facilities, ensure water availability and management, and sustain farmers' agricultural productivity. The study aimed to evaluate the levels and significant differences in the effectiveness of climate change adaptation interventions implemented by the National Irrigation Administration (NIA) using the identified effectiveness indicators. The findings showed that the three climate change adaptation interventions collectively improved irrigation services; however, integrating modern and advanced technologies and risk management can further strengthen the long-term sustainability, reliability, and productivity of irrigation services. The researcher recommended the continuous strengthening of the operation, maintenance, and monitoring of irrigation infrastructure by conducting periodic structural assessments and supporting farmers through capacity-building and extension programs on climate-smart agriculture, so that the benefits of improved irrigation infrastructure can translate into higher farm productivity and sustainable agricultural development.

KEYWORDS: Climate Change Adaptation, Canal System, Solar-Powered Irrigation, Agricultural Productivity, Farmer-Beneficiaries

INTRODUCTION

Climate change significantly affects the development of irrigation in the Philippines. Irrigation systems are among the most vulnerable to the effects of climate change. Climate change affects not only the efficiency of irrigation systems but also their resilience and sustainability. This has been especially true in recent years, as seen in the massive damage caused by flooding, super typhoons, and other climate change-related disasters that have damaged irrigation systems.

The National Irrigation Administration (NIA) has implemented climate change adaptation interventions such as dam strengthening and rehabilitation, canal system repair and rehabilitation, and the establishment of solar-powered irrigation pumps to address such issues. These measures aim to improve the resilience of irrigation facilities, ensure water availability and management, and sustain farmers' agricultural productivity. The study sought to evaluate the effectiveness of NIA's climate change adaptation interventions from the farmer-beneficiaries' perspective, specifically at the local irrigation-system level, particularly the Sta. Cruz River Irrigation System.

Dam Strengthening / Rehabilitation

Dams require rehabilitation primarily for two reasons: to address aging effects and to comply with newly introduced standards. Large numbers of dams worldwide were rehabilitated to meet stability criteria for floods, earthquakes, and uplift. The main areas subjected to rehabilitation include the foundation, the dam body, and structural stability (Panicker et al., 2020).

Recent studies recognize dam strengthening and rehabilitation as essential climate change adaptation measures for irrigation systems. As climate change increases the frequency and intensity of extreme rainfall, floods, and droughts, aging dam infrastructure requires continuous upgrading to maintain structural integrity, improve operational safety, and ensure a reliable water supply for agriculture (Choi et al., 2018; Quinn et al., 2017).

Likewise, Palmieri et al. (2022) emphasized that structural rehabilitation, spillway enhancement, seepage control, and other retrofit measures extend the service life of dams while increasing their resilience to climate-related hazards. Moreover, effective rehabilitation planning enables water resource agencies to minimize disaster risks, improve the reliability of irrigation systems, and sustain agricultural productivity under changing climatic conditions.

Canal System Repair and Rehabilitation

The importance of canal system repair and rehabilitation has become increasingly evident as climate change places greater pressure on agricultural water resources and irrigation infrastructure. The Food and Agriculture Organization (2021) emphasized that rehabilitating and modernizing canal systems through repair and lining minimizes conveyance losses, enhances water-use efficiency, and ensures more reliable water delivery despite growing climate variability. The United Nations Educational, Scientific and Cultural Organization. UNESCO (2020) highlighted that the rehabilitation and modernization of irrigation infrastructure are critical strategies for strengthening water security and sustaining agricultural productivity under changing climatic conditions.



Lining canals is a major component of irrigation system rehabilitation works to reduce seepage losses in irrigated agriculture. Canal lining technologies appropriate for addressing the current climate change risks and vulnerabilities of irrigation infrastructure require detailed assessment and study (Moya, 2018).

Establishment of Solar-Powered Irrigation Pumps

As investment costs for solar-powered irrigation systems (SPIS) are coming down and subsidy schemes are being rolled out, solar technologies are becoming a viable option for both large- and small-scale farmers. SPIS provides reliable, affordable energy, potentially reducing irrigation costs. The use of renewable energy in irrigation has become an increasingly important strategy for enhancing agricultural resilience under changing climatic conditions. While Hartung and Pluschke (2018) noted that solar-powered irrigation systems (SPIS) provide reliable and affordable energy for both large- and small-scale farmers by reducing dependence on diesel fuel and grid electricity, recent studies further highlight their role in climate change adaptation. According to the International Renewable Energy Agency (2022), SPIS supports sustainable agricultural production by lowering greenhouse gas emissions, reducing irrigation costs, and improving farmers' access to reliable energy for water pumping.

Similarly, the Food and Agriculture Organization (2022) emphasized that integrating solar energy into irrigation systems enhances water and energy efficiency while increasing farmers' resilience to climate variability, particularly in areas with limited access to conventional energy sources. These findings suggest that establishing solar-powered irrigation pumps not only promotes environmentally sustainable irrigation practices but also strengthens farmers' capacity to cope with the challenges posed by climate change.

Resilience of Irrigation Facilities

The resilience of irrigation facilities is a key indicator of the effectiveness of climate change adaptation interventions because it reflects the ability of irrigation infrastructure to withstand, adapt to, and recover from climate-related hazards while continuing to provide reliable irrigation services. According to the Food and Agriculture Organization (2021), climate-resilient irrigation systems are designed to maintain functionality despite the increasing occurrence of floods, droughts, and extreme weather events through infrastructure improvements, efficient operation, and proper maintenance. Likewise, the Intergovernmental Panel on Climate Change (2022) emphasized that strengthening the resilience of water infrastructure is essential for reducing climate risks, sustaining agricultural production, and ensuring long-term water security in vulnerable regions.

Water Availability and Management

Effective water availability and management are fundamental indicators of the success of climate change adaptation interventions, as they ensure that irrigation systems can continue supplying adequate water despite increasing climate variability.

The Intergovernmental Panel on Climate Change emphasizes that climate change is altering hydrological cycles, making efficient water management essential for reducing water-related risks and sustaining agricultural production. Furthermore, Lanie A. Alejo et al. (2021) found that climate change significantly affects irrigation diversion water requirements in the Philippines, demonstrating the need for adaptive irrigation planning and improved water management to maintain reliable irrigation services under changing climatic conditions.

Agricultural Productivity

Agricultural productivity is a widely recognized indicator of the effectiveness of climate change adaptation interventions because it reflects the ability of irrigation systems to sustain or enhance crop production despite climate-related challenges. Ariel Ortiz-Bobea et al. (2021) reported that climate change has substantially reduced global agricultural productivity, highlighting the importance of adaptation measures that strengthen the resilience of farming systems.

In the Philippine context, Delos Reyes et al. (2020) demonstrated that improvements in irrigation infrastructure and management enhance irrigation performance and support farm productivity, provided that modernization is accompanied by effective participation of irrigators' associations and sound water management practices.

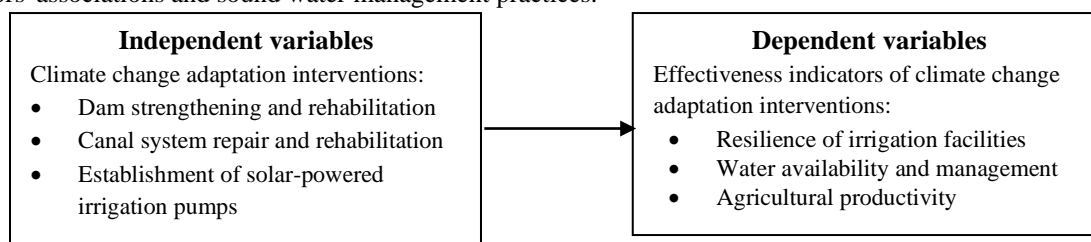


Figure 1. Paradigm of the Study



In this study, the adaptation interventions implemented by the National Irrigation Administration served as the independent variables. These interventions included dam strengthening and rehabilitation, canal system repair and rehabilitation, and the establishment of solar-powered irrigation pumps. These measures were introduced to address the growing challenges brought about by climate change, particularly those affecting irrigation systems and agricultural activities. The study's dependent variables focused on the effectiveness of these interventions in terms of the resilience of irrigation facilities, water availability and management, and agricultural productivity. The framework assumes that improving and modernizing irrigation infrastructure can provide a more reliable water supply, strengthen irrigation facilities against climate-related risks, and support better crop production for farmers.

The directional relationship between the variables suggests that implementing climate change adaptation interventions may improve irrigation system performance and agricultural outcomes. Through this framework, the study sought to determine whether these interventions are effective in helping farming communities adapt to climate-related challenges and support sustainable agricultural development.

Statement of the Problem

The main purpose of the study was to evaluate the effectiveness of the climate change adaptation interventions implemented by the National Irrigation Administration (NIA). Specifically, it sought to answer the following questions:

1. What is the level of effectiveness of the adaptation interventions in terms of:
 - a. Resilience of irrigation systems and facilities;
 - b. Water availability and management; and
 - c. Agricultural productivity?
2. What is the overall effectiveness of each climate change adaptation intervention based on its average mean score?
3. Is there a significant difference in the effectiveness among the different types of climate change adaptation interventions?

METHODOLOGY

Design

The study employed a quantitative research design, specifically a descriptive-comparative research design, to evaluate the effectiveness of the climate change adaptation interventions implemented by NIA. The study sought to quantify the effectiveness of the different interventions and their influence on the resilience of irrigation systems and facilities, water availability and management, and agricultural productivity, and to determine whether significant differences exist in their effectiveness. This design enabled systematic measurement, objective analysis, and statistical comparison, making it suitable for evaluating the effectiveness of the climate change adaptation interventions and generating evidence-based conclusions for policy and program improvement.

Respondents of the Study

The study used purposive sampling, a non-probability sampling technique in which participants are selected based on specific criteria relevant to the research objectives. Purposive sampling was used to focus on individuals with specific characteristics who were better able to contribute relevant information to the study (Etikan et al., 2016). The respondents consisted of 100 farmer-beneficiaries from Sta. Cruz River Irrigation System, which has directly experienced NIA interventions. Selecting only farmers who had been exposed to all interventions ensured that the effectiveness of each measure could be accurately assessed based on information and firsthand experience.

Data Gathering Procedures

The study employed a researcher-made survey questionnaire to gather the necessary data. The questionnaire was divided into two parts. For the first part, the respondents identified climate change adaptation interventions in their area that directly affected their daily farming activities. The second part was composed of forty-five (45) statements that measured the perceived effectiveness of the interventions based on the personal experiences of the respondents. Each item was measured using a four-point Likert Scale ranging from "Strongly Disagree (1)" to "Strongly Agree (4)".

Cronbach's alpha was used to assess the reliability and internal consistency of the study questionnaires. An alpha coefficient of 0.70 or higher was considered acceptable. The results showed an overall Cronbach's alpha value ranging from 0.867 to 0.969, indicating that the questionnaire is reliable and suitable for data collection from the targeted respondents.

Data Analysis

The data gathered from the respondents through the questionnaire were analyzed using appropriate descriptive and inferential statistical tools with the aid of SPSS software.

To assess the effectiveness of the interventions in terms of resilience, water availability and management, and agricultural productivity, the mean and standard deviation were used as descriptive statistics. The mean was used to determine the perceived level



of effectiveness for each indicator, and the standard deviation indicated the consistency of respondents' ratings across all variables. These measures provided a quantitative basis for interpreting the extent to which the interventions meet their intended outcomes.

The second statement of the problem assessed the overall effectiveness of each intervention based on its mean score. The overall average mean score for each climate change adaptation intervention was calculated by averaging the three indicator mean scores. The resulting values for the first and second statements of the problem were interpreted using the established four-point Likert scale: 3.26-4.00 (Strongly Agree/Highly Effective), 2.51-3.25 (Agree/Effective), 1.76-2.50 (Disagree/Slightly Effective), and 1.00-1.75 (Strongly Disagree/Not Effective).

The Kruskal–Wallis H-test was employed to determine whether significant differences existed in the respondents' assessment of the effectiveness of the different types of climate change adaptation interventions. This test served as the nonparametric equivalent of Analysis of Variance (ANOVA) because the data did not meet the assumption of normality. An alpha level of 0.05 was set as the criterion for statistical significance in all analyses conducted.

RESULTS AND DISCUSSIONS

Analysis of the Differences in the Effectiveness of Different Types of Climate Change Adaptation Interventions

The Kruskal–Wallis H-test was employed to determine whether significant differences existed in the respondents' assessment of the effectiveness of the different types of climate change adaptation interventions.

Table 1 presents the analysis of differences in respondents' assessments of the effectiveness of different types of climate change adaptation interventions in terms of the resilience of irrigation systems and facilities.

Table 1

Analysis of Differences in the Effectiveness of Different Types of Climate Change Adaptation Interventions in terms of Resilience of Irrigation Systems and Facilities

Climate Change Adaptation Interventions	Outcome	H-value	p-value	Interpretation*
Dam Strengthening and Rehabilitation Canal System Repair and Rehabilitation Establishment of Solar-powered Irrigation Pumps	Resilience of Irrigation Systems and Facilities	0.740	0.691	Not Significant

*significant at the 0.05 level of significance

The p-value of **0.691** is greater than the 0.05 level of significance, indicating that there is no significant difference in the respondents' assessment of the effectiveness of the different climate change adaptation interventions in terms of the resilience of irrigation systems and facilities. This implies that the three interventions, namely dam strengthening and rehabilitation, canal system repair and rehabilitation, and the establishment of solar-powered irrigation pumps, are perceived to contribute similarly and effectively to enhancing the durability, stability, and overall resilience of irrigation systems against climate-related challenges.

Table 2 presents the analysis of differences in respondents' assessments of the effectiveness of different types of climate change adaptation interventions in terms of water availability and management.

Table 2

Analysis of Differences in the Effectiveness of Different Types of Climate Change Adaptation Interventions in terms of Water Availability and Management

Climate Change Adaptation Interventions	Outcome	H-value	p-value	Interpretation*
Dam Strengthening and Rehabilitation Canal System Repair and Rehabilitation Establishment of Solar-powered Irrigation Pumps	Water Availability and Management	3.803	0.149	Not Significant

*significant at the 0.05 level of significance



The p-value of 0.149 is greater than the 0.05 significance level, indicating no significant difference in respondents' assessments of the effectiveness of different types of climate change adaptation interventions for water availability and management. This implies that the interventions, including dam strengthening and rehabilitation, canal system repair and rehabilitation, and the establishment of solar-powered irrigation pumps, are perceived to be equally effective in ensuring a reliable water supply, improving distribution efficiency, and supporting sustainable water management practices across agricultural areas.

Table 3 presents the analysis of differences in respondents' assessments of the effectiveness of different types of climate change adaptation interventions in terms of agricultural productivity.

Table 3

Analysis of Differences in the Effectiveness of Different Types of Climate Change Adaptation Interventions in terms of Agricultural Productivity

Climate Change Adaptation Interventions	Outcome	H-value	p-value	Interpretation*
Dam Strengthening and Rehabilitation Canal System Repair and Rehabilitation Establishment of Solar-powered Irrigation Pumps	Agricultural Productivity	2.136	0.344	Not Significant

*significant at the 0.05 level of significance

The p-value of 0.344 is greater than the 0.05 significance level, indicating no significant difference in respondents' assessments of the effectiveness of different types of climate change adaptation interventions for agricultural productivity. This implies that the interventions, namely dam strengthening and rehabilitation, canal system repair and rehabilitation, and the establishment of solar-powered irrigation pumps, are perceived to be equally effective in enhancing crop production, improving irrigation reliability, and supporting the overall productivity of farmlands.

Overall, the results of the Kruskal–Wallis H-test revealed that there were no significant differences in the respondents' assessment of the effectiveness of the three climate change adaptation interventions in terms of resilience of irrigation systems and facilities (H = 0.740, p = 0.691), water availability and management (H = 3.803, p = 0.149), and agricultural productivity (H = 2.136, p = 0.344). Since all computed p-values were greater than the 0.05 significance level, the study failed to reject the null hypothesis, indicating that the respondents perceived Dam Strengthening and Rehabilitation, Canal System Repair and Rehabilitation, and the Establishment of Solar-Powered Irrigation Pumps as equally effective in achieving the intended climate change adaptation outcomes.

These findings suggest that the three interventions complement one another to enhance irrigation system resilience, improve water availability and management, and support agricultural productivity. Rather than one intervention being significantly more effective than the others, the results indicate that each intervention contributes a distinct but equally important role in strengthening the adaptive capacity and sustainability of irrigation systems under changing climatic conditions.

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AI Declaration

The researchers used Grammarly Pro as an AI-assisted language editing tool during the preparation of this manuscript. Its use was limited to correcting grammatical errors, improving sentence structures, and enhancing readability. The conceptualization of the study, data collection, interpretation of findings, and writing of the substantive content were performed by the researchers. All AI-generated suggestions were critically reviewed before incorporation into the final document.